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RECENT TRENDS IN NOVEL DRUG DELIVERY SYSTEM

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Abstract: Novel technology had been developed recently for drug delivery systems. Drug delivery is the method of administering the drug or pharmaceutical product, in an effort to acquire favored therapeutic impact. The technique with the aid of using which drug introduced is important, because it has massive impact on its efficacy. Novel drug delivery systems can consist of those based on physical mechanisms and those based on biochemical mechanisms. Physical mechanisms additionally referred as controlled drug delivery systems consist of osmosis, diffusion, erosion, dissolution and electro transport. Novel drug delivery technology have received the significance to acquire modified delivery of drugs there with the aid of using increasing the therapeutic value in addition to decreasing toxicity. In the form of a Novel Drug Delivery System a present drug molecule can get a new life. An accurately designed Novel Drug Delivery System may be a main enhance for fixing the troubles associated toward the release of the drug at particular site with particular rate. But now days with the development with inside the technology, novel drug delivery systems (NDDS) open the door toward the improvement of natural novel drug delivery system. This article covers the basic information regarding Novel Drug Delivery Systems.

Key words: phytosome, liposome, nanoparticles, niosome

INTRODUCTION:

Drug delivery is the technique of administering the drug or pharmaceutical product, in order to obtain desired therapeutic impact. The technique with the aid of using which drug introduced is important, because it has tremendous impact on its efficacy. Novel drug delivery system includes numerous approaches like clinical gadgets or drug-tool aggregate products. Novel drug delivery system (NDDS) includes combining polymer science, pharmaceutics and molecular biology.[1,2]

Novel drug delivery systems can consist of those primarily based totally on physical mechanisms and those based on biochemical mechanisms. Physical mechanisms additionally referred as managed drug delivery systems consist of osmosis, diffusion, erosion, dissolution and electro transport. Biochemical mechanisms consist of monoclonal antibodies, gene therapy, and vector systems, polymer drug adducts and liposomes.[3,4] NDDS drugs are designed to goal the site precise region, in an effort to achieve preferred therapeutic impact, thereby decreasing the side or poisonous effects.[5]

Novel drug delivery system tries to remove all of the disadvantages related to conventional drug delivery systems. There are numerous approaches with the aid of using which novel drug delivery may be achieved.[6,7]

Advantages of novel drug delivery system

1. protection from toxicity.
2. Enhancement of pharmacological activity.
3. Enhancement of stability.
4. Improving tissue macrophages distribution.
5. Sustained delivery.
6. Protection from physical and chemical degradation.
7. Reduce side effect.
8. Rapid onset of action.
9. Increased bioavailability.[8,9]

Recent developments in novel drug delivery system

1. Phytosome
2. Liposome
3. Nanoparticles
4. Nanoemulsions
5. Microsphere
6. Ethosome
7. Niosomes
8. Proniosomes[11]

1. Phytosome:

Phytosomes are phospholipids-primarily based totally drug delivery system has been determined promising for natural drug delivery.[10] Complexing the polyphenolic phytoconstituents withinside the molar ratio with phosphatidyl choline consequences in a new natural drug delivery system, recognized as "Phytosome".[12] The phytosome offer an envelope, like coating across the active constituent of drug and because of this the leader constituent of natural extract stays secure from degradation through digestive secretion and bacteria. Phytosome is correctly capable of absorb from a water loving environment into lipid loving environment of the cell membrane and finally achieving to blood circulation.[21]It may be used withinside the treatment of various fatal diseases with out denaturing the active phytocompounds and improved bioavailability. Phytosomesshowbetter pharmacokinetic and therapeutic profiles than conventional herbal extracts.[14]

