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Comprehensive Review on Vesicular Drug Delivery Systems

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ABSTRACT

Vesicular drug delivery system is a promising drug delivery system for the targeting of BCS class 2 & 4 drugs. It is superior to other drug delivery systems because of the high bioavailability, efficacy, & ease of preparation. Additionally, it was noted that because vesicular systems' lipidic components can penetrate and change the stratum corneum's intercellular lipid matrix, they can increase the penetration of medications into the layer. Although traditional vesicular systems like liposomes and niosomes have been around for a while, their limited physical stability causes problems including drug fusion, aggregation, and leakage. It was discovered that the transdermal drug delivery method was a useful means of resolving issues with traditional oral dose forms, including low bioavailability, frequent high dosage, and untargeted drug activity. However, the stratum corneum functions as a strong barrier that lowers drug permeability and, thus, the bioavailability of big molecules and hydrophilic medications. Recent years have seen the development of novel, adaptable non-ionic surfactant-based vesicles, such as niosomes, proniosomes, transferosomes, pharmacosomes, etc., enabling effective medication delivery via the skin.

INTRODUCTION

Vesicles are colloidal carriers made of one or more concentric lipid bilayers surrounded by an aqueous phase and certain amphiphilic substances, such as phospholipids or surfactants. Drugs that are lipophilic or hydrophilic can be trapped by vesicles in the lipid bilayer or the aqueous compartment. They can lower the concentration of medications at other sites in the body by delivering them to the intended site of action, which lowers the risk of drug toxicity. Additionally, the duration of medicines in systemic circulation is extended by their trapping in vesicles. Additionally, it was noted that because vesicular systems' lipidic components can penetrate and change the stratum corneum's intercellular lipid matrix, they can increase the penetration of medications into the layer. Although traditional vesicular systems like liposomes and niosomes have been around for a while, their limited physical stability causes problems including drug fusion, aggregation, and leakage. In order to get around this problem, a number of new vesicular systems have been effectively deployed to transport medications for the treatment of disease.[1-5]

Advantages of Vesicular Systems

- Effective way to administer medication straight to the illness site
- Decreases drug toxicity without causing side effects
- Lowers therapy costs due to increased medication bioavailability ncorporate both hydrophilic and lipophilic drugs
- Act as mechanisms for sustained release
- Delay the removal of medications that are quickly metabolized.
- Addresses the issues of fast degradation, instability, and insolubility of drugs.[1-5]

REVIEW SECTION

Liposomes

Liposomes, also known as lipid bodies, are spherical, tiny vesicles with a diameter ranging from 25 nm to 10,000 nm that are made up of one or more concentric lipid bilayers divided by water or aqueous buffer compartments. Liposomes are formed when phospholipid molecules self-assemble in an aqueous medium. In general terms, they consist of one or more amphiphilic phospholipid bilayer membranes, also known as phospholipid vesicles, which have the ability to capture both hydrophilic and hydrophobic medications. Hydrophilic medications are confined within the aqueous core of liposomes, whereas hydrophobic compounds might be retained within the phospholipid membrane of the liposome wall. Liposomes are made up of several different substances, the two primary ones being cholesterol and phospholipids. Phospholipids such as phosphatidylcholines (PC), phosphatidylethanolamines (PE), and phosphatidylserines (PS) are utilized in the production of liposomes. Moreover, liposomes can be made using sterols, glycolipids, phospholipids, and sphingolipids. Targeted therapy and modified drug pharmacokinetics are made possible by these vesicles.[1-3]

Niosomes

A non-phospholipid vesicular substitute for liposomes is called a niosome. Niosomes are unilamellar or multilamellar vesicular systems that are osmotically stable and are produced when synthetic non-ionic surfactants are hydrated. The discovery of niosomes was prompted by the success of liposomal systems and the hunt for additional vesicle-forming amphiphiles. Since many surfactants have been found to self-assemble into closed bilayer vesicles that are employed for drug delivery, non-ionic surfactants were among the first alternative materials explored.[2]

Proniosomes

Proniosomes are free-fowing vesicular carriers covered with a dry surfactant. Compared to traditional niosomes, they are easier to handle and store, more consistent in size, and more stable. Proniosomes are able to overcome physical obstacles such drug hydrolysis and leakage, as well as aggregation, sedimentation, and fusion when stored. They can also accept medicinal molecules with varying solubilities. [1,2,6,7]

