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# A CRITICAL ANALYSIS OF THE VESICULAR DRUG DELIVERY SYSTEM: RECENT ADVANCEMENTS AND PROSPECTS FOR THE FUTURE

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**Abstract**

Vesicular system drug design has revitalised the efficacy of previous medications by effectively regulating and sustaining their therapeutic action. The objective of this study is to evaluate the feasibility of utilizing pharmaceutical interventions to target novel vesicular drug delivery systems. The objective of innovative medication administration is to minimize adverse effects while ensuring drug efficacy at a predetermined or reasonably consistent level within the body. A novel drug delivery approach is characterized by the controlled release of medication at a predetermined rate, which is determined based on factors such as therapeutic requirements, pharmacological properties, drug characteristics, physiological condition of the organism, and other relevant considerations. At present, there is a lack of medication delivery technologies that effectively achieve the aforementioned objectives while minimizing adverse effects. The utilization of vesicular systems in drug delivery has brought about changes in the understanding and application of diagnosis and therapy across different domains within the biomedical field. The vesicular drug delivery system [VDDS] serves as a means to address the disparity between the theoretical ideal and the presently accessible innovative drug delivery systems, accomplishing this by enclosing active moieties within vesicular structures. Various vesicular drug delivery systems, such as liposomes, niosomes, transferases, pharmacosomes, colloidosomes, herbosomes, sphinosomes, among others, have been developed. This review primarily focuses on the examination of various pharmacological targets, both lipiodal and nonlipoidal, within vesicular systems. Liposomes and niosomes represent innovative drug delivery systems.



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## Introduction

Upon exposure to water, specific amphiphilic building blocks undergo self-assembly to form vesicular systems consisting of one or more concentric lipid bilayers, exhibiting a high degree of organisation. A wide variety of amphiphilic constituents can be employed for the formation of vesicles. In 1965, Bingham made the initial discovery of the biological source of these vesicles, afterwards designating them as Bingham bodies. The development of drug carriers with site-specific targeting, controlled degradation, and responsiveness to external stimuli is a feasible endeavor. The primary objective is to minimize medication loss and degradation, mitigate adverse side effects, and optimize drug accessibility at the disease site. One can anticipate that the utilization of vesicular structures for encapsulating medications may result in an extended duration of systemic circulation and, potentially, a reduction in toxicity if selective absorption is achievable. Lipid vesicles are a subset of experimental bio membrane models that have demonstrated efficacy as delivery mechanisms. The efficacy of standard chemotherapy in treating intracellular infections is hindered by the restricted entry of medicine into cells. Vesicular drug delivery systems have the potential to address this issue. The user has provided a numerical sequence: [1, 2, 3].

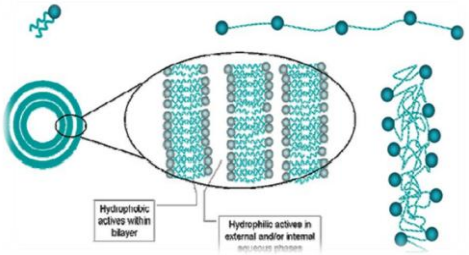


Fig: 1 Structure of Vesicular system

**Advantages of vesicular drug delivery system**

- The extension of the drug's presence in the systemic circulation and potential reduction in toxicity may be facilitated by achieving selective absorption, which can be accomplished through the direct administration of the drug to the infection site.
- Enhances the bioavailability, particularly for medicines with low solubility.
- Both hydrophilic and lipophilic medicines have the potential to be integrated.
- The mechanism of action of these systems involves the prolongation of drug elimination, hence functioning as sustained release systems for fast metabolizablemedicines.