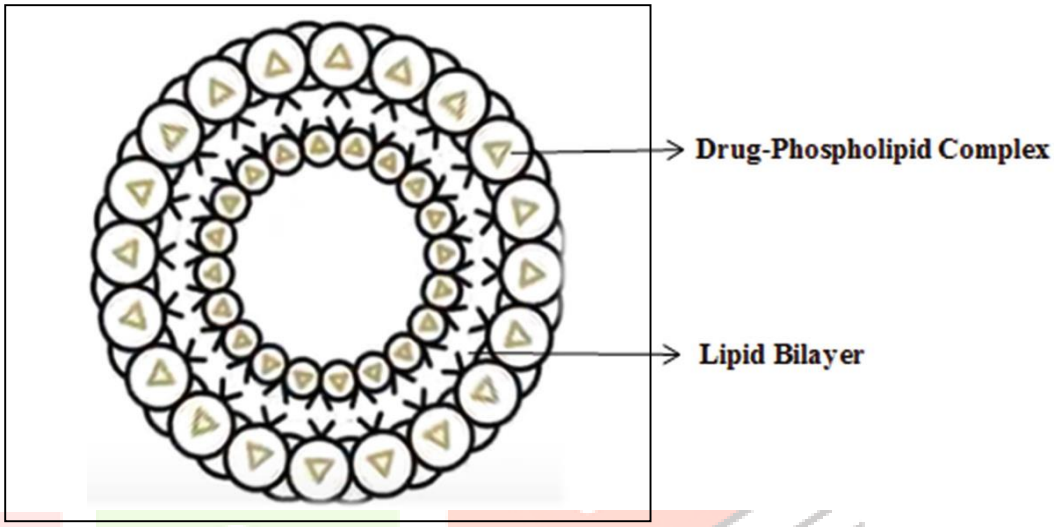

Fig no.01. structure of phytosomes

1.1 Properties of phytosome

1. Chemical properties

   A phytosomes is a complex between a natural product and natural phospholipids, like soya phospholipids. Such a complex consequences from the response of stoichiometric quantities of phospholipid with the chosen polyphenol (like easy flavonoids) in a nonpolar solvent.[15] During the interaction there arise formation of hydrogen bonds between the polar groups of phospholipids and polarportion of the substrate molecule. [16,17]
2. Biological properties

   Pharmacokinetic and pharmacodynamic research in experimental animalsand in human topics have beenused to illustrate the biological behaviour of phytosomes.[18]

1.2 Advantages of phytosomes

1. It enhances the absorption of lipid insoluble polar phytoconstituents via oral as well as topical path showing higher bioavailability, therefore significantly more therapeutic benefit.
2. Appreciable drug entrapment.
3. As the absorption of active constituent is improved, its dose requirement is also reduced.
4. Phosphatidylcholine utilized in preparation of phytosomes, except appearing as a provider also acts as a hepatoprotective, therefore giving the synergistic impact while hepatoprotective materials are employed.
5. Chemical bonds are formed between phosphatidylcholine molecule and phytoconstituent, so the phytosomes show higher stability profile.[39,40]

1.3 Method of Preparation

General method of preparation of phytosome involves following steps:
Phospholipids and substrate is mixed in the suitable ratio (preferably 1:1) withinside the presence of aprotic solvent (example-dioxane and acetone).Isolation of the complex is achieved by precipitation method. Precipitation may be done with the aid of using any of the following :

1. Lyophilization
2. Aliphatic hydrocarbons
3. Spray drying method.
4. Drying of phytosomes
5. Hydration of prepared phytosomes to obtain phytosomalsuspension.[19]

Phytosomes are usually prepared with the aid of using including accurate amount of phospholipid,i.e., Soya lecithinwithherbal extracts in an aprotic solvent. Soya lecithin includes major constituent, i.e., Phosphatidylcholine that is having a twin function. Phosphatidyl part is lipophilic in nature and choline part is hydrophilic in nature. The choline part connected with hydrophilic leader active constituents, while phosphatidyl part lipid soluble compound connected with choline sure complex.It consequences withinside the formation of lipid complex with higher stability and bioavailability.[51]

