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# A REVIEW ON LIPOSOMES

**M. Ramya Teja [1*], M. Navaneesh [2], M. Siddu [3], P. Manikanya [4], Dr. J.N Suresh Kumar [5]**

[1] Assoc. Professor, Department of Pharmaceutics, Narasaraopeta Institute of Pharmaceutical Sciences

[2,3,4] Students , Narasaraopeta Institute of Pharmaceutical Sciences.

**Abstract:**

Liposome's, sphere-shaped vesicles consisting of one or more phospholipids bilayers. Today, they are a very useful reproduction, reagent, and tool in various scientific disciplines, including mathematics and theoretical physics, biophysics, chemistry, colloid science, biochemistry, and biology. A number of clinical studies have now demonstrated the superiority of liposomal drug formulations over conventional delivery systems. Liposomes characterize an advanced technology to deliver active molecules to the site of action, and at present, several formulations are in clinical use. Research on liposome technology has progressed from conventional vesicles to 'second-generation liposome's', in which long-circulating liposomes are obtained by modulating the lipid composition, size, and charge of the vesicle. Liposome with modified surfaces have also been developed using several molecules, such as glycolipids or sialic acid. Antineoplastic agents, doxorubicin, daunorubicin and cytarabine, are in advanced stages of clinical testing in humans. One or more of these should prove to be a medically useful and commercially viable product within the next few years. This paper summarizes exclusively scalable techniques and focuses on strengths, respectively, limitations in respect to industrial applicability and regulatory requirements concerning liposomal drug formulations based on FDA and EMEA documents.

**Keywords**: Liposomes, Drug delivery system, Phospholipids, Components of liposome.

## Introduction:

Liposomes are colloidal, vesicular structures composed of one or more lipid bilayers surrounding an equal number of aqueous compartments[1]. The sphere like shell encapsulated a liquid interior which contain substances such as peptides and protein, hormones, enzymes, antibiotic, anti-fungal and anticancer agents. A free drug injected in bloodstream typically achieves therapeutic level for short duration due to metabolism and excretion. Drug encapsulated by liposome achieve therapeutic level for long duration as drug must first be release from liposome before metabolism & excretion. They are small artificial vesicles of spherical shape that can be created from cholesterol and natural non-toxic phospholipids. Due to their size and hydrophobic and hydrophilic character (besides biocompatibility), liposomes are promising systems for drug delivery. Liposome properties differ considerably with lipid composition, surface charge, size, and the method of preparation. Furthermore, the choice of bilayer components determines the rigidity or fluidity and the charge of the bilayer. For instance, unsaturated phosphatidylcholine species from natural sources (egg or soybean phosphatidylcholine) give much more permeable and less stable bilayers, whereas the saturated phospholipids with long acyl chains. (For example, dipalmitoyl-phosphatidyl choline) form a rigid, rather impermeable bilayer structure[2]. It has been displayed that phospholipid impulsively form closed structures when they are hydrated in aqueous solutions. Such vesicles which have one or more phospholipids bilayer membranes can transport aqueous or lipid drugs, depending on the nature of those drugs. Because lipids are amphipathic (both hydrophobic and hydrophilic) in aqueous media, their

thermodynamic phase properties and self-assembling characteristics influence entropically focused confiscation of their hydro-phobic sections into spherical bilayers. Those layers are referred to as lamellae. Generally, liposomes are Spherical vesicles with particle sizes ranging from 30 nm to several micrometres. They consist of one or more lipid bilayers surrounding aqueous units, where the polar head groups are oriented in the pathway of the interior and exterior aqueous phases. On the other hand, self-aggregation of polar lipids is not limited to conventional bilayer structures which rely on molecular shape, temperature, and environmental and preparation conditions but may self-assemble into various types of colloidal particles. A liposome is an artificially-prepared spherical vesicle composed of a lipid bilayer. The liposome can be used as a vehicle for administration of nutrients and pharmaceutical drugs[3]. Liposome's can be prepared by disrupting biological membrane (such as sonication). Liposomes are often composed of phosphatidylcholine-enriched phospholipids and may also contain mixed lipid chains with surfactant properties such as egg or phosphatidylethanolamine.

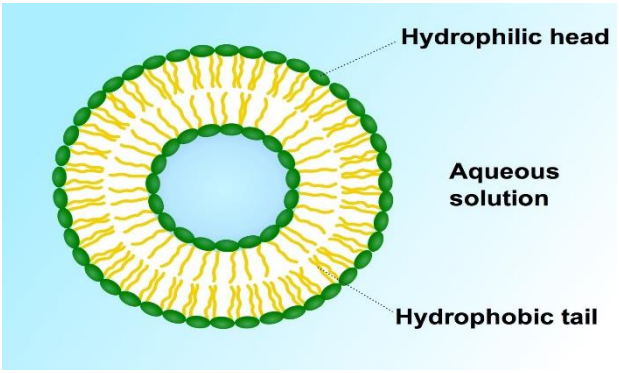


**Fig no: 1 Structure of liposome.**

**Advantages:**

- Some of the advantages of liposome are as follows:
- Provides selective passive targeting to tumour tissues (Liposomal doxorubicin).
- Increased efficacy and therapeutic index.
- Increased stability via encapsulation.
- Reduction in toxicity of the encapsulated agents.
- Site avoidance effect.
- Improved pharmacokinetic effects (reduced elimination, increased circulation life times).
- Flexibility to couple with site specific ligands to achieve active targeting.

**Disadvantages:**

- Short half-life.
- Low solubility.
- Leakage and fusion of encapsulated drug/ molecules.
- Production cost is high.
- Fewer stables.
- Sometimes phospholipids undergo oxidation and hydrolysis-like reaction.

**Classification of liposomes:**

The liposome size can vary from very small (0.025 µm) to large (2.5 µm) vesicles. Moreover, liposomes may have one or bilayer membranes. The vesicle size is an acute parameter in determining the circulation half-life of liposomes, and both size and number of bilayers affect the amount of drug encapsulation in the liposomes[9].

On the basis of their size and number of bilayers, liposomes can also be classified into one of two categories:

1. Multilamellar vesicles (MLV).
2. Unilamellar vesicles.

Unilamellar vesicles can also be classified into two categories:

1. Large unilamellar vesicles (LUV).
2. Small unilamellar vesicles (SUV).

In unilamellar liposome's, the vesicle has a single phospholipids bilayer sphere enclosing the aqueous solution. In multilamellar liposome's, vesicles have an onion structure[10]. Classically, several unilamellar vesicles will form on the inside of the other with smaller size, making a multilamellar structure of concentric phospholipids spheres separated by layers of water.

| **Types of liposomes** | **Size range (nm)** |
|---|---|
| Small unilamellar vesicles | 20-40 |
| Medium unilamellar vesicles | 40-80 |
| Large unilamellar vesicles | 100-1000 |

TABLE NO: 1

**Multilamellar vesicles (MLV):**

MLV have a size greater than 0.1μm and consists of two or more bilayer. Their method of formulation is simple and very easy to carry which includes thin– film hydration method or hydration of lipids in excess of organic solvent. They are mechanically stable on long storage. Due to the large size, they are cleared early or rapidly by the reticuloendothelial system (RES) cells and hence can be beneficial for various targeting the organs of RES. MLV have a moderate trapped volume, i.e., amount of aqueous volume to lipid ratio. The drug entrapment or corporate into the vesicles can be enhanced by slower rate of hydration and gentle mixing. Hydrating thin films of dry lipids can also easily enhance encapsulation efficiency. Subsequent lyophilization and rehydration after mixing with the aqueous phase (containing the drug) can yield MLV with good encapsulation efficiency i.e., 40%.

**Large unilamellar vesicles (LUV) (Donaruma et al., 1985):**

This class of liposomes particularly large unilamellar vesicles consists of a single bilayer and has a size greater than 0.1μm. They have higher encapsulation efficiency, since they can hold a large volume of solution in their cavity. They have high trapped volume and can be useful for encapsulating hydrophilic drugs. Most useful advantage of LUV is that less amount of lipid is required for encapsulating large quantity of drug. Similar to MLV, they are rapidly cleared by RES cells, due to their larger size. LUV can be formulated by various methods like ether injection, detergent dialysis and reverse phase evaporation techniques. Apart from these methods, freeze thawing of liposomes, dehydration/ rehydration of SUV and slow swelling of lipids in non-electrolyte solution can a prepare LUV.

**Small unilamellar vesicles (SUV) (Abra et al., 1981):**

SUV are smaller in size (less than 0.1 μm) when compared to MLV and LUV, and have a single bilayer. They have a low entrapped aqueous volume to lipid ratio and characterized by having long circulation half-life. SUV can be prepared by using solvent injection method (ethanol or ether injection methods) or alternatively by reducing the size of MLV or LUV using sonication or extrusion process under an inert atmosphere like nitrogen or Argon. The sonication can be performed using either a bath or probe type sonicator. SUV can also be achieved by passing MLV through a narrow orifice under high pressure. These SUV are susceptible to aggregation and fusion at lower or negligible/ no charge.

**Methods of liposomes preparations:**

Method:

The correct choice of liposome preparation method depends on the following parameters:

1. The physicochemical characteristics of the material to be entrapped and those of the liposomal ingredients;
2. The nature of the medium in which the lipid vesicles are dispersed;
3. The effective concentration of the entrapped substance and its potential toxicity;
4. Additional processes involved during application/ delivery of the vesicles;
5. Optimum size, polydispersity and shelf-life of the vesicles for the intended application and
6. Batch-to-batch reproducibility and possibility of large-scale production of safe and efficient liposomal products.[3,4]

**Handling of Liposomes:**

- The lipids used in the preparation of liposomes are unsaturated and hence susceptible to oxidation.
- Also, volatile solvents such as chloroform which are used will tend to evaporate from the container.
- Thus, liposomes must be stored in an inert atmosphere of nitrogen, and in the dark, in glass vessels with a securely fastened cap.

**General methods of preparation (Gabizon et al., 1998):**

All the methods of preparing the liposomes or formulating the liposomes involve four basic stages:

1. Drying down lipids from organic solvent.
2. Dispersing the lipid in aqueous media.
3. Purifying the resultant liposome.
4. Analysing the final product.

**Method of liposome preparation and drug loading (Abra et al., 1981):**

The following methods are used for the preparation of liposome:

1. Passive loading techniques.
2. Active loading technique.

Passive loading techniques include three different methods:

1. Mechanical dispersion method.
2. Solvent dispersion method.
3. Detergent removal method (removal of non-encapsulated material).

**Mechanical dispersion method:**

The following are types of mechanical dispersion methods:

A. Sonication.
B. French pressure cell: extrusion.
C. Freeze-thawed liposomes.
D. Lipid film hydration by hand shaking, non-hand shaking or freeze drying.
E. Micro-emulsification.
F. Membrane extrusion.
G. Dried reconstituted vesicles.

**1. Sonication:**

Sonication is perhaps the most extensively used method for the preparation of SUV. Here, MLVs are sonicated either with a bath type sonicator or a probe sonicator under a passive atmosphere [11]. The main disadvantages of this method are very low internal volume/encapsulation efficacy, possible degradation of

phospholipids and compounds to be encapsulated, elimination of large molecules, metal pollution from probe tip, and presence of MLV along with SUV.

**There are two sonication techniques:**

- **Probe sonication**: The tip of a sonicator is directly engrossed into the liposome dispersion. The energy input into lipid dispersion is very high in this method. The coupling of energy at the tip results in local hotness; therefore, the vessel must be engrossed into a water/ice bath. Throughout the sonication up to 1 h, more than 5% of the lipids can be de-esterified. Also, with the probe sonicator, titanium will slough off and pollute the solution.
- **Bath sonication:** The liposome dispersion in a cylinder is placed into a bath sonicator. Controlling the temperature of the lipid dispersion is usually easier in this method, in contrast to sonication by dispersal directly using the tip. The material being sonicated can be protected in a sterile vessel, dissimilar the probe units, or under an inert atmosphere.

2. **French pressure cell:**

Extrusion French pressure cell involves the extrusion of MLV through a small orifice. An important feature of the French press vesicle method is that the proteins do not seem to be significantly pretentious during the procedure as they are in sonication. An interesting comment is that French press vesicle appears to recall entrapped solutes significantly longer than SUVs do, produced by sonication or detergent removal.

The method involves gentle handling of unstable materials. The method has several advantages over sonication method. The resulting liposomes are rather larger than sonicated SUVs. The drawbacks of the method are that the high temperature is difficult to attain, and the working volumes are comparatively small (about 50 mL as the maximum).

3. **Freeze-thawed liposomes:** SUVs are rapidly frozen and thawed slowly. The short-lived sonication disperses aggregated materials to LUV. The creation of unilamellar vesicles is as a result of the fusion of SUV throughout the processes of freezing and thawing. This type of synthesis is strongly inhibited by increasing the phospholipid concentration and by increasing the ionic strength of the medium. The encapsulation efficacies from 20% to 30% were obtained.
4. **Solvent dispersion method Ether injection (solvent vaporization):** A solution of lipids dissolved in diethyl ether or ether-methanol mixture is gradually injected to an aqueous solution of the material to be encapsulated at 55°C to 65°C or under reduced pressure [12]. The consequent removal of ether under vacuum leads to the creation of liposomes. The main disadvantages of the technique are that the population is heterogeneous (70 to 200 nm) and the exposure of compounds to be encapsulated to organic solvents at high temperature.
5. **Ethanol injection:**

A lipid solution of ethanol is rapidly injected to a huge excess of buffer. The MLVs are at once formed. The disadvantages of the method are that the population is heterogeneous (30 to 110 nm), liposomes are very dilute, the removal all ethanol is difficult because it forms into azeotrope with water, and the probability of the various biologically active macromolecules to inactivate in the presence of even low amounts of ethanol is high.

6. **Reverse phase evaporation method:**

This method provided a progress in liposome technology, since it allowed for the first time the preparation of liposomes with a high aqueous space-to-lipid ratio and a capability to entrap a large percentage of the aqueous material presented. Reverse-phase evaporation is based on the creation of inverted micelles. These inverted micelles are shaped upon sonication of a mixture of a buffered aqueous phase, which contains the water-soluble molecules to be encapsulated into the liposomes and an organic phase in which the amphiphilic molecules are solubilized. The slow elimination of the organic solvent leads to the conversion of these inverted micelles into viscous state and gel form. At a critical point in this process, the gel state collapses, and some of the inverted micelles were disturbed. The excess of phospholipids in the

environment donates to the formation of a complete bilayer around the residual micelles, which results in the creation of liposomes. Liposomes made by reverse phase evaporation method can be made from numerous lipid formulations and have aqueous volume-to-lipid ratios that are four times higher than hand-shaken liposomes or multilamellar liposomes.

7. **Detergent removal method (removal of non-encapsulated material):**

Dialysis The detergents at their critical micelle concentrations (CMC) have been used to solubilize lipids. As the detergent is detached, the micelles become increasingly better-off in phospholipid and lastly combine to form LUVs. The detergents were removed by dialysis. A commercial device called LipoPrep (Diachema AG, Switzerland), which is a version of dialysis system, is obtainable for the elimination of detergents. The dialysis can be performed in dialysis bags engrossed in large detergent free buffers (equilibrium dialysis).

**8. Detergent (cholate, alkyl glycoside, Triton X100) removal of mixed micelles (absorption):**

Detergent absorption is attained by shaking mixed micelle solution with beaded organic polystyrene adsorbers such as XAD-2 beads (SERVA Electrophoresis GmbH, Heidelberg, Germany) and Bio-beads SM2 (Bio-RadLaboratories, Inc., Hercules, USA). The great benefit of using detergent adsorbers is that they can eliminate detergents with a very low CMC, which are not entirely depleted.

9. **Gel-permeation chromatography:**

In this method, the detergent is depleted by size special chromatography. The liposomes do not penetrate into the pores of the beads packed in a column. They percolate through the inter-bead spaces. At slow flow rates, the separation of liposomes from detergent monomers is very good.

The swollen polysaccharide beads adsorb substantial amounts of amphiphilic lipids; therefore, pre-treatment is necessary. The pre-treatment is done by pre-saturation of the gel filtration column by lipids using empty liposome suspensions[13].

**10. Dilution:**

Upon dilution of aqueous mixed micellar solution of detergent and phospholipids with buffer, the micellar size and the polydispersity increase fundamentally, and as the system is diluted beyond the mixed micellar phase boundary, a spontaneous transition from polydispersed micelles to vesicles occurs.

**11. Drug loading in liposomes:**

Drug loading can be attained either passively (i.e., the drug is encapsulated during liposome formation) or actively (i.e., after liposome formation). Hydrophobic drugs, for example amphotericin B Taxol or annamycin, can be directly combined into liposomes during vesicle formation, and the amount of uptake and retention is governed by drug-lipid interactions. Trapping effectiveness of 100% is often achievable, but this is dependent on the solubility of the drug in the liposome membrane. Passive encapsulation of water-soluble drugs depends on the ability of liposomes to trap aqueous buffer containing a dissolved drug during vesicle formation. Trapping effectiveness (generally<30%) is limited by the trapped volume delimited in the liposomes and drug solubility. On the other hand, water-soluble drugs that have protonizable amine functions can be actively entrapped by employing pH gradients, which can result in trapping effectiveness approaching 100%.

12. **Freeze-protectant for liposomes (lyophilization):**

Natural excerpts are usually degraded because of oxidation and other chemical reactions before they are delivered to the target site. Freeze-drying has been a standard practice employed to the production of many pharmaceutical products. The overwhelming majority of these products are lyophilized from simple aqueous solutions. Water is the only solvent that must be detached from the solution using the freeze-drying process.

**Purification of liposome:**

Liposomes are generally purified by gel filtration chromatography14, Dialysis and centrifugation. In chromatographic separation, Sephadex-50 is most widely used. In dialysis method hollow fibre dialysis cartridge maybe used. In centrifugation method, SUVs in normal saline may be separated by centrifuging at 200000 g, for 10-20hours. MLVs are separated by centrifuging at 100000g for less than one hour.

**Mechanism of transportation through liposome:**

The limitations and benefits of liposome drug carriers lie critically on the interaction of liposomes with cells and their destiny in vivo after administration. In vivo and in vitro studies of the contacts with cells have shown that the main interaction of liposomes with cells is either simple adsorption (by specific interactions with cell-surface components, electrostatic forces, or by non-specific weak hydrophobic) or following endocytosis (by phagocyte cells of the reticuloendothelial system, for example macrophages and neutrophils). Fusion with the plasma cell membrane by insertion of the lipid bilayer of the liposome into the plasma membrane, with simultaneous release of liposomal content into the cytoplasm, is much rare. The fourth possible interaction is the exchange of bilayer components, for instance cholesterol, lipids,and membrane-bound molecules with components of cell membranes.

**EVALUATION OF LIPOSOMES:**

Liposomal formulation and processing for specified purpose are characterized to ensure their predictable in vitro and in vivo performance. The characterization parameters for purpose of evaluation could be classified into three broad Categories, which include physical, chemical and biological parameters. Physical characterization evaluates various parameters including size, shape, surface features, lamellarity phase-behaviour and drug release profile. Chemical characterization includes those studies which establish the purity and potency of various lipophilic constituents. Biological characterization parameters are helpful in establishing the safety and suitability of formulation for therapeutic application. Some of parameters are:

1) **Vesicle shape and lamellarity:**

Vesicle shape can be assessed using electron Microscopic Techniques. Lamellarity of vesicles i.e., number of bilayers presents in liposome's is determined using Freeze Fracture Electron Microscopy and P31 Nuclear Magnetic Resonance Analysis.

**2) Vesicle size and size distribution:**

Various techniques are described in literature for determination of size and size distribution. These include Light Microscopy, Fluorescent Microscopy, Electron Microscopy (Transmission Electron Microscopy), Laser light scattering Photon correlation Spectroscopy, Field Flow fractionation, Gel Permeation and Gel Exclusion. The most precise method of determine size of liposome is Electron Microscopy. It is very time consuming and require equipment's that may not always be immediately to hand. In contrast, laser light scattering method is very simple and rapid to perform but having disadvantage of measuring an average property of bulk of liposomes. Another more recently developed microscopic technique known as atomic force microscopy has been utilized to study liposome morphology, size, andstability[15]. Most of methods used in size, shape and distribution analysis can be grouped into various categories namely microscopic, diffraction, scattering, and hydrodynamic techniques.

**3) Microscopic Techniques:**

**a) Optical Microscopy:**

The microscopic method includes use of Brightfield, phase-Contrast Microscope and Fluorescent Microscope and is useful in evaluating vesicle size of large vesicles[16]

**b) Cryo-Transmission Electron Microscopy Techniques (cryo-TEM):**

This technique has been used to elucidate the surface morphology and size of vesicles.

**c) Diffraction and Scattering Techniques Laser Light Scattering Photon correlation spectroscopy (PCS):**

Is analysis of time dependence of intensity fluctuation in scattered laser light due to Brownian motion of particles in solution/suspension. Since small particles diffuse more rapidly than large particles, the rate of fluctuation of scattered light intensity varies accordingly. Thus, the translational diffusion coefficient (D) can be measured, which in turn can be used to determine the mean hydrodynamic radius (Rh) of particles using the Stoke-Einstein equation. Using this technique one can measure particles in range of about 3nm.

**4) Hydrodynamic Techniques:**

This technique includes gel Permeation and Ultracentrifuge. Exclusion chromatography on large pure gels was introduced to separate SUVs from radial MLVs. However, large vesicles of 1- 3µmdiameter.usually fail to enter the gel and are retained on top of column. A thin layer chromatography system using agarose beads has been introduced as a convent, fast technique for obtaining a rough estimation of size distribution of liposome preparation. However, it was not reported if this procedure was sensitive to a physical blockage of pores of the agarose gel as is the more conventional column chromatography.

**5) Encapsulation Efficiency:**Determine amount and rate of entrapment of water-soluble agents in aqueous compartment of liposome.

**6) Surface charge (Andreas et al., 2011):**

The lipid – cell interaction can be governed by the nature and density of charge on the liposome surface. Charging the lipid composition can alter the nature and charge on the liposome. Lack of charge in the SUV liposomes can lead to their aggregation and thereby reducing the stability of the liposome; whereas, the interaction of neutrally charged liposome with the cell is almost negligible. High electrostatic surface charge on the liposome may provide useful results in promoting lipid – cell interaction. Negatively charged density influences the extent of lipid – cell interactions and increase the intracellular uptake of liposomes by target cells. But positively charged liposomes are cleared more rapidly after systemic administration. Unlike negatively charged liposomes, cationic liposomes deliver the contents to cells by fusion with cell membrane. (Johnston et al., 2007).

**7) Surface hydration (Andreas et al., 2011):**

Liposomes with hydrophilic surface coatings are less prone to opsonization, hence reducing its uptake by RES cells. This can be attributed to the hydrophilic surface coating, which reduces the interaction of liposomes with cell and blood components. These sterically stabilized liposomes are more stable in the biological environment and exhibit high circulationhalf-lives, when compared to liposomes coated with hydrophobic coatings. Monogangliosides, hydrogenated phosphotidyl inositol, polyethylene glycol is some of the hydrophilic groups responsible for steric stabilization of liposomes.

**ApplicationsFor Liposomes:**

- Gene therapy.
- Liposomes as carriers for vaccines.
- Liposomes as carrier of drug in oral treatment.
- Liposomes for topical applications.
- Liposomes for pulmonary delivery.
- Against Leishmaniasis.
- Lysosomal storage disease.
- Cell biological application.
- Metal storage disease.
- Ophthalmic delivery of drugs.

**Therapeutic applications of liposomes:**

**1. Liposome as drug/protein delivery vehicle:**

Controlled and sustained drug release insitu. Enchaned drug solubilization, Altered pharmacokinetic and biodistribution. Enzyme replacement therapy and lysosomal disorders.

**2. Liposome in antimicrobial, antifungal and antiviral therapy:**

- Liposomal drugs.
- Liposomal biological response modifier.

**3. Liposomes in tumour therapy:**

Carrier of small cytotoxic molecule. Vehicle for macromolecule as cytokines or genes.

**4. Liposome in gene therapy:**

Gene and antisense therapy, Genetic (DNA) vaccination.

**5. Liposome in immunology:**

Immunoadjuvant, ImmunomodulatorandImmunodiagnosis, Liposome as artificial blood surrogates, Liposomes as radiopharmaceutical and radio-diagnostic carrier. Liposomes in cosmetics and dermatology. Liposomes in enzyme immobilization and bioreactor technology.

| **Benefits of drug load in liposome** | **Examples** |
|---|---|
| Improved solubility oflipophilic and amphiphilic drugs. | Minoxidil, amphotericin B, porphyrins, some peptides, and anthracyclines, respectively; hydrophilic drugs, such as anticancer agent doxorubicin or acyclovir. |
| Sustained release system of systemically or locally administered liposomes. | cortisones, Doxorubicin, cytosine arabinoside, biological proteins or peptides such as vasopressin. |
| Passive targeting to the cells of the immune system, especially cells of the mononuclear phagocytic system. | Antimonial, amphotericin B, porphyrins, vaccines, immunomodulators. |
| Site-avoidance mechanism. | Doxorubicin andamphotericin B. |
| Site-specific targeting. | Anti-inflammatory drugs, anti-cancer, anti-infection. |
| Improved penetration into tissues. | Anaesthetics, corticosteroids and insulin. |
| Improved transfer of hydrophilic, charged molecules. | Antibiotics, chelators, plasmids, and genes. |

TABLE NO: 2 Benefits of drug load in liposomes.

**Limitation in liposome technology:**

- Stability.
- Sterilization.
- Encapsulation efficiency.
- Active targeting.
- Gene therapy.
- Lysosomal degradation.

**Conclusion:**

Liposomes have been used in a broad range of pharmaceutical applications. Liposomes are showing particular promise as intracellular delivery systems for anti-sense molecules, ribosomes, proteins/peptides, and DNA. Liposomes with enhanced drug delivery to disease locations, by ability of long circulation

residence times, are now achieving clinical acceptance. Also, liposomes promote targeting of particular diseased cells within the disease site. Finally, liposomal drugs exhibit reduced toxicities and retain enhanced efficacy compared with free complements. However, based on the pharmaceutical applications and available products, we can say that liposome's have definitely established their position in modern delivery systems. The use of liposomes in the delivery of drugs and genes are promising and is sure to undergo further developments in future.

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