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A Review on Liposomes: A Novel Drug Delivery System

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ABSTRACT

Liposomal delivery methods have been essential in the development of powerful medications to enhance therapeutic outcomes since the discovery of the liposome, also known as the lipid vesicle, which resulted from self-forming enclosed lipid bi-layer upon hydration. Spherical vesicles with an aqueous compartment, liposomes are made up of one or more lipid bilayers. Lipid body is the definition of a liposome. The name of the subcellular particles—ribosomes—has been used to derive it. An early 1960s invention of liposomes was created by A.D. Bangham. Between 25 and 500 nm is the range of their size. Presently, they serve as an extremely valuable instrument in numerous scientific fields, such as chemistry, pharmaceutical science, biology, physics, and biochemistry.

..In addition to other novel drug delivery methods, liposomes use cutting-edge technology to carry active molecules to the site of action. Currently, multiple dosage forms are being used in clinical settings. This study provides a summary that only addresses the classification, preparation techniques, stability, and applications related to liposomal drug formulations.

In recent years, liposomes—versatile lipid-based nanoparticles—have gained attention as possible drug delivery vehicles. The goal of this thorough review is to present a thorough examination of the developments, difficulties, and possible uses of liposomes in drug administration. The paper discusses the structure, formulation techniques, benefits, drawbacks, and most recent developments in the field of liposome-based drug delivery. In addition, we go over the wide variety of medications and medicinal substances that can be contained in liposomes and their therapeutic uses in addressing particular medical conditions.

KEYWORDS: Liposomes, Drug Delivery System, Nanocarriers, Targeted Drug Delivery, Controlled Release, Biocompatibility, Pharmacokinetics

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INTRODUCTION

The age of development for targeted distribution was ushered in by August Ehrlich in 1906. Posilipids spontaneously form a closed structure in water when they are disseminated; this vesicular system is known as a liposome and has an internal aqueous environment surrounding it.Originating from two Greek words, "Lipos" (fat) and "Soma" (body), the term liposome is derived. As specific lipids are hydrated in aqueous conditions, liposomes—microparticulate or colloidal carriers—that typically have a diameter of 0.05 to 5.0 µm spontaneously develop. The small, spherical vesicles known as liposomes can be made from membrane proteins, sphingolipids, glycolipids, cholesterol, and non-toxic surfactants. Liposomes are a type of drug carrier that may hold a wide range of molecules, including plasmids, proteins, nucleotides, and tiny drug molecules. Alec D. Bangham created liposomes for the first time in England in 1961. The liquid inside of the sphere-shaped shell is filled with peptides and proteins, hormones, enzymes, antibiotics, antifungal, and anticancer chemicals. To regulate the size and size distribution, methods such as membrane extrusion, sonication, homogenization, and or freeze-thawing are used. It is possible to create and process liposomes with varying lamellarity, charge, content, and size. The reticuloendothelial system (RES) causes liposomes to degrade quickly, which poses a significant disadvantage for liposomes used in pharmaceutics. Another issue is that liposomes have not been shown to be a reliable carrier for therapeutically active compounds over an extended length of time.Liposomal drug delivery is becoming more and more popular because of its contributions to a variety of fields, including medication delivery, cosmetics, and biological membrane structure.Liposomes function both inside and outside the body through a number of methods, including the following: 1) The liposome adheres to the membrane of the cell and gives the impression of fusing with it, releasing its contents into the cell. 2) Occasionally, they are absorbed by the cell, and their phospholipids are integrated into the membrane, releasing the medication that has been imprisoned inside. 3) In the case of a phagocyte cell, the liposomes are taken up, the active pharmaceutical substances are released, and the phospholipid walls are acted with by organelles known as lysosomes.