2. Liposomes:

Liposomes are defined as shape consisting of one or greater concentric spheres of lipid bilayers separated by water or aqueous buffer compartments. Phospholipids are the main component of naturally occurring bilayers. These phospholipids include phosphatidylcholines (PC), phosphatidylethanolamines (PE) and phosphatidylserines (PS).[20] Liposomes are composed of small vesicles of phospholipids encapsulating an aqueous space ranging from approximately 0.03 to 10 µm in diameter. Consisting of one or more concentric spheres of lipid bilayers enclosing aqueous compartments. Liposomes had been attracting growing attention as a drug provider for drug delivery systems due to the fact they could convey each hydrophilic compounds and lipophilic compounds.[13]

Liposomes are significantly used as carriers for numerous molecules in cosmetic and pharmaceutical industries. Additionally, meals and farming industries have significantly studied using liposome encapsulation to develop delivery systems that may entrap volatile compounds (for example, antimicrobials, antioxidants, flavors and bioactive elements) and defend their functionality. Liposomes can trap each hydrophobic and hydrophilic compounds, keep away from decomposition of the entrapped combinations, and release the entrapped at special targets .[25,26]

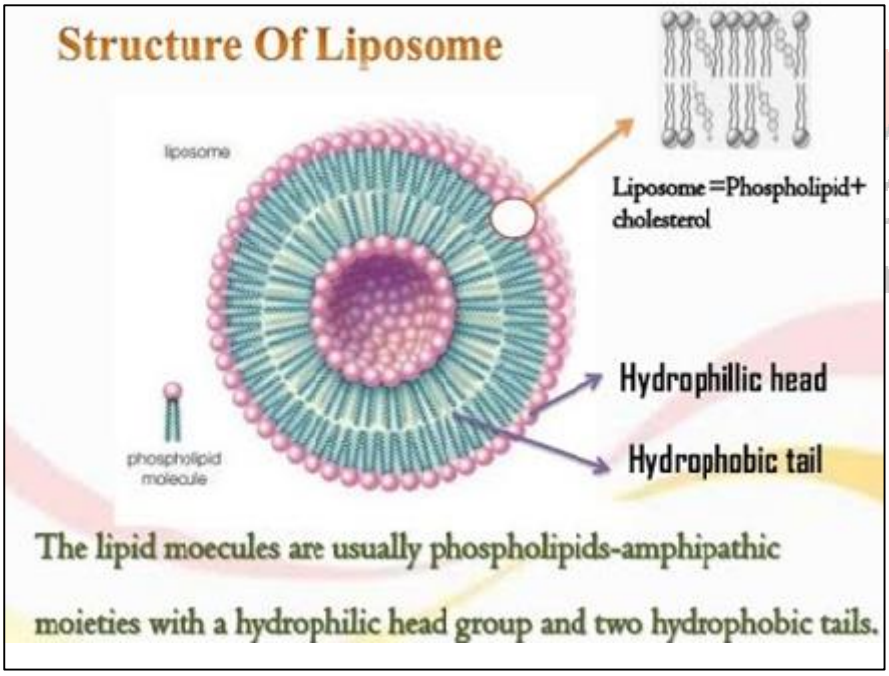

Fig no.02 Internal structure of liposome

2.1 Advantages of Liposomes [22, 23, 24]

1. Encapsulate each hydrophilic as well as lipophillic drug molecule.
2. Good solubilisation power.
3. Exhibit excellent colloidal, chemical and organic stability.
4. Reduce their uptake through macrophages.
5. Enhancing the therapeutic effectiveness of encapsulated drug.
6. Maintain therapeutic drug level into blood stream.
7. Provide safety of drug from environmental factors.
8. Promote the intracellular delivery of drug molecules.