Transferosomes

Cevc et al. introduced transferosomes, which are biocompatible and biodegradable vesicular carriers, in the mid-1990s. They consist of edge activator and phospholipids. The ultra-deformable properties of transferosomes, known as self-optimizing deformability, are attributed to the presence of an edge activator in their structure. This extra characteristic enables the transferosomes to alter their fexibility and naturally flow through the extremely tiny pores in the skin. Transferosomes are hence the primary delivery system for topical and transdermal applications. Transferosomes do, however, have certain drawbacks, including low natural phospholipid purity, high production costs, and a small amount of chemical instability.[8]

Pharmacosomes

The pharmacosome technique has the potential to overcome the constraints of both liposomes and transferosomes. These are described as colloidal dispersions of pharmaceuticals that are covalently bonded to lipids. Depending on the chemical nature of the drug-lipid combination, these can exist as extremely fine vesicular, micellar, or hexagonal aggregates. The pharmacosomes strategy can circumvent many of the drawbacks of several traditional vesicular drug delivery systems, including issues with drug integration, leakage from the carrier, and inadequate shelf life**.**

The interaction between the drug and lipids in bulk and surface form the basis for the creation of the vesicular pharmacosome. With or without a spacer chain, any medication having an active hydrogen atom (-COOH, -OH, -NH2, etc.) can be esterified to the lipid. Such a molecule's synthesis may be directed in a way that substantially produces an amphiphilic compound, which will aid in the organism's ability to transfer membranes, tissues, or cell walls**.**[3,8]

Enzymosomes

Enzymosomes are covalently fixed or linked to the surface of liposomes in a liposomal construct designed to create a miniature bioenvironment. Employed to specifically distribute to tumor cells.[8]

Ufasomes

Long chain fatty acids (oleic and linoleic acid) were used to create the vesicles encased in fatty acids by mechanically agitating evaporated films in the presence of buffer solutions. utilized to target drugs via ligands was known as ufasomes.[8]

Emulsomes

In order to incorporate water-insoluble medications in a solution form without the need for a surface active agent or co-solvent, nanosize lipid particles, also known as bioadhesive nano emulsions, are made up of tiny lipid assemblies with polar cores. Dispersed in an aqueous phase are these fat-cored lipid particles. Particularly for parenteral administration of weakly water soluble medicines, emulsomes represent lipid-based drug delivery devices with a broad variety of therapeutic applications.[8]

Discosomes

Niosomes were dissolved in a non-ionic surfactant solution (Solulan C24, a polyoxyethylene cetyl ether class). Water-soluble solutes can be ensnared by huge (12–60 μm) structures called discosomes. used in medication targeting by ligand mediation.[8]

Nano erythrosomes

Red blood cells have several uses in controlled medication delivery systems as drug carriers. They are employed in both site-directed and sustained-release systems and their release rate from erythrosomes, lifespan, and physical properties are easily adjusted to change the delivery mechanism. Liposomal systems containing chemically crosslinked human erythrocytes with cytoskeletons coated with a lipid bilayer as a support. utilized to effectively target macromolecular medications. By extruding erythrocyte ghouls a drug carrier based on erythrocytes called "Nano erythrosomes" with an average diameter of 100 nm is created. Oxygen carriers have been made from artificial red blood cells by encasing hemoglobin by interfacial polymerization.[8]

Vesosomes

In vitro nested bilayer compartments developed by adding ethanol to several types of saturated phospholipids, or the "interdigitated" bilayer phase. Application: The internal components of serum are better protected by the vesosome's many compartments.[8]

Proteosomes

Catalytic activity in high molecular weight multi-subunit enzyme complexes is directly attributed to the way the enzymes assemble. utilized to increase catalytic activity turnover more effectively than other enzymes.[8]

Genosomes

Since cationic lipids are highly stable and biodegradable in the bloodstream, they are the most appropriate artificial macromolecular complexes for functional gene transfer. used to deliver genes to targeted cells.[8]