The Greek terms "Lipos," which means fat, and "Soma," which means body, were combined to create liposomes, which are spherical, concentric vesicles. Round sac phospholipid molecules make up liposomes. It encloses a droplet of water, specifically one that is formed artificially to transport a medication into the tissue membrane. A liposome is a 100 nm-sized

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nanoparticle [1]. When Bangham accidentally dispersed the phosphatidyl choline molecule in water in 1961, he discovered that the molecule was forming a closed bilayer shape with an aqueous segment that was entrapped by a lipid bilayer. This led to the discovery of liposomes. Liposomes offer potential medicinal or other uses in addition to serving as drug carriers for a range of substances. Drugs can be targeted to certain areas using a variety of carriers, including liposomes, polysaccharides, nanoparticles, and microparticles. Because of its contributions to drug delivery, cosmetics, and biological membrane structure, liposomal drug delivery is becoming more and more popular [3]. A liposome is a microscopic bubble, or vesicle, with a phospholipid bilayer for a membrane. Phospholipids such as phosphatidylcholine and phosphatidylet - hanolamine are typically used to make membranes. Amphiphilic phospholipids have a hydrophilic polar head and a hydrophobic hydrocarbon tail.

Structure of liposomes:

.1). Phospholipids

Naturally occurring phospholipids used in liposome:

- Phosphatidylethanolamine
- Phosphatidylcholine
- Phsphatidylserine

Synthetic phospholipids used in the liposomes are:

- Dioleoyl phosphatidylcholine
- Disteroyl phosphatidylcholine
- Dioleoyl phosphatidylethanolamine

2) Cholesterol

The phospholipid membrane can contain cholesterol in very high concentrations, up to a molar ratio of 1:1 or 2:1 between cholesterol and phospatidylcholine. As an amphipathic molecule, cholesterol inserts into the membrane with its hydroxyl group facing the aqueous floor and its aliphatic chain parallel to the acyl chains in the middle of the bilayers. It also increases the distance between choline head organizations and eliminates the regular hydrogen bonding and electrostatic interactions.

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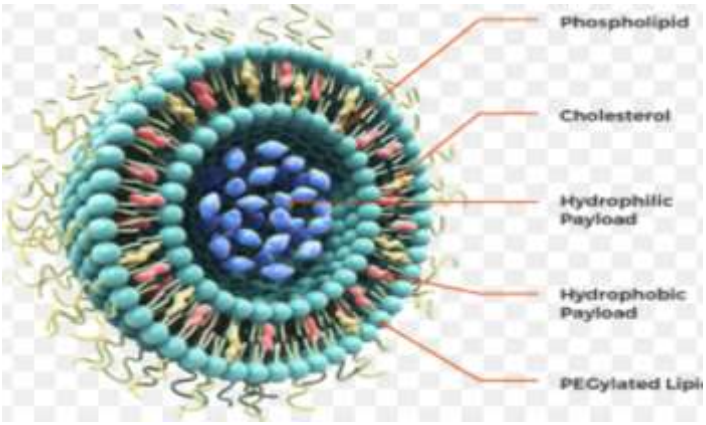

ADVANTAGE OF LIPOSOME

- If the liposome is created by encapsulation, stability will increase.
- Liposomes improved a drug's therapeutic index and efficacy (actinomycin-D).
- Amphotericin B, or Taxol, is the encapsulating agent whose toxicity is lessened by liposomes.
- Liposomes lessen the amount of harmful medication that reaches delicate tissues.
- For systemic and non-systemic treatments, liposomes are adaptable, non-toxic, biocompatible, fully biodegradable, and non-immunogenic
- flexibility in combining with ligands specific to a certain location to accomplish active targeting.
- Ideal for administering medications that are hydrophilic, amphipathic, and hydrophobic.
- tailored Drug Delivery: Drugs can be encapsulated in liposomes and delivered to particular target cells or tissues, enabling tailored therapy. As a result, there are fewer adverse effects and less exposure of healthy tissues to the medication.
- Enhanced Bioavailability: Liposomes have the potential to encapsulate medications that are not very soluble in water, hence enhancing their solubility and bioavailability. This can have a significant impact on the efficacy of the drug.

DISADVANTAGE OF LIPOSOME

- limited half-life
- minimal solubility.
- drug/molecule encapsulation leakage and fusing.
- Production comes at a heavy cost.

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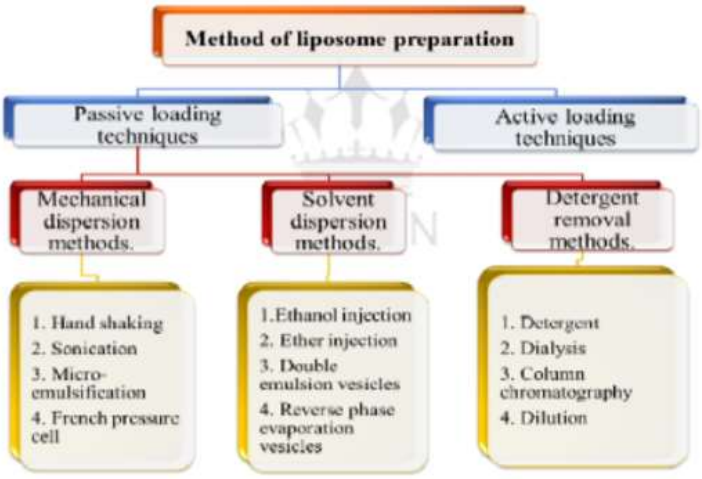
- Phospholipids can occasionally experience an oxidation and hydrolysis-like process.
- a lengthy process.
- Liposomal components may cause allergic responses.
- Storage Stability: During storage, liposomes may become unstable and aggregate, leak compounds that are encapsulated, or undergo structural and/or morphological changes.
- Scalability: The difficulty and expense of increasing liposome production may prevent them from being widely used in large-scale pharmaceutical manufacture.

METHOD FOR PREPRATION OF LIPOSOMES

Techniques for preparing liposomes:

The primary objectives of an optimal liposome formulation technique are to achieve effective drug entrapment, a limited particle size distribution, and long-term stability of liposome products.



1) in-Film Hydration Method:

One of the most popular techniques for preparing liposomes is this one.

- To make a lipid solution, dissolve lipids (phospholipids and cholesterol) in an organic solvent such as methanol or chloroform.
- Reduced pressure is used to evaporate the solvent, creating a thin lipid layer on the glass vial or round-bottom flask walls.

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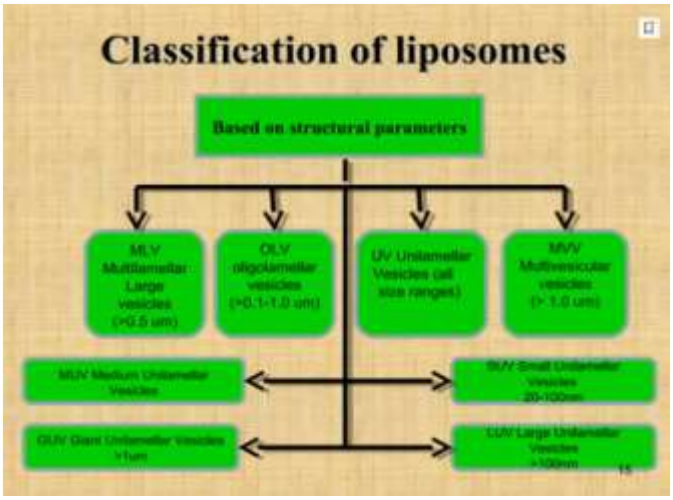
- To create multilamellar vesicles (MLVs), hydrate the lipid film by adding an aqueous solution (such as buffer or distilled water) and vortexing or sonicating.
- It is also possible to use sonication or extrusion to shrink MLVs into smaller unilamellar vesicles (SUVs).

Classification of Liposomes:



Mechanism of formation of Liposomes:

There are four different mechanisms by which liposomes move.

STEPS

- Endocytosis: This occurs when neutrophils and phagocytic reticuloendothelial system cells come contact.
- Adsorption: Adsorption happens on the cellular surface via the interaction of additives on the surface or through imprecise electrostatic forces.
- Fusion: occurs when the liposomal bilayer is inserted into the plasma membrane and the liposomal content is continuously released into the cytoplasm.
- Lipid exchange: refers to the movement of liposomal lipids into the cellular membrane without the liposomal contents being associated with them

EVALUATION OF LIPOSOME

Structure Characterization of Liposomes

Morphology

- The size, shape, and lamellarity of liposomes can be seen in high-resolution images obtained by Transmission Electron Microscopy (TEM).
- Scanning Electron Microscopy (SEM): Provides details on surface morphology.

Size and Size Distribution:

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- Polydispersity, size distribution, and particle size are all measured using dynamic light scattering (DLS).
- Nanoparticle Tracking Analysis (NTA): This method measures and tracks individual liposomes suspended in a liquid

Lipid Composition Analysis

- Lipids in liposomal compositions are identified and quantified using high-performance liquid chromatography (HPLC).

Liposome Properties:

- Efficiency of Encapsulation.
- Fluorescence or UV-Visible Spectroscopy Spectroscopy: Determines the amount of molecules or medications that are encapsulated

Stability:

evaluating how size, polydispersity, and zeta potential vary over time in different storage environments (such as temperature and pH)

Drug Release Kinetics

To ascertain the speed and volume of medication release from liposomes, in vitro release experiments are used.

Application for Liposomes

Drug Delivery:

- Drugs that are both hydrophobic and hydrophilic can be encapsulated and delivered using liposomes as a popular drug delivery method.
- They can enhance the stability, bioavailability, and solubility of drugs.
- Targeting certain tissues or cells using liposomal medication compositions can minimize systemic negative effects.

Vaccines:

- To improve immunogenicity, liposomes are added to vaccinations as carriers or adjuvants.
- They can enhance the immune cells' uptake of antigens, resulting in an enhanced immunological response.

Cosmetics and Skincare:

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- Liposomes are used in healthcare and cosmetics products to release active compounds like vitamins and antioxidants under controlled conditions.
- They can increase an ingredient's ability to penetrate the skin and increase its effectiveness.

Gene Delivery:

- For gene therapy applications, liposomes can be used to transfer genetic material, such as DNA and RNA.
- They shield genetic cargo and make it easier for it to enter target cells.

Diagnostics:

- In medical imaging techniques such as magnetic resonance imaging (MRI) and ultrasound, liposomes can function as carriers for contrast chemicals.
- They allow for the targeted imaging of particular cells or tissues.

Cancer Treatment:

- Chemotherapy medications such as liposomal doxorubicin, or Doxil, are administered in liposomal form to treat cancer.
- They can lessen harm to healthy tissues and increase the duration that drugs circulate.

Biotechnology

- Liposomes are employed in biotechnology and research for drug delivery and screening to cells in vitro.
- They are useful resources for researching drug transport processes and interactions between cell membranes.

Drug Delivery Through Transdermal:

- Drugs can be administered topically via liposomal formulations to penetrate the skin.
- They can circumvent the liver's first-pass metabolism and provide regulated release.

Conclusion: In the realm of pharmaceuticals, liposomes offer a novel and promising drug delivery technology with a broad range of uses. Many studies conducted over the years have shown that they are capable of overcoming a variety of obstacles connected to conventional drug delivery techniques. A new and exciting class of drug delivery vehicles called liposomes has shown promise in improving the safety and therapeutic efficacy of a wide range of medications. Even though there are still difficulties, the pharmaceutical industry's ability to deliver drugs in the future seems highly promising because to the ongoing development and improvement of liposomal technology. With the potential to change the pharmaceutical

business by increasing treatment efficacy, lowering side effects, and enabling precise targeting of therapies, liposomes provide an innovative and adaptable strategy to drug delivery. Liposomal technology is expected to be used in a greater number of medicinal applications as it continues to progress.

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