2.2 Properties of liposomes

1. The system consists of structures of bimolecular sheets intercalated by aqueous space.
2. They are permeable to water.
3. They are osmotically sensitive.
4. Positively charged membranes are impermeable to cations and negative are highly permeable to anions.[27,41]

2.3 Method of liposome preparation

1. Sonication
2. Freeze-thawed liposomes
3. French Pressure cell liposome
4. Solvent Dispersion Method

Sonication

There are two sonication techniques:

1. Probe sonication: The tip of a sonicator is without delay engrossed into the liposome dispersion. The energy enter into lipid dispersion could be very excessive on this method. The coupling of energy on the tip results in nearby hotness; therefore, the vessel have to be engrossed into a water/ice bath. Throughout the sonication up to 1 h, greater than 5% of the lipids may be de-esterified. Also, with the probe sonicator, titanium will slough off and pollute the solution.[43]

2. Bath sonication: The liposome dispersion in a cylinder is positioned into a bath sonicator. Controlling the temperature of the lipid dispersion is generally less complicated in this method, in assessment to sonication with the aid of using dispersal directly the usage of the tip. The material being sonicated may be covered in a sterile vessel, dissimilar the probe units, or under an inert atmosphere. [42]

Freeze thaw method

The method is primarily based totally upon freezing of a unilamellar dispersion after which thawing by standing at room temperature for 15 min and subsequently subjecting to short sonication cycle. Thus the method rupture and fuses SUVs (Small unilamellar liposome vesicles) during which the solute equilibrates among inside and outside and the liposome themselves fuse and increase markedly in size.[44]

French pressure cell extrusion

French pressure cell includes the extrusion of MLV (multilamellar vesicle) through a small orifice.[33] An crucial function of the French press vesicle method is that the proteins do now no longer appear to be signifi-cantly pretentious during the technique as they're in sonication.[45] An exciting comment is that French press vesicle appears to recall entrapped solutes signifi-cantly longer than SUVs do, produced by sonication or detergent removal.[46]

3. Nanoparticles

Nanoparticles are described as particulate dispersions or solid particles with a length in the range of 10-1000nm.The drug dissolved, entrapped, encapsulated or connected to nanoparticles matrix. Nanoparticles (consisting of nanospheres and nanocapsules of size 10-200 nm) are withinside the solid state and are both amorphous or crystalline . Polymeric substances have been significantly used for the preparation of nanoparticles. Depending upon the method of preparation, nanoparticles, nanospheres or nanocapsules may be obtained. Nanocapsules are systems wherein the drug is confined to a hollow space surrounded by a completely unique polymer membrane, even as nanospheres are matrix systems wherein the drug is physically and uniformly dispersed. In current years, biodegradable polymeric nanoparticles, in particular those covered with hydrophilic polymer including poly (ethylene glycol) (PEG) called long-circulating debris, were used as cappotential drug delivery devices due to their ability to flow into for a extended duration time target a selected organ, as carrier of DNA in gene therapy, and their ability to supply proteins, peptides and genes.[28,29]

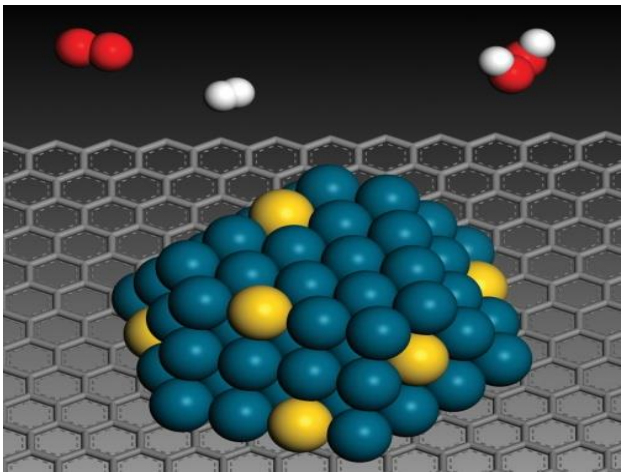

Fig no.03 structure of nanoparticles

3.1 Advantages of nanoparticles

1. They are biodegradable, non- toxic, site precise and able to being saved for as a minimum one year.
2. They provide managed rate of drug release and particle degradation characteristics that may be comfortably modulated with the aid of using the selection of matrix constituents.(28)
3. They provide higher therapeutic effectiveness and usual pharmacological response/unit dose.
4. Nanoparticles will increase balance of drug/proteins against enzymatic degradation.(57)
5. They are able to concentrated on a drug to a particular site withinside the body by attaching targeted ligands to surface of particles.
6. Drug loading is excessive and drugs may be integrated into the systems with none chemical reaction; that is an essential issue for keeping the drug activity.(58)