**Liposomes**

- Liposomes, which are small vesicles at the microscopic level, consist of lipid bilayers encompassing an aqueous compartment, wherein the membrane is composed of lipid
- Selective passive targeting is achieved via lipiodal doxorubicin, which specifically targets tumour tissues.
- There is an observed improvement in the effectiveness and therapeutic ratio.
- One of the benefits of encapsulation is the enhancement of stability.
- One potential benefit of encapsulation is a decrease in the toxicity of the enclosed substance.
- The phenomenon of site avoidance has been observed [3].
- Enhanced pharmacokinetic effects, such as decreased clearance and prolonged circulation lifetimes, have been observed.
- The ability to bind with ligands specific to a particular spot, hence enabling active targeting.

**Disadvantages**

- One of the primary challenges associated with this particular issue is the elevated cost of production.
- The phenomenon of leakage and fusion of encapsulated drugs or molecules.
- Phospholipids are subject to oxidation.

- MLV Multilamellar Large Vesicles – >0.5µm
- OLV Oligolamellarvesicles -0.1- 1µm
- UV Unilamellar Vesicles [all size ranges]
- SUV Small Unilamellar Vesicles – 20-100nm
- Extraction method: VET [Vesicles prepared by Extraction method]
- French Press Cell method
- Fusion method

3. Based on In-Vivo applications:

- Conventional liposomes
- Long circulatory liposomes
- Immunoliposomes

**Preparative methods of liposomes:**

All methods of liposomes involve dissolution of cholesterol, lecithin, and charge in organic solvent, followed by drying it to a thin film and then dispersion of film in an aqueous medium to obtain liposome suspension at a critical hydrating temperature. General steps involved in the preparation of Liposomes are [7]:

1. Preparation of lipids for Hydration

- molecules. Liposomes consist of a range of chemicals, with phospholipids and cholesterol being the predominant components [1]. The stratum corneum lipid liposomes [SCLL] refer to vesicular structures composed of lipids that exhibit a high degree of similarity to the lipids found in the stratum corneum, which is the outermost layer of the human skin. The primary components consist of phospholipids, while an additional surfactant functions as an edge activator, so modifying elasticity and enhancing deformability. The user did not provide any text to rewrite. Liposomes are composed of one or more concentric lipid bilayers, enclosing an interior aqueous compartment[s]. Liposomes commonly exhibit a unilamellar structure and possess a diameter ranging from 50 to 150 nm when employed in drug delivery applications. The blood circulation efficiently eliminates liposomes of larger sizes [2].

**Advantages**:

- Liposomes are employed as medication delivery devices owing to their distinctive structural features.
- Liposomes have the ability to encapsulate and transport both hydrophobic and hydrophilic drugs. Hence, liposomes, when employed as a drug carrier, possess the capability to carry medicines across the cell membrane in a non-selective manner [4].
- Liposomal herbal medicine functions as a means of transportation for small cytotoxic compounds and as a delivery system for macromolecules such as genes.
- The utilization of liposome formulation has been shown to result in a prolonged and regulated release of the drug formulation, while also improving the solubility of the drug [5].

- The reaction under consideration has characteristics similar to hydrolysis.
- The substance in question exhibits a relatively brief half-life of unit.

**Classification**

Classification according to size:

- MUV Medium sized Unilamellar Vesicles
- LUV Large Unilamellar Vesicles - >100
- GUV Giant Unilamellar Vesicles - >1µm

**2. Classification according to methods of preparation:**

- IV Reverse Phase Evaporation method: SUVs, MLVs & OLVs
- Frozen and thawed multilayered vesicles
- Dehydration & rehydration method: DRV
- Stable Plurilamellar air vesicles method: SPLV

- Cationic liposomes
- Fusogenic liposomes [6]

2. Hydration of lipid film/cake

3. Sizing of lipid suspension

i. Sonication

ii. Extraction

All the methods of preparing liposomes involve four basic stages :

1. Drying down lipids from organic solvent.

2. Dispersion of lipid in aqueous media.
3. Purification of resultant liposome.
4. Analysis of final product.

The methods of preparation have been classified to the three basic modes of dispersion:

- Physical dispersion involving hand shaking and non-hand shaking methods.
- Solvent dispersion involving ethanol injection, ether injection, double emulsion vesicle method, reverses phase evaporation method, and stable plurilamellar.
- Detergent solubilization.

**Structural components of liposomes:**

Various lipids and amphiphiles are available as liposomes raw materials or additives that are required for the formation of lipid bilayers. Phospholipids, Synthetic phospholipids, Glycolipids, Sphingolipids, Glycosphingolipids, Steroids, Polymeric material, Charge inducing lipids.

- Phospholipids

**Natural phospholipids**

Phosphotidylcholine
Phosphatidylserine
Phosphotidylethanolamine
Phosphatidylinositol

**Synthetic phospholipids**

Dioleoyl-Sn-Glycero-3- [Phospho-L-Serine [Sodium Salt]] [DOPS]
Distearoylphosphotidylcholine [DSPC]
Dipalmitoylphosphotidylserine [DPPS]
¬ Sphingolipids
Sphingomyelin
¬ Glycosphingolipids
Gangliosides
¬ Steroids
Cholesterol
¬ Polymeric material
Lipids conjugate to dine,
Methacrylate,
Thiol group
¬ Charge-inducing lipids
Dioctadecyldimethyl ammonium bromide/chloride [DODAB/C]
Dioleoyltrimethyl ammonium propane [POTAP]
¬ Other substances
Stearylamine&Dicetylphosphates
Polyglycerol&polyethoxylated mono &dialkylamphiphiles

**Applications of Liposomes**

- Enzyme replacement therapy and lysosomal storage disorders, changed pharmacokinetics and biodistribution, regulated and prolonged drug release, improved drug stability, and liposomes as drug/protein delivery vehicles
- Liposomes in the treatment of viruses, fungi, and microbes The use of liposomal medications and biological response modifiers
- Liposomes are used to deliver tiny cytotoxic chemicals to tumours as well as macromolecules like cytokines or genes.
- Gene and antisense therapy, genetic [DNA] vaccination, and liposomes in gene delivery
- Liposomes as substitutes for synthetic blood
- Radiopharmaceutical and radio diagnostic carriers using liposomes
- Liposomes in dermatology and cosmetics
- Liposomes in bioreactor and enzyme immobilization technologies [8]

**Niosomes:**

The process of hydrating synthetic non-ionic surfactants, with or without the inclusion of cholesterol or lipids, leads to the creation of niosomes. Niosomes are vesicles composed of non-ionic surfactants [9]. Niosomes are vesicles that are generated by hydrating a mixture of cholesterol and non-ionic surfactants. Furthermore, apart from the inverse structures that exclusively manifest in an aqueous solvent, these formations can also be generated through the self-assembly of nonionic surfactants in non-aqueous environments, resulting in spherical, multilamellar systems, as well as polyhedral structures. Subsequently, a diverse range of nonionic surfactants has been employed for the synthesis of vesicles, including polyglycerol alkyl ethers, glucosyldialkyl ethers, crown ethers, polyoxyethylene alkyl ethers, ester linked surfactants, steroid linked surfactants, brij, as well as various spans and tweens. These structures exhibit a vesicular morphology similar to liposomes and have the ability to transport medications that are both amphiphilic and lipophilic. The term "vesicles" denotes little, pouch-like structures or their constitution. Both niosomes and liposomes exhibit comparable potential for drug delivery and provide superior efficacy compared to unencapsulated medicines. Due to their enhanced chemical stability and cost-effectiveness, niosomes are considered a more favourable alternative to liposomes. Niosomes, alternatively referred to as nonionic surfactant vesicles, are characterized as spherical, unit or multilamellar, and polyhedral vesicles when present in aqueous solutions. The size of these entities spans a range of 10 to 1000 nanometers. [10].