Ethosomes

Hydroalcoholic phospholipid-based vesicular carriers with a high alcohol content are called ethosomes. In addition to alcohol, water, and propylene glycol, ether may also include various phospholipids such as phosphatidylglycerol, phosphatidylcholine, hydrogenated phosphatidylcholine, phosphatidylinositol, phosphatidic acid, phosphatidylserine, and phosphatidylethanolamine. Research revealed that because of their high fexibility, ethosomes can easily penetrate human skin. Ethosomes are mostly employed topically because they are more effective at transporting various medication types across the skin barrier. Since phospholipids found in nature make up ethosomes, purity can be a problem. In addition to clumping together and producing precipitation, a high alcohol content can irritate skin.[9,10]

Transethosomes

Transethosomes are novel vesicular systems with an additional edge activator or penetration enhancer that are composed similarly to ethosomes. They benefit from ethosomes and transferosomes. Compared to other vesicular systems, transethosomes are extremely flexible vesicles with a high flux rate and great skin permeability. They have a high rate of patient compliance and are very stable, biocompatible, and biodegradable. For the medications

to be absorbed through the skin, their molecular size must be acceptable. Furthermore, transethosomes have the same potential to produce skin dermatitis as ethosomes due to their high alcohol concentration.[11,12]

Bilosomes

Bile salts and non-ionic amphiphiles combine to generate vesicles known as bilosomes. The vesicles in bilosomes are more flexible due to their shape, which enables them to squeeze themselves and deliver the medication to the site of action. Bilosomes have great patient compliance, high chemical stability in the gastrointestinal tract, and no additional handling or storage requirements. However, there is currently a lack of sufficient research on the interactions between oral bilosomes and food that has been consumed, as well as a comphrensive simulation of bilosome digestion *in- vivo*.[12-14]

cubosomes

Liquid crystalline, optically isotropic cubic nanoparticles known as cubosomes are made of lipid layers that divide non-intersecting water channels. Drug delivery methods that are biocompatible, non-toxic, bioadhesive, and non-immunogenic include cubosomes. Due to their large internal surface area and distinctive geometric structure, they can hold a large number of different medications. The limited stability of cubosomes, which can lead to drug leakage, and the challenges associated with large-scale manufacture are its limitations.[16-17]

Spanlastics

Spanlastics are extremely elastic nanovesicles made of a non-ionic surfactant and an edge activator. Convenience, target specificity, chemical stability, and excellent patient compliance are only a few of its benefits. When it comes to ocular delivery, they have a low release profle. Because spanlastics contain an edge activator that offers tremendous flexibility and improves the permeability of the drug, they may be a potential vehicle for the delivery of antifungal medicines.[18,19]

Cerosomes

Cerosomes are vesicles containing ceramides that are made with various surfactants and phospholipids. When used topically, they offer good drug bioavailability, stability, and permeability. To improve vesicle stability, a surfactant is added to a lipidic phosphatidylcholine-ceramide mixture for creating vesicles. Since phospholipids are added throughout the cerosome production process, purity may be an issue. Cerosomes are further limited by the fact that they are made up of two long chains and a short head group, which results in a critical packing parameter of 1.2, which is regarded as a high number. This issue can be resolved by employing mixed systems.[21-23]

Terpesomes

Terpenes are naturally occurring substances generated from essential oils that are composed of several isoprene units. Terpesomes are vesicles that contain terpenes. Due to their lipophilic nature, terpenes have antibacterial and antifungal properties. This is because they can transfer vital oil ingredients inside of cells, resulting in cytoplasmic penetration and cell death. Even while terpesomes have several benefits, their high cost of production and the terpenes that are part of their structure can make them poisonous and irritate skin.[24]

Novasomes

The vesicular carriers known as novasomes are made up of monoesters of poly-oxyethylene fatty acid, free fatty acids, and cholesterol. Large doses of drugs can be delivered by novasomes, which are multi-bilayered nanosized vesicles with a high capacity central core and site specificity. They are widely used in the creation of chemicals, foods, cosmetics, vaccinations, and personal care products. However, there may be some stability problems due to the free fatty acid present in the novasome structure.[25,26]