3.2 Properties of nanoparticles (47)

1. The excessive surface region to extent ratio of nanoparticles offers a tremendous using pressure for diffusion, specially at increased temperatures. Sintering can take place at lower temperatures, over shorter time scales than for large particles.
2. Nanoparticles also regularly own unexpected optical properties as they're small sufficient to restrict their electrons and convey quantum effects. For example, gold nanoparticles seem deep red to black in solution.
3. Suspensions of nanoparticles are feasible because the interaction of the particle surface with the solvent is powerful enough to overcome density differences, which in any other case typically bring about a material both sinking or floating in a liquid.
4. Nanoparticles with one-half hydrophilic and the other half hydrophobic are termed Janus particles and are specifically powerful for stabilizing emulsions.

3.3 Preparation of nanoparticles

Polymerization method

In this technique, polymerization of monomers is performed in an aqueous solution and after polymerization completed, drug is integrated both by adsorption onto the nanoparticles or by being dissolved withinside the polymerization medium. To eliminate numerous stabilizers and surfactants, employed for polymerization by extremely centrifugation the nanoparticle suspension is then purified and in an isotonic surfactant-unfastened medium re-suspending the particles. For making polybutyl cyanoacrylate or poly (alkylcyano acrylate) nanoparticles, this method has been reported.Formation of nanocapsule and their particle size stricken by the surfactants and stabilizers concentration used.(48)

High-pressure homogenization method

In this technique, the lipid is driven with excessive pressure (100–2000 bar) via a completely excessive shear stress, which leads to disruption of particles right all the way down to the submicrometer range. High-pressure homogenization technique is a completely dependable and effective method for the large-scale manufacturing of nanostructured lipid carriers, lipid drug conjugate, solid lipid nanoparticles (SLNs), and parenteral emulsions.(49,50)

4. Niosomes:

Niosomes are multilameller vesicular shape of non-ionic surfactants, just like liposomes and are composed of non-ionic surfactant rather than phospholipids that are the additives of liposomes.(30,38) Niosome or non-ionic surfactant vesicles at the moment are extensively studied as an opportunity tool to liposome. Various styles of surfactants were stated to form vesicles, and feature the potential to entrap and maintain the hydrophilic and hydrophobic solute particles.(30,31)

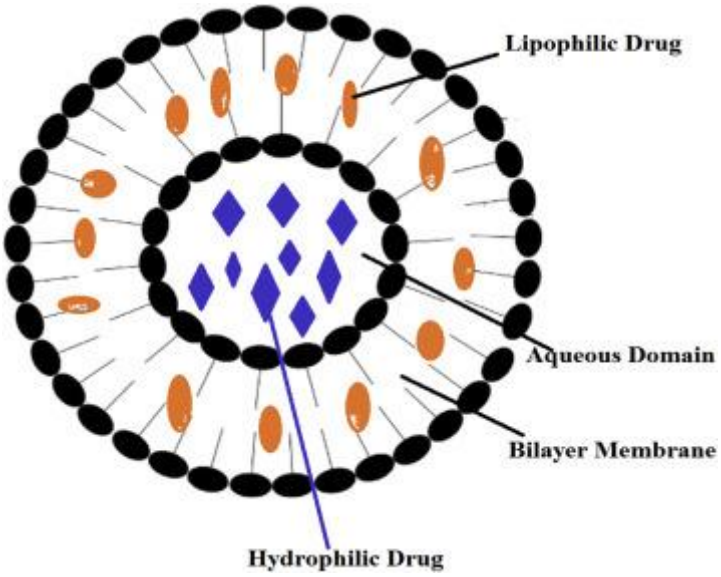

Fig no.04 structure of noisome

4.1 Advantages of niosomes

1. Niosomes have better patient compliance and higher therapeutic impact than conventional oily formulations.
2. Niosomes may be utilized withinside the delivery of huge range of medicine because it has functionality to entrap hydrophilic, lipophilic as well as amphiphilic drugs.[35]
3. Niosomes show managed and sustained release of medicine because of depot formation.
4. Shape, size, composition, fluidity of niosomes drug may be controlled as and while required.
5. Niosomes show a more bioavailability than conventional dosage forms.
6. Niosomes were efficiently utilized in concentrated on drugs to numerous organs.
7. Niosomes are more stable than liposomes.[34]
8. Niosomes can increase the permeation of drugs via the skin.[32]

4.2 Method of Preparation

Method of preparations can also have an effect on the niosomal properties. Different kind of techniques like ether injection, hand shaking; sonication etc.[37] The common size of acyclovir niosomes prepared with the aid of using hand-shaking technique became larger (2.7m m) compared to the common size of niosomes 1.5m m prepared by ether injection technique which can be attributed to the passage of cholesterol and span-80 solution through an orifice into the drug solution.[36]

Reverse phase evaporation may be used to supply smaller size vesicles. Vesicles with smaller size and more stability may be produced by micro fluidization technique. Niosomes acquired by transmembrane pH gradient (inner acidic) drug uptake method confirmed more entrapment performance and higher retention of drug.[39]

5. Nanoemulsions

Nanoemulsions are a colloidal particulate system withinside the submicron size range appearing as providers of drug molecules. Their size varies from 10 to 1,000 nm. These providers are stable spheres and their surface is amorphous and lipophilic with a negative charge. Magnetic nanoparticles may be used to enhance site specificity. As a drug transport system they enhance the therapeutic efficacy of the drug and decrease adverse impact and poisonous reactions. Major utility consists of remedy of infection of the reticuloendothelial system (RES), enzyme substitute remedy withinside the liver, treatment of cancer, and vaccination.[56] Emulsions, also known as asmacroemulsions, are normally defined as immiscible phases dispersed inside another.[54]There are primary variations between conventional emulsions and nanoemulsions which ends up from size and shape of the particles withinside the continuous phase. Firstly, particle sizes in nanoemulsions (5-200 nm) are very smaller than conventional emulsions (0.1-100 μm).[55]

5.1 Advantages of Nanoemulsion

1. Provides aqueous dosage form for water insoluble drugs.
2. Eliminates variability in absorption. [52]
3. Increases bioavailability.
4. They do not show the troubles of inherent creaming, flocculation, coalescence and sedimentation.
5. Increase the rate of absorption.
6. Helps in solubilizing lipophilic drug.[53]

5.2 Preparation of nanoemulsions

Microfluidization

Microfluidization is a blending technique, which uses a tool known as microfluidizer. This device makes use of a high-strain fine displacement pump (500-20000psi), which forces the product via the interaction chamber, which includes small channels known as 'microchannels' The coarse emulsion is right into a microfluidizer wherein it's miles similarly processed to gain a stable nanoemulsion. The coarse emulsion is exceeded through the interaction chamber microfluidizer repeatedly till preferred particle size is obtained. The bulk emulsion is then filtered via a clear out out under nitrogen to eliminate massive droplets ensuing in a uniform nanoemulsion.[59,60]

6. Conclusion

Novel Drug delivery System (NDDS) NDDS can be a mixture of improve method and new indefinite quantity forms that area unit a great deal better than preferred dosage forms. Advantages of Novel Drug Delivery System are: Optimum dose at the best time and proper location, affordable use of expensive drugs, excipients and discount in cost, useful to patients, better clinical aid, stepped forward consolation and commonplace of living.

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