**Preparation methods:**

Various methods are reported for the preparation of niosomes. Such as

1. Ether injection method
2. Hand shaking method [Thin film hydration technique]
3. Sonication method
4. Reverse phase evaporation technique [REV]
5. Micro fluidization
6. Multi membrane extrusion method
7. Trans membrane pH gradient [inside acidic] drug uptake process [remote loading]
8. Bubble method
9. Formation of niosomes from proniosomes [11]

**Advantages of niosomes:**

- Compared to oily formulations, higher patient compliance and therapeutic effect
- can be used to transport pharmaceuticals that are hydrophilic, lipophilic, and amphiphilic and can accommodate medications with a variety of solubilities.
- controlled and continuous medication release caused by depot formation
- increase the medicines' oral bioavailability
- biocompatible, nontoxic, osmotically stable, nonimmunogenic

- Increase the drug's stability by shielding it from enzymatic metabolism processes.
- Drugs that target different organs
- increase the penetration of different medicines through skin
- simple to store, handle, and transport
- administered via a variety of methods, including parenteral, topical, oral, etc.
- Niosomes' size, content, shape, and fluidity can all be altered as needed [12]

**Therapeutic applications of niosomes:**

Niosomal drug delivery is potentially too many pharmacological agents for their action against various diseases.

Some of their therapeutic applications are

- Targeting of bioactive agents to reticular endothelial system [RES] To organs other than RES
- Neoplasia
- Immunological applications of niosomes
- Transdermal delivery of niosomes [13]

**Ethosomes:**

The role of vesicles in cellular communication and particle transportation has been well acknowledged for a considerable period of time. The enhanced dispersion of active compounds contained within ethosomes can be attributed to the interactions occurring between ethosomes and skin lipids. The malleability of ethosomes and their ability to fuse with skin lipids facilitate the penetration of medications into deeper layers of the skin, potentially creating novel avenues for drug delivery. The lipid vesicles characterized by their soft nature and varying diameters within the range of tens of nanometers to microns are commonly referred to as ethosomes. Consequently, the dimensions of ethosomal vesicles exhibit an increase in magnitude when the concentration of ethanol diminishes. [14]

**Methods of preparation:**

There are 2 methods which can be used for the formulation and preparation of ethosomes. Both of the methods are very simple and convenient and do not involve any sophisticated instrument or complicated process.

They are:

1. Hot method
2. Cold method

**Advantages:**

- Large molecules can be delivered [peptides, proteins]
- Contains harmless ingredients in the formulation; improves medicine penetration through skin for TDD; frequently used in the veterinary, pharmaceutical, and cosmetic industries.
- High patient adherence as a result of application in semisolid form
- Compared to iontophoresis, phonophoresis, and other complex procedures, a simple form of drug delivery
- It is non-invasive, passive, and ready for rapid commercialization [15]

**Therapeutic applications:**

- used for a variety of medication delivery reasons
- Primarily used to replace liposomes in transdermal delivery
- Used to deliver hydrophilic and impermeable medications transdermally [through the skin], including acyclovir, erythromycin, and insulin

**Transferosomes**:

Transferosomes are vesicles made of phospholipids, ethanol, and a surfactant. They are also ultra-formable vesicles with an aqueous core and a complex lipid bilayer surrounding them. Higher membrane hydrophilicity and transferosome flexibility help prevent aggregation and fusion. For the efficient transdermal distribution of a variety of low and high molecular weight medications, transfersomes were developed. It can spontaneously permeate the intact stratum corneum along two intracellular lipid pathways with different bilayer characteristics. Both hydrophilic and hydrophobic characteristics are present, and its great deformability improves the entry of intact vesicles.

**Method of Preparation:**

Alcohol is used to dissolve phospholipids, surfactants, and the medication. Rotary evaporation is then used to evaporate the organic solvent at 400°C under reduced pressure. Under vacuum, the last remnants of the solvent are eliminated. Rotation at 60 rpm for an hour at room temperature hydrates the deposited lipid layer with the proper buffer. At room temperature, the resultant vesicles swell for two hours. To create tiny vesicles, the multilamellar lipid vesicles [MLV] are subsequently sonicated at room temperature [16].

**Advantages:**

- Include both hydrophobic and hydrophilic moieties, allowing them to accommodate medicinal molecules with a variety of solubilities.
- Transferosomes can swell and pass through constriction that is between five and ten times smaller than their own diameter without suffering appreciable loss.
- Have a high rate of entrapment, around 90% for lipophilic medicines.
- Used for both systemic and topical medication delivery

**Limitations:**

- Transferosomes are chemically unstable because of their predisposition to oxidative degradation
- Purity of natural phospholipids is another criterion militating against adoption of transferosomes as drug delivery vehicles

**Pharmacosomes**:

The words "pharmakon" and "soma" both refer to the linking of a drug. The "pharmacosome" technique can get around transferosomes' drawbacks. The prodrug combines hydrophilic and hydrophobic properties, acquiring amphiphilic characteristics, and was found to lower interfacial tension and demonstrate mesomorphic behavior at increasing concentrations [17]. Any medication having an active hydrogen atom [COOH, -OH, -NH2, etc.] can be esterified to a lipid with or without the addition of a spacer chain, producing an amphiphilic molecule that will help membrane, tissue, or cell interactions as well as weakly lipophilic medications . The salient features of Pharmacosomes are:

- Entrapment efficiency is not only high but also predefined because the medication creates vesicles when it conjugates with lipids.

- Unlike liposomes, the difficult, time-consuming step of extracting the free, unentrapped medication from the formulation is not necessary.
- Since the drug is covalently attached, there will be a loss if the drug is not taken because of leakage.
- No issue with drug integration
- In the case of pharmacosomes, captured volume and drug bilayer interactions have no bearing on the effectiveness of entrapment. On the other hand, in the case of liposomes, these parameters have a significant impact on entrapment efficiency.
- The liposome's lipid content determines the fluidity of its membrane, which in turn affects the rate of drug release and the structural stability of the system.

**Advantages:**

- High and predefined entrapment efficiency Effective technique to achieve desired therapeutic aims, such as medication targeting and controlled release
- The amount of inclusion has no bearing on the effectiveness of trapping.
- No need to remove untapped, loose drugs
- Increases the bioavailability of medicines with poor solubility

**Disadvantages:**

- Amphiphilic nature is vital for the synthesis of compounds, and a covalent bond is necessary to prevent drug leakage. Additionally, compounds undergo chemical hydrolysis, fusion, and aggregation when stored.

**Preparation methods:**

Generally, pharmacosomes are prepared by 2 methods [18]:

1. Hand shaking method
2. Ether injection method

**Colloidosomes**

Colloidosomes refer to microcapsules characterized by hollow shells that emerge at the interface of emulsion droplets, housing coagulated or fused particles. Colloidalosomes exhibit promising potential in the realm of regulated drug delivery, protein and vitamin release, as well as applications in cosmetics and dietary supplements. Due to their capacity to effectively regulate size, permeability, mechanical strength, and compatibility, they demonstrate exceptional efficacy in encapsulation. The microcapsules in question possess a shell composed of colloidal particles that have undergone fusion or coagulation at the interface of the emulsion droplets. To minimize the overall interfacial energy, colloidosomes are formed through the self-assembly of particles on the surface of droplets. The colloidosomes described in this study are characterized by the presence of hairy polymeric micro rod shells surrounding an aqueous gel core. The achievement involved the initial formation of a water-in-oil emulsion that was stabilized using rod-shaped particles. Subsequently, the aqueous phase underwent gelation, while the oil phase dissolved in ethanol. This led to the development of colloidosome microcapsules, which were subsequently dispersed again in water.

**Advantages**:

- Control of size allows flexibility in applications and choice of encapsulated materials
- Great potential in controlling permeability of entrapped species and allow selective and time release
- Control of mechanical strength

**Herbosomes:**

The term "herb" is used to denote a botanical organism, whereas the term "some" pertains to entities that possess a cellular structure. Phytochemical and Phytopharmacological investigations conducted during the past century have provided valuable insights into the compositions, biological activities, and health-promoting qualities of various botanical items. Polar or water-soluble chemicals constitute the predominant portion of a plant's physiologically active constituents. In contrast, the water-soluble Phytoconstituents have limited lipid solubility, which greatly hinders their ability to pass through lipid-rich cellular membranes. As a result, their bioavailability is compromised. In comparison to conventional herbal extracts, herbosomes exhibit a more favorable pharmacokinetic and pharmacodynamic profile. The proteins are integrated into a cohesive matrix, which is formed by the presence of phosphatidylcholine [PC] and other phospholipids inside the molecular layer.

**Advantages:**

- improves the bioavailability of polar phytoconstituents that are lipid insoluble when applied topically and orally.
- Reduced dose requirement
- The preparation's utilization of phosphotidylcholine also has hepatoprotective effects.
- Better stability profile due to chemical interactions established between phosphotidylcholine molecules and phytoconstituents2 that allow non-lipophilic botanical extract to penetrate and be better absorbed in intestinal lumen.

**Sphingosomes:**

Sphingosomes can be described as vesicles characterized by concentric, bilayered structures, wherein an aqueous compartment is completely enclosed by a lipid bilayer composed primarily of natural or synthesized sphingolipids [19]. Sphingosomes have been developed to effectively tackle the inherent challenges associated with the vesicle system, such as its inherent instability, limited in vivo circulation duration, and suboptimal tumour loading efficiency in the context of cancer therapy. In clinical contexts, sphingosomes are utilized as carriers for the delivery of chemotherapeutic drugs, biological macromolecules, and diagnostics. Transdermal or oral administration can be employed. Sphingosomes can be described as liposomes composed primarily of sphingolipids.

**Advantages:**

- Improved pharmacokinetics;
- selective passive targeting of tumour tissue;
- increased efficacy and therapeutic index;
- increased stability by encapsulation;
- decreased toxicity of encapsulated substance [20]

**Layerosomes:**

The layer-by-layer coating strategy is a viable technique for the generation or maintenance of Nano systems. Layerosomes are liposomes that have been coated with biocompatible polyelectrolytes to enhance their structural integrity. The formulation strategy relies on an alternative coating technique

that involves the use of initially charged small unilamellar liposomes, along with positively charged poly [lysine] [pLL] and negatively charged poly [glutamic acid] [pGA] polypeptides. One of the limitations associated with liposomes is their inherent instability in both storage conditions and biological environments, mostly due to surface features. The creation of stable drug delivery systems was achieved through the stabilization of the surface chemistry of liposomes. Possible applications encompass the administration through oral means or their incorporation into biomaterial matrices. The layerosome concept has been employed to introduce the stable Nano system. [21]

**Ufosomes:**

The formation of lipid vesicles, known as unsaturated fatty acid liposomes or "ufosomes," is observed. Fatty acid vesicles refer to colloidal suspensions composed of closed lipid bilayers consisting of fatty acids and their ionised species. The ternary phase diagram of fatty acid-soap-water depicts their presence within a confined region above the chain melting temperature of the corresponding fatty acid soap mixture. Fatty acid vesicles contain both the nonionized neutral form and the ionised form of amphiphilic compounds. The stability of the vesicle is contingent upon the relative proportions of the nonionized neutral form and the ionised form. In actuality, the term "fatty acid/soap vesicles" refers to vesicles composed primarily of fatty acids. In contrast to liposomes, the membranes of ufosomes exhibit significantly enhanced stabilization [22].

**Strategies to Improve VDDS:**

To improve VDDS mainly 2 strategies are reported:

- Pro-vesicular drug delivery:

Developed to overcome the stability problems associated with vesicular drug delivery systems composed of dry products or liquid crystalline gel that can be hydrated immediately before use.

e. g., Proliposomes, Proniosomes

**Characterization**:

Morphology, Angle of repose, Rate of hydration, Degree of deformity & permeability measurements, Size & Size distribution etc.

Types of pro-vesicular drug delivery system:

1. Proliposomes
2. Proniosomes

- Improve permeability:

a. Physical means b. chemical means

**Prospects in VDDS:[23]**

**Aquasomes**: Three layered self-assembly compositions with ceramics carbon nanocrystalline particulate core coated with glassy cellobiose specific targeting and molecular shielding.

**Cryptosomes**: Lipid vesicles with a surface coat composed of pc and of suitable polyoxyethylene derivative of phosphotidyl ethanolamine, capable of ligand mediated drug targeting.

**Discosomes**: Discosomes are niosomes solubilized with non-ionic surfactant solutions. They show ligand mediated drug delivery

**Emulosomes**: Nano size lipid particles consisted of microscopic lipid assembly with a polar core used parenteral delivery of poor water-soluble drugs.

**Enzymosomes**: Liposomal constructs engineered to provide a mini bioenvironmental in which enzymes are covalently immobilized or coupled to the surface of liposomes. Targeted delivery to tumor cells.

**Genosomes**: Artificial macromolecular complexes for functional gene transfer. Cationic lipids are most suitable because they possess high biodegradability and stability in the blood stream. Cell specific gene transfer.

**Photosomes**: Photolysase encapsulated in liposomes, which release the content photo triggered charges in membrane permeability characteristics.

**Virosomes**: Liposomes spiked with virus glycoprotein, incorporated into the liposomal bilayers based on retro viruses derived lipids.

**Vesosomes**: A nested bilayer compartment is generated in vitro through the interdigitation of a bilayer phase, achieved by introducing ethanol to various saturated phospholipids. The presence of several compartments within Vesosomes enhances the level of protection afforded to the internal contents when exposed to serum. Proteasomes: The catalytic activity of high molecular weight multi-subunit enzyme complexes is attributed to the unique assembly pattern of enzymes. Enzymes that are associated exhibit superior catalytic activity turnover compared to enzymes that are not related.

**Emulosomes**: Hemoglobin [Hb] encapsulated within liposomes has been modified through the immobilization of Hb using polymerizable phospholipids E.

**Rythrosomes**: The liposomal system involves the utilization of chemically cross-linked human erythrocytes as a supportive structure, upon which a lipid bilayer is coated.

**Enzymosomes**: Enzymes can be immobilized through covalent bonding or linked to the surface of liposomes.

**Archaesome**: Over the past decade, there has been substantial research conducted on the possible uses of medicine and vaccine delivery using natural archaeal membrane lipids and/or synthetic lipid analogues. Archaeal-type lipids are composed of core structures derived from archaea and/or caldarchaeol. These structures typically feature regularly branched and fully saturated phytanyl chains, which are attached to the sn-2,3 carbons of the glycerol backbone through ether bonds.

## Conclusion

In numerous scientific disciplines, the vesicular system has been widely acknowledged as a highly advantageous carrier system. The utilization of vesicular drug delivery technology has witnessed a significant increase in prevalence in contemporary times, mostly attributed to its ability to facilitate site-specific targeting of drugs and a multitude of other advantageous features. In order to mitigate toxicity and minimize adverse effects in non-target areas, medications can be efficiently and precisely delivered to their intended site of action. Additionally, they can be employed to enhance the bioavailability, reduce the administered dosage, and enhance the pharmacological efficacy of the medication. Liposomes, niosomes, and other vesicular drug delivery systems have demonstrated significant efficacy as drug delivery systems within the contemporary pharmaceutical industry. These systems have notable positions within pharmaceutical dosage forms and are employed to tackle crucial difficulties within the pharmaceutical field.

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Authors are declared that no conflict of interest

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All authors are contributed equally.

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