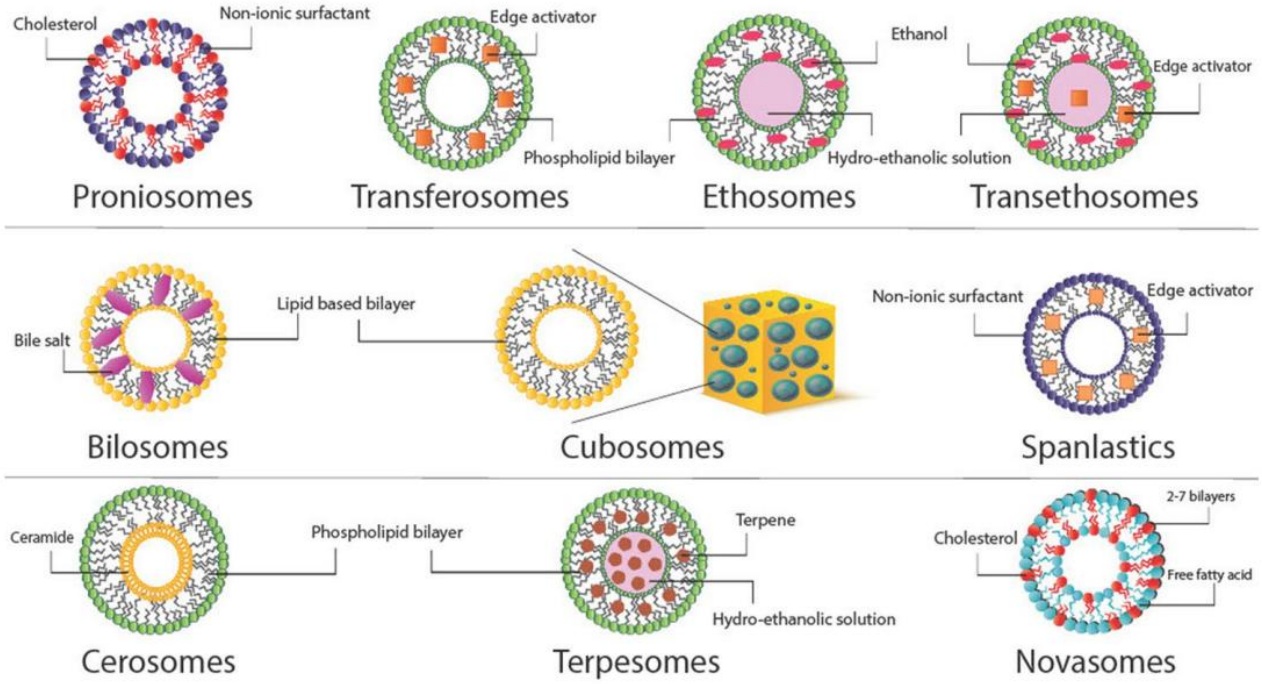

Figure 1: Vesicular system [14]

Apsasomes

One potential material for bilayer vesicles was ascorbyl palmitate vesicles (ASP). Therapeutic applications for illnesses associated with reactive oxygen species may be possible for vesicles made with amphiphiles possessing antioxidant properties. Within human plasma and throughout cell membranes, ascorbic acid, also known as vitamin C, is a potent antioxidant. Reactive oxygen species like superoxide and peroxides are also reduced by it, along with α-tocopherol.[27]

Colloidosomes

A new kind of microcapsules known as colloidosomes is made up of fused or coagulated colloid particles at the interface of emulsion droplets. Colloidosomes are formed when the particles self-assemble on the droplet surface in an effort to reduce the overall interfacial energy. The spherical capsules known as "colloidosomes" are created when colloidal particles are carefully allowed to self-assemble onto emulsion droplets. In order to reduce the overall interfacial energy and function as a bridge between the particles, colloidal particles in aqueous solution adhere to the emulsion droplets in colloidosomes. This locks the particles together and stabilizes the structure, enabling the removal of the initial templating surfaces.[28

CONCLUSION

It was discovered that the transdermal drug delivery method was a useful means of resolving issues with traditional oral dose forms, including low bioavailability, frequent high dosage, and untargeted drug activity. However, the stratum corneum functions as a strong barrier that lowers drug permeability and, thus, the bioavailability of big molecules and hydrophilic medications. Recent years have seen the development of novel, adaptable non-ionic surfactant-based vesicles, such as niosomes, proniosomes, transferosomes, pharmacosomes, etc., enabling effective medication delivery via the skin. These vesicles have been investigated for a variety of uses in the delivery of anti-inflammatory, anti-cancer, antiviral, and other medications by lowering adverse effects and improving drug absorption through the skin and bioavailability..

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