JCARR
JOURNAL OF CLINICAL ADVANCES AND RESEARCH REVIEWS

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Journal of Clinical Advances and Research Reviews 2024; 01(01); 11-23

Review Article

An Approach in Novel Drug Delivery Systems Future Prospects and Opportunities

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Received: 20-01-2024 / Revised: 20-02-2024 / Accepted: 26-02-2024
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Conflict of interest: Nil

Abstract: The term "novel drug delivery system" (NDDS) refers to techniques, formulations, technologies, and systems for conveying a pharmaceutical substance in the body as needed to safely achieve its targeted therapeutic effects. The Novel Drug Delivery System (NDDS) combines advanced techniques with a standard drug delivery system to deliver drugs in a different way. Compared to traditional dose forms, NDDS are a considerably superior new dosage form. The development of an existing therapeutic molecule from a traditional form to a unique delivery method can greatly increase its performance in terms of patient compliance, safety, and efficacy. Novel Drug Delivery System uses a variety of ways, such as medical devices or drug-device combo solutions. Designing such delivery systems is primarily done to reduce drug loss and degradation, avoid negative side effects, and boost bioavailability. New medication delivery methods are created based on biological and physical processes. Diffusion, osmosis, erosion, and dissolution are examples of physical mechanisms or controlled drug delivery systems. Nanoparticles, liposomes, gene therapy, and monoclonal antibodies are examples of biochemical mechanisms. Different drug targeting and delivery technologies are currently under development. This article covers the basic information regarding Novel Drug Delivery Systems

Keywords: *Novel drug delivery system, Phytosomes, Liposomes, Nanoparticles, Dosage forms.*

Introduction: Novel drug delivery methods can be based on physical mechanics or biological principles. Physical mechanisms, which are also known as controlled drug delivery systems, encompass osmosis, diffusion, erosion, dissolution, and electrotransport. Monoclonal antibodies, gene therapy, vector systems, polymer drug addicts, and liposomes are all examples of biochemical mechanisms. The capacity to guide the drug-loaded system to the desired location is known as targeting. When it comes to addressing the targeted areas for drug release, two main methods may be identified:

i. Passive targeting
ii. Active targeting

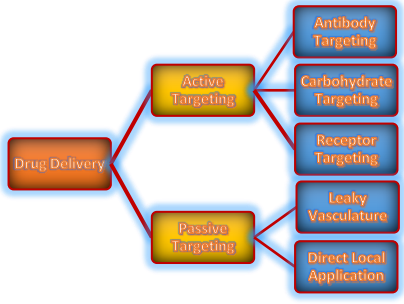

Fig. 1 Type of Drug Delivery

Some of the therapeutic advantages of novel drug delivery systems include extending the duration of medication action, decreasing dosing frequency, regulating the site of release, and maintaining stable drug levels. [1-3]

Nanoparticles with a diameter of 10 to 100 nm are classified as nanoparticles. As a targeted supply mechanism for the distribution of small and large molecules, their pharmacodynamic and pharmacokinetic properties are modified. They are defined as systems that contain dissolved active agents that are encapsulated or adsorbed in the matrix material used to deliver the target tissue. Medication has been shown to increase the retention stability of nanoparticles by enzymes and intravascular solubilization of nanoparticles in target tissue. Some controls must be observed during the design of nanoparticles, such as their release pattern, dimensions, and surface characteristics, which determine the specific site action at optimum rates with the appropriate dose scheme. The first nanoparticles discovered were based on a non-biodegradable polymeric framework (polyacrylamide, polymethyl-methaacrylate).

Definition: The medication is referred to as a solid particulate with sizes ranging from 10 to 1000 NM or as a dissolved, trapped, encapsulated, or nanoparticle-attached nanoparticle matrix. Amorphous or crystalline[4–7] nanoparticles, such as 10-200 nm-sized nanospheres and nanocapsules, are solid particles. The creation of nanoparticles was frequently accomplished with polymeric materials. It is possible to obtain nanoparticles, nanospheres, or nanocapsules depending on the preparation technique. The pharmaceutical substance is physically and uniformly dispersed by the nanosphere, a matrix system, whereas nanocapsules contain the medicinal product within a cavity with a special polymeric membrane.[8]

Nanoparticles have undergone extensive research as a targeted drug delivery system[9]. The delivery of targeted drugs can be achieved through active or passive targeting. Active drug targeting can occur through the conjugation of the drug molecule with a cell or tissue-specific ligand. [10]. While passive drug targeting can be accomplished by incorporating a drug molecule into micro- or nanoparticles. Natural, synthetic, and semi-synthetic polymers comprise the Colloidal Framework for Drug Delivery Nanoparticles (NP). The diameter of NP particles ranges from 10 nm to 1,000 nm[11]. This colloidal drug delivery system has a unique inner structure.

The following are the benefits of a novel drug delivery system[12]:

1. Protection from physical and chemical degradation.
2. Improvement in solubility.
3. Increased tissue macrophage distribution.
4. Improvement in stability.
5. Increased pharmacological activity.
6. Consistent delivery..
7. Improved bioavailability.
8. Toxicological protection.

Disadvantages [13]

1. Bioacceptability has its limits.
2. Difficult to produce in large quantities.
3. The small amount of particles and the large area can make it difficult to aggregate particles due to their small size, thereby making it difficult to physically handle nanoparticles in liquid and dry form.
4. Limited loading and explosion contribute to small particle size and large surface area. These practical issues should be addressed until nanoparticles are clinically or commercially available.
5. The current work is a step toward the development of drug delivery systems for nanoparticles, surface modulation, drug loading strategies, release control, and future nanoparticle applications.

Ideal Characteristics [14]

1. Targeted drug delivery framework
2. Non-immunogenic, biochemically inert (not toxic).
3. Physically and chemically stable in vivo and in vitro. Drug delivery should be standardized and restricted to target cells (or) organs. Controllable and predictable drug release. The release of medications has no effect on drug action. The amount of medicine released is therapeutic. Minimal drug leakage during travel.

4. The carriers used have no issue or bear-mediated disease modulation without being biodegradable (or) easily removed from the body. Quick (or relatively easy) reproductive and cost-effective delivery system preparation.

The objective[15]

The main goals when developing nanoparts as an input device are to monitor particle size, surface properties, or release of pharmacologically active agents in order to achieve site specific action at the therapeutically optimized rate and dosage scheme.

As a result, the medication is explicitly engineered with minimal side effects and an enhanced therapeutic index to achieve the desired pharmacological response in a specific site while avoiding adverse interactions in other sites.

For example, cancer chemotherapy and enzyme replacement therapy.

The Need for Research [16]

Currently, 95% of all experimental drugs have low pharmacokinetic and biopharmaceutical properties. As a result, appropriate medication distribution schemes must be established only at the site without harming healthy bodies and tissues, dispersing therapeutically activated drug molecules, lowering efficacy doses, and improving therapeutic indices and safety profiles in new therapists. There are numerous explanations.

pharmaceutical - Confusion in traditional dosing - Solubility.

Biotechnology - Poor uptake. - High diaphragm borders - Instability of the organism.

Pharmaceuticals/pharmacodynamics - Short half of a lifespan - Wide distribution volumes - Limited pace.

Clinical Clinical - Poor Index of Therapy.

Mechanisms:

Nanoparticles deliver drugs onsite by avoiding the reticuloendothelial system and utilizing improved permeability, retention effect, and targeting. Drugs using nanoparticles as carriers use two approaches.

a. Surface bound: The drug molecules are attached to the surface of the nanoparticles.

b. Core bound: The drug particles are concentrated in this manner into the nano pharma matrix and transported into the body to the target. Drugs can be loaded onto nanoparticles by adding or adding to the reaction mixture during polymerization to a solution containing previously prepared nanoparticles. The interaction of nanoparticles with drug products may be based on chemistry, superficial adsorption, or any binding or contact. The number Rely on the chemical structure of the drug and polymer and the conditions for drug loading, the binding drug, and the form of interaction of the drug and nanoparticles.[15]

Types of NDDS[17, 18,19]

NDDS stands for Novel Drug Delivery Systems, and it refers to various technologies and approaches used to deliver drugs in a targeted and controlled manner. These systems aim to improve the therapeutic efficacy and safety of drugs by optimizing their pharmacokinetics and pharmacodynamics. There are several types of NDDS, and they can be classified based on different criteria. Here are some common types:

1. **Based on the route of administration**
   - **Oral drug delivery system** These include technologies such as liposomes, nanoparticles, and microparticles designed to improve drug delivery through the oral route.
   - **Injectable Drug Delivery System:** Examples include liposomes, microspheres, and nanoparticles designed for parenteral administration, such as intravenous or intramuscular injection.
   - **Topical Drug Delivery systems:** These are systems designed for application on the skin or mucous membranes, including transdermal patches, gels, and creams.
   - **Pulmonary Drug Delivery Systems:** Inhalation system for delivery drug directly to the lungs, often used for treating respiratory conditions.
2. **Based on structure:**
   - **Lipid Based drug delivery systems:** Examples include liposomes and solid lipid nanoparticles.
   - **Polymeric drug delivery systems:** These involve the use of polymers to encapsulate and deliver drugs, such as microparticles and nanoparticles.
   - **Protein-Based Drug Delivery Systems:** Utilizing proteins or peptides as carriers for drug delivery
3. **Based on Release Mechanism:**
   - **Sustained/Controlled Release Systems:** These systems release the drug over an extended period, maintaining therapeutic levels in the body.

- **Targeted Drug Delivery Systems:** Designed to deliver drugs specifically to the target site, minimizing systemic exposure and side effects.
- **Responsive Drug Delivery Systems:** Systems that respond to specific stimuli (e.g., pH, temperature, enzymes) to release the drug in a controlled manner.

4. **Based on Nature of Carriers:**
   - **Micelles:** Colloidal structures formed by amphiphilic molecules that can encapsulate hydrophobic drugs.
   - **Nanoparticles:** Small particles, often in the nanometer range, used to encapsulate and deliver drugs.
   - **Liposomes:** Spherical vesicles composed of lipid bilayers, commonly used as drug carriers.
5. **Based on Administration Goals:**
   - **Theranostic Systems:** Combine therapy and diagnostics, allowing simultaneous treatment and monitoring of the therapeutic response.
   - **Immunotherapeutic Drug Delivery Systems:** Aimed at enhancing the immune response against diseases, especially in the context of cancer.
6. **Based on Material of Construction:**
   - **Organic Nanocarriers:** Such as liposomes and polymeric nanoparticles.
   - **Inorganic Nanocarriers:** Like silica nanoparticles or gold nanoparticles.

Recent developments in novel drug delivery system:

1. Liposome
2. Nanoparticles
3. Phytosomes
4. Emulsions
5. Microsphere
6. Ethosome
7. Transdermal Drug Delivery System
8. Dendrimers
9. Solid lipid nanopartical
10. Niosomes
11. Fast dissolving Tablets
12. Hydrogels

Liposomes:

Tiny pouches made of lipids, or fat molecules, encircling a water core that are widely used in clinical cancer treatment. Several types of liposomes are widely used to combat infectious diseases and can deliver vaccines. They encapsulate drugs during cancer treatment, protecting healthy cells from toxicity and preventing their concentration in vulnerable tissues such as the patient's kidneys and liver. Liposomes can also reduce or eliminate certain common side effects of cancer treatment, such as nausea and hair loss. They are form of vesicles that consist either of many, few or just one phospholipid bilayers. The polar character of liposomal core enables polar drug molecules to be encapsulated. Amphiphilic and lipophilic molecules are solubilized within phospholipid bilayer according to their affinity towards phospholipids. [20,21]

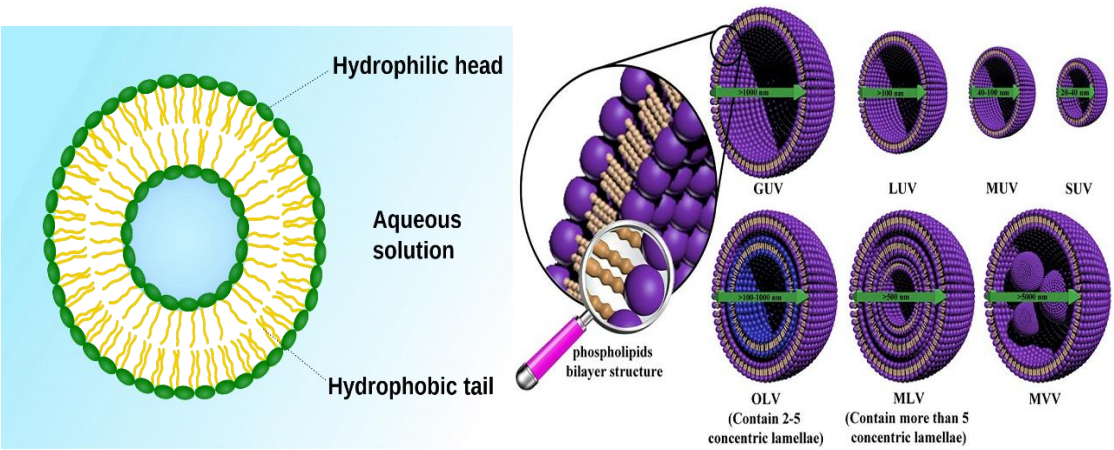

Fig. 2 Liposome and classification of Liposome

Liposome classification based on structural features[17]

1. MLV - Multilamellar large vesicles
2. OLV - Oligolamellar vesicles
3. UV - Unilamellar vesicles
4. SUV- Small unilamellar vesicles
5. MUV - sized unilamellar vesicles
6. LUV - Large unilamellar vesicles

7. GUV - Giant unilamellar vesicles
8. MVV -Multivesicular vesicle

Advantages of Liposome

- Reduction in toxicity of the encapsulated agents
- The easiness of preparation.
- The chemical versatility that allows the loading of hydrophilic, amphiphilic, and lipophilic compounds
- Improved pharmacokinetic effects (reduced elimination, increased circulation life times). [20,21]

Nanoparticles: Nanoparticles: Nanoparticles (including nanospheres and nanocapsules with sizes ranging from 10-200 nm) are solids that can be amorphous or crystalline. They can adsorb and/or encapsulate a drug, shielding it from chemical and enzymatic degradation. Biodegradable polymeric nanoparticles have garnered considerable attention as potential drug delivery devices in recent years due to their applications in controlled drug release, targeting specific organs/tissues, as carriers of DNA in gene therapy, and their ability to deliver proteins, peptides, and genes via the peroral route.

Advantages of herbal nanoparticle delivery system

- Producible with various sizes, compound surface properties
- Increased efficacy and therapeutic index.
- Nanoparticulate system delivers the herbal formulation directly to the site of action. Increased stability via encapsulation
- Improved pharmacokinetic effect. [22-23]

Phytosomes: The word "Phyto" indicates plant while others means cell-like. "Phyto" means plant. Phytosomes were the Method of vesicular supply of herbal extract phytoelectric ingredients and Lipid bound (one molecular phyto-constituent, bound to a phospholipid at least molecular).). Phytosomes guard against degradation of important herbal extract components Digestive secretion and intestinal bacteria which have increased absorption Provides improved pharmacological and pharmacokinetic biological and improved availability Parameters of herbal extract traditional.16 and the distinction between phytosomes and liposome.[24]

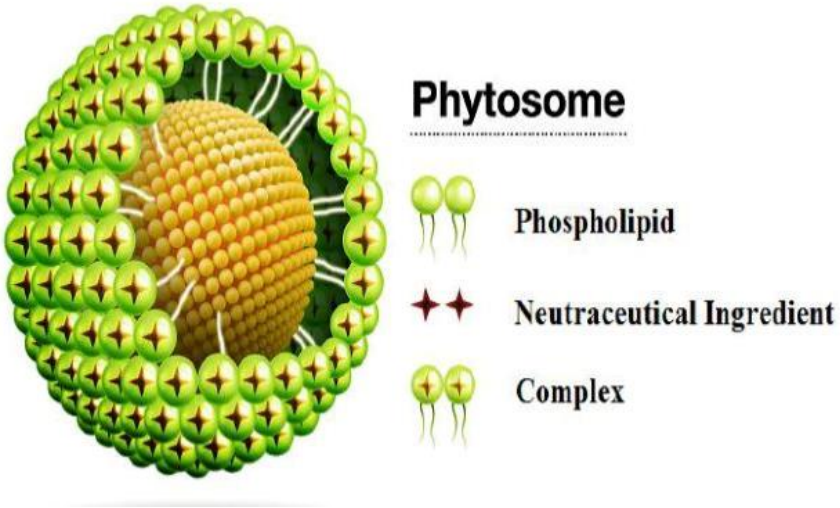

Fig. 3 Structure of Phytosome

Advantages of Phytosome:

- Phytosome increases the absorption of active constituents, so its dose size required is small.
- There is appreciable drug entrapment and improvement in the solubility of bile to herbal constituents, and it can target the liver.
- In Phytosome, chemical bonds are formed between phosphatidylcholine molecules, so it shows good stability [12].
- Phytosome improves the percutaneous absorption of herbal phytoconstituents
- High bioavailability requires less dosage.

- Greater stability. More stability.
- High lipophilicity causes high penetration and is thus used over liposomes in cosmetics
- Significant clinical advantages. 8. Phosphatidylcholine is not a carrier but serves as a liver protection.[25]

Niosomes: They are lamellar microscopic structures which are produced by a nonionic surfactant, cholesterol admixture and a charges-inducer with a subsequent hydrating in watery media. Niosomes have a hydrophobic and hydrophilic moiety infrastructure, which allows drug molecules with a large range of solubilities to be accommodated. In several pharmaceutical applications, niosomes have been assessed. Significant benefits in clinical application such as the ability to reduce systemic toxicity by encapsulating treatment agents include the ability to decrease clearance from the body by slowing drug release of such agents. [26]

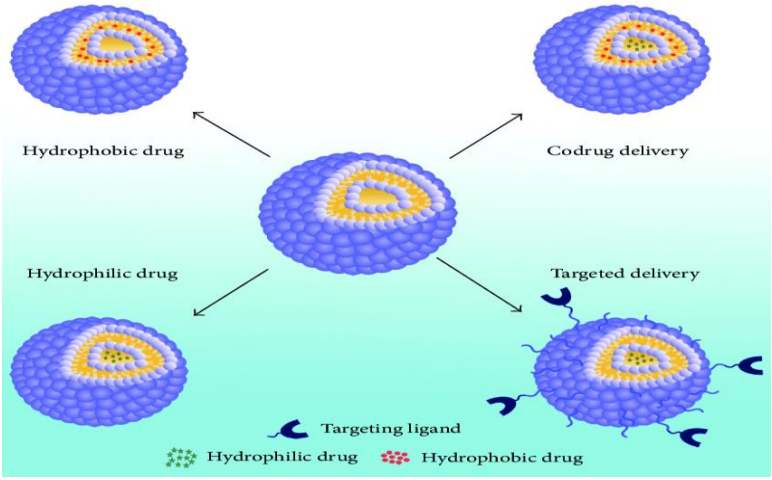

Fig. 4 Structure of Niosome

Types of Niosomes

1. Niosomes are classified based on number of bilayer, size
2. and method of preparation.
3. Mulitlamellar- 0.5µm to 10µm in diameter
4. Larger unilamellar- 0.1µm to 1µm in diameter
5. Small unilamellar – 25-500nm in diameter.

Advantages of Niosome[21]

- Niosomes are non-toxic, non-immunogensic, biodegradable and compatible.
- In a small volume of vesicles, niosomes can encapsulate large amounts of material.
- Niosomes have greater compliance, happiness and efficacy than Common oily formulae.
- Niosomes can trap a broad range of (hydrophilic, lipophilic, and amphiphilic) chemicals.The unique structure of drugs).
- Niosome features such as type, flow and size can easily be monitored Modification of structural structure and manufacturing processes.
- Niosomes can be administered through several routes including oral, parenteral and administrative.Available in various types, such as semisolids, powders or suspensions, topical, etc. 7. Since the structural structure's chemical stability, the niosome is simple to store.

Transdermal Drug Delivery System: Transdermal drug delivery is defined as self contained, discrete dosage forms which, when applied to the intact skin, deliver the drug, through the skin at controlled rate to the systemic circulation. Transdermal drug delivery system (TDDS) established itself as an integral part of novel drug delivery systems 28 . Delivery via the transdermal route is an interesting option because transdermal route is convenient and safe.

The positive features of delivery drugs across the skin to achieve systemic effects are:

- Avoidance of first pass metabolism
- Avoidance of gastro intestinal incompatibility
- Predictable and extended duration of activity

- Improving physiological and pharmacological response Termination of therapy is easy at any point of time
- Greater patient compliance due to elimination of multiple dosing profile
- Provide suitability for self administration
- Enhance therapeutic efficacy[27]

Microspheres: Microspheres are characteristically free flowing powders consisting of proteins or synthetic polymers which are biodegradable in nature and ideally having a particle size less than 200 µm. Materials used for preparing Microspheres are polymers.

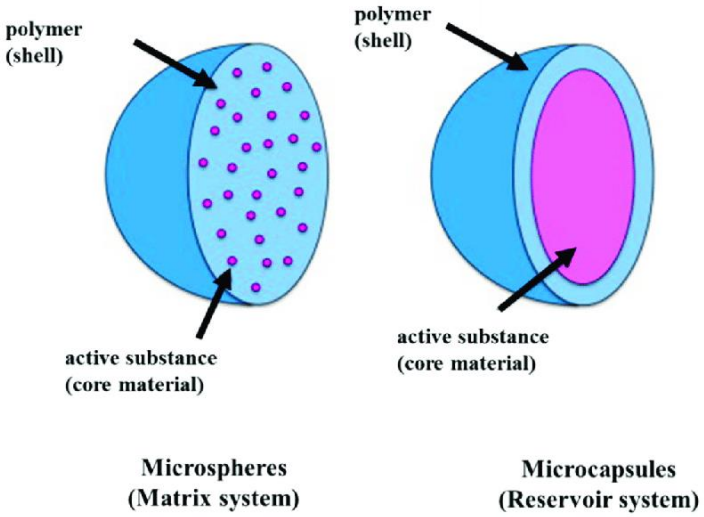

Fig. 5 Structure of Microsphere

They are classified into two types:
1. Synthetic Polymers
2. Natural polymers

1. Synthetic polymers are divided into two types.
a. Non-biodegradable polymers
- Poly methyl methacrylate (PMMA)
- Glycidyl methacrylate
- Epoxy polymers

b. Biodegradable polymers
- Lactides, Glycolides & their co polymers
- Poly alkyl cyano acrylates
- Poly anhydrides

2. Natural polymers: obtained from different sources like proteins, carbohydrates and chemically modified carbohydrates**.**
- **Proteins:** Albumin, Gelatin, and Collagen
- **Carbohydrates:** Agarose, Carrageenan, Chitosan, Starch
- **Chemically modified carbohydrates**: Polydextran, Poly starch.[28]

Fast dissolving tablet: A novel tablet concept which offers ease of oral administration and benefits of increased patient compliance is fast dissolving tablet (FDT). This tablet format is designed to allow administration of oral solid dosage form in absence of water or fluid intake. Such tablets readily dissolve or disintegrate in saliva generally within less than 60 seconds. When put on tongue, this tablet disintegrate instantaneously, release in the drug. Good in chemical stability. Suitable during traveling where water is may not be available.[29,30]

Fig. 6 Fast dissolving Tablets

Ethosomes:

Ethosomes are developed by mixture of phospholipids and high concentration of ethanol. This carrier can penetrate through the skin deeply lead to improve drug delivery into deeper layer of skin and in blood circulation. These formulations are useful for topical delivery of alkaloids in form of gel and cream for patients comfort. They show increase in their permeability through the skin by fluidizing the lipid domain of the skin. Unstable nature and poor skin penetration are limits for Ethanosomes tropical delivery. The Ethosomes was developed and examined for their ability the topical absorption of Tetrandine through dermal delivery, and the relation of formulations to the pharmacological activity of Tetrandrine loaded in the formulation was also accessed. Result of the drug levels in rat plasma showed that when Tetrandrineloded Ethosomes were topically administered in rats the drug level was low to be detected in rat plasmaIn conclusion, Ethosomes were demonstrated to be promising carrier for improving topical delivery of Tentrandrine via skin [31].

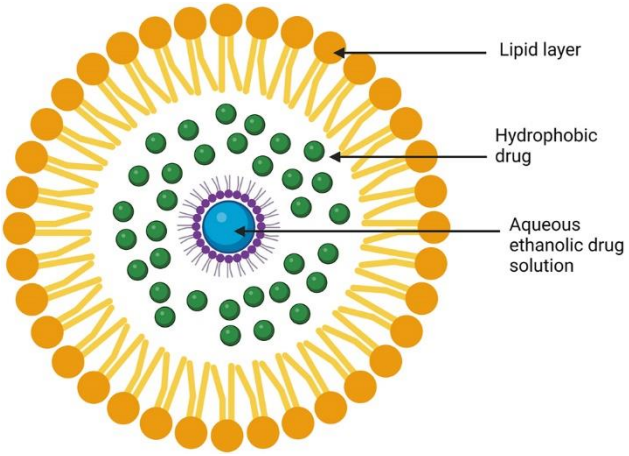

Fig. 7 Structure of ethosomes

Advantages of ethosomal drug delivery:

- Ethosomes enhance transdermal permeation of drug through skin.
- Ethosomes are a platform for the delivery of large amounts of diverse groups of drugs.
- Ethosomaldrud is administered in semisolid form resulting in improvement in patients compliance [30].

Dendrimers:

Dendrimers are nanometer-sized, highly branched and monodisperse macromolecules with symmