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# ROLE OF LIPOSOMES IN DRUG DELIVERY SYSTEM

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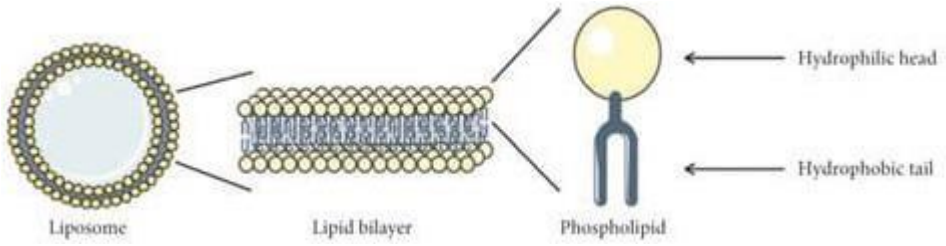
ABSTRACT:

Liposomes are tiny vesicles made of a phospholipid bilayer that have been studied in great detail as a means of delivering drugs. They are a desirable platform for targeted and regulated drug administration because of their special qualities, which include biocompatibility, biodegradability, and the capacity to encapsulate both hydrophilic and lipophilic medications. To increase their therapeutic index, very few medications are made as liposomes. As a result, several vesicular drug delivery systems, including pharmacosomes, transfersomes, niosomes, and liposomes, are created. Since radiotracers can be attached to many liposome locations, liposomes can be utilized to transport radioactive substances.

**KEYWORDS**: liposomes, drug delivery system, chemotherapy, targeted drug delivery, controlled release.

## INTRODUCTION:

The Greek terms "Lipos," which means fat, and "Soma," which means body, are the roots of the word "liposome." The term of a liposome refers to its structural components, the phospholipids, rather than its size. Liposomes can be unilamellar or multilamellar and can occur in a range of sizes. Due to the adsorption of plasma proteins in their "second generation form," known as sterically stabilized liposomes, one of the main disadvantages of conventional liposomes has been their quick removal from the blood. Liposomal compositions have the potential to enhance anticancer medicines' in vivo efficacy. When mice with L1210 leukemia were given the anticancer medication cytosine arabinoside in a liposomal formulation, the animals's life periods were greatly extended and the consequent in vivo activity was enhanced.




***TYPES:***

There are three types of liposomes:

1. MLV (Multilamellar vesicles)
2. SUV (Small unilamellar vesicles)
3. LUV (Large unilamellar vesicles)

### 1. MLV (MULTIAMELLAR VESICLES)

Multilamellar liposomes (MLLs) are a particular kind of liposome that resembles an onion and is composed of several concentric phospholipid spheres that are divided by layers of water. They are frequently employed as a model for biological membranes in order to investigate the characteristics, organization, and dynamics of the lipid bilayer.

### 2. SUV (SMALL UNILAMELLAR VESICLES)

Small unilamellar liposomes (SUVs) are spherical vesicles that range in diameter from 20 to 100 nanometers (nm) and have a single lipid bilayer: SUVs serve a variety of functions, such as:

1. Model biomembranes: SUVs are used to simulate cell membranes and investigate biological systems.
2. Drug and gene delivery: Genes and medications can be transported in SUVs.

Transdermal medication delivery: Lipid vesicles can improve the absorption of drugs through the skin.

**3. 3.LUV (LARGE UNIMELLAR VESICLES)**

LUVs, which are spherical vesicles with a single phospholipid bilayer containing an aqueous solution, are used to mimic cell membranes and study biological systems. They are larger than SUVs, which range in size from 100 to 1000 nanometers (nm).

**Liposomes can be classified in terms of work and mechanism of intracellular delivery into five types as:**

1. Conventional liposomes
2. pH sensitive liposomes
3. Cationic liposomes
4. Immune liposomes
5. Long circulating liposomes

## METHODS OF PREPARING LIPOSOMES:

**Mechanical Dispersion Methods**

1. Thin-Film Hydration Method: To create a thin film, a combination of lipids is mixed in an organic solvent and subsequently evaporated. The formation of the liposomes occurs when the film is hydrated with an aqueous solution.
2. Mechanical Dispersion Method: A sonicator or homogenizer is used to mechanically disperse lipids after they have been combined with an aqueous solution.
3. Microfluidization Method: To make liposomes, lipids and an aqueous solution are combined and then pushed through a microfluidizer.

**Solvent-Based Methods**

1. Ether Injection Method: An aqueous solution is injected with lipids that have been dissolved in an organic solvent, like ether.
2. The second method is the injection of ethanol into an aqueous solution after lipids have been dissolved in it.
3. Dialysis Method: An organic solvent is used to dissolve lipids, which are subsequently dialyzed against an aqueous solution.

**Detergent-Based Methods**

1. Detergent Removal Method: A detergent is combined with lipids and subsequently eliminated by gel filtration or dialysis.
2. The detergent dilution method involves mixing lipids with a detergent and then diluting the combination with water.

## LIPOSOMES AS CARRIER SYSTEMS:

Anti-cancer drugs are frequently delivered using liposomal DDS, and liposomes have been used to encapsulate doxorubicin, daunorubicin, annamycin, cisplatin derivatives, vincristine paclitaxel, camptothecin derivatives, 5-fluorouracil derivatives, and retinoids. By using remote loading techniques, anthracyclines and other agents can be loaded into pre-formed liposomes with nearly 100% trapping efficiency. Macrophages like superoxide dismutase, hemoglobin, tumor necrosis factor [40], erythropoietin [41], interleukin-2, and interferon- have also been delivered using liposomes. Because liposomal formulations can be administered intravenously, orally, or intranasally, there are several ways to administer them. Additionally, liposomes containing antibiotics, amikacin, ciprofloxacin, or polymyxin B have been applied topically [49], and liposomal aerosols containing camptothecin, which has been demonstrated to be effective in preventing the growth of human breast, lung, and colon cancer xenografts, have been used.

## Mechanism of Action of Liposomes:

Liposomes are made up of a region of aqueous solution inside a hydrophobic membrane. Hydrophobic chemicals can be readily dissolved into the lipid membranes, allowing liposomes to carry both hydrophilic and hydrophobic molecules. The physiochemical properties and composition of the lipid will determine the extent of the drug's location, and the lipid bilayers will fuse with other cell bilayers (cell membrane) to release the liposomal content.

**Steps involved in liposome action of drug delivery: Adsorption:**

1. Liposomes come into contact with cell membranes when they adsorb to them.
2. Endocytosis: Liposomes adhere to the cell membrane, then are engulfed and internalized by the liposomes.
3. Fusion: lateral diffusion and lipid mixing cause the lipid bilayers of liposomes to fuse with the lipoidal cell membrane. leads to the cytoplasm receiving liposomal contents directly.
4. Lipid exchange: Lipid transfer proteins in the cell membrane may readily identify liposomes and initiate lipid exchange because the phospholipids in the cell membrane and the lipid membrane of liposomes are identical. For instance, cancer cells see liposomes containing anti-cancer drugs as a possible source of nutrition while consuming vast amounts of fat to meet their needs for rapid development.

**Advantages of Liposomes in Drug Delivery**

1. Targeted delivery: To lessen systemic side effects, liposomes might be designed to target particular cells, tissues, or organs.
2. Controlled release: Drugs can be released from liposomes in a regulated way, sustaining therapeutic amounts for a long time.
3. Improved bioavailability: Drugs that are poorly soluble can have their bioavailability increased by liposomes, improving their effectiveness.

4. Reduced toxicity: By encapsulating medications and reducing their exposure to healthy tissues, liposomes can lessen their toxicity. Pharmacokinetic and pharmacodynamic control and improvement.
5. Decreased toxicity
6. Enhanced drug activity against intracellular pathogens
7. Liposomes as a selective target
8. Increased efficacy against infections outside of cells.
9. Both positively and negatively charged compounds can form complexes with liposomes.
10. The DNA is somewhat protected from deteriorating processes by liposomes.
11. Large DNA fragments, potentially as large as a chromosome, can be carried by liposomes.
12. Certain cells or tissues can be the target of liposomes.

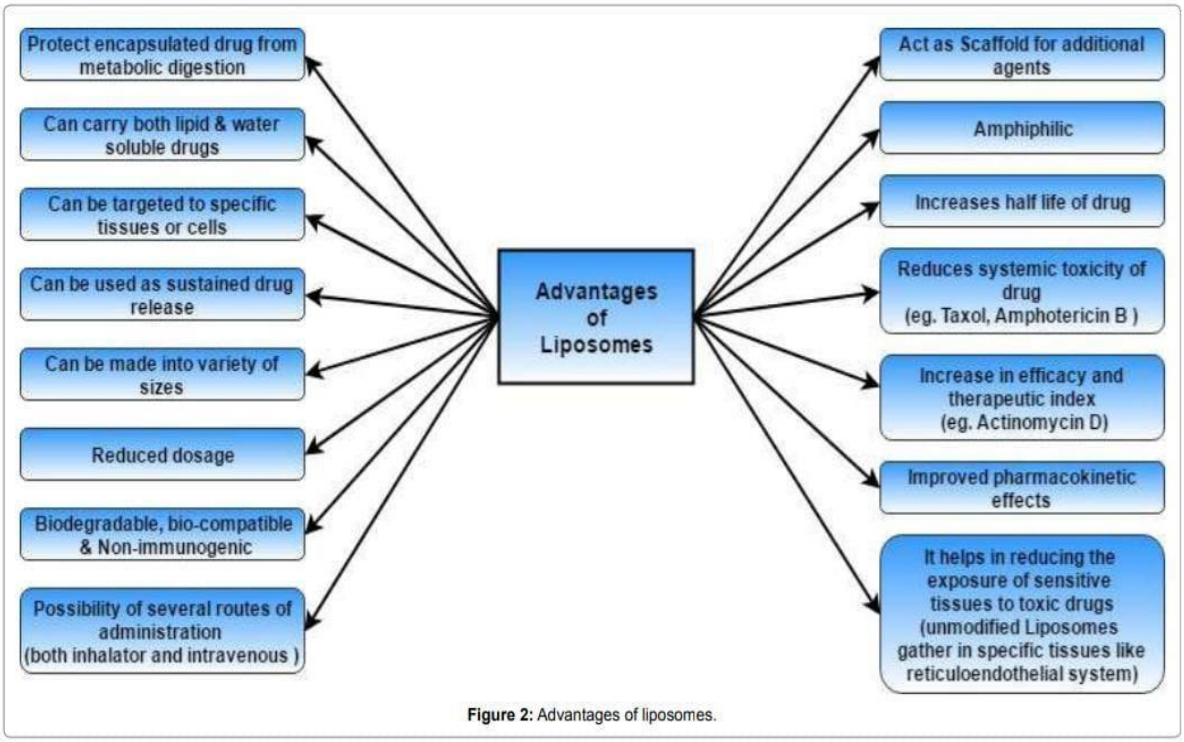



**Figure 2:** Advantages of liposomes.

**Disadvantages of liposomes:**

1. Production cost is high.
2. Leakage and fusion of encapsulated drug / molecules.
3. Sometimes phospholipid undergoes oxidation and hydrolysis-like reactions
4. Low solubility.
5. Fewer stables.
6. Less stability.
7. Short half-life.
8. High production cost.

## APPLICATIONS:

Anti-cancer medications' narrow therapeutic index (TI) is the reason for their cytotoxicity to healthy tissues. In these situations, the TI can be enhanced by encapsulating the medicine in liposomes to reduce its transport to healthy cells. Doxorubicin, for instance, has a serious cardiac toxicity side effect; nevertheless, when liposomes were created, the toxicity was lessened without affecting the therapeutic effect.

Long circulating immunoliposomes can more precisely identify and attach to target cells after systemic injection. For instance, when muramyl peptide derivatives were prepared as liposomes and given systemically to patients with recurrent osteosarcoma, monocytes' tumoricidal activity was increased.

## Intracellular drug delivery :

LDDS can be used to increase the delivery of possible medications to the cytosol, which contains drug receptors. Cells often absorb N-(phosphonacetyl)-L-aspartate (PALA) weakly. Compared to the free drug, these medications exhibited higher action against ovarian carcinoma cell lines when encapsulated in liposomes.

***Sustained release drug delivery***

Liposomes offer sustained release of target medications, which is necessary for the best therapeutic efficacy, which necessitates a prolonged plasma concentration at therapeutic levels [17]. Liposomes can be used to encapsulate medications such as cytosine arabinoside for prolonged release and an optimal drug release rate in vivo.

***Intraperitoneal administration***

The medicine can be administered to the intra-peritoneal (ip) cavity to treat tumors that form there. However, the amount of medication at the sick site is reduced due to the quick evacuation of the medications from the IP cavity. However, compared to free pharmaceuticals, liposomal encapsulated medications have a reduced clearance rate and can provide a maximal proportion of drug to the target location over an extended period of time.

***Immunological adjuvants in vaccines***

Adjuvants can be encapsulated in liposomes to improve the immune response. The liposome can either incorporate into the bilayers or accommodate antigens in the aqueous cavity, depending on how lipophilic the antigens are. The initial application of liposomes as immunological adjuvants was to boost the immune response to diphtheria toxoid.

***liposomes in cancer therapy:***

**Liposomes in Cancer Therapy**

1. Targeted Delivery: By engineering liposomes to specifically target cancer cells, damage to healthy cells can be minimized.
2. Increased Efficacy: By transporting anti-cancer drugs straight to the tumor site, liposomes can increase their effectiveness.
3. Less Toxicity: By limiting exposure to healthy tissues, liposomes can lessen the toxicity of anti-cancer drugs.

**Anti-Cancer Agents Delivered by Liposomes**

1. Doxorubicin: A chemotherapy medication used to treat ovarian, lung, and breast cancer, among other cancers.
2. Paclitaxel: A chemotherapy medication for lung, ovarian, and breast cancer.
3. Cisplatin: A chemotherapy medication used to treat lung, ovarian, and testicular cancer, among other cancers.

A chemotherapy medication called vinorelbine is used to treat lung and breast cancer.

**Liposome-Based Chemotherapy**

AIDS-related Kaposi's sarcoma, ovarian cancer, and breast cancer can all be treated with liposomal doxorubicin. Leukemia can be treated with liposomal daunorubicin. Lung, breast, and ovarian cancer can be treated with liposomal paclitaxel.

## CONCLUSION:

Liposomes are a strong and adaptable component of medication delivery systems. They are very useful in increasing the therapeutic efficacy of therapies because of their capacity to encapsulate a variety of medications, both hydrophilic and hydrophobic, as well as their potential for controlled release, targeted administration, and decreased toxicity. Additionally, liposomes increase the stability and bioavailability of medications, which makes them appropriate for a range of uses, including vaccine delivery and chemotherapy.

Their safety profile is further enhanced by their biocompatibility and biodegradability. All things considered, liposomes have enormous potential to improve contemporary medicine by offering a more secure, efficient, and focused drug delivery method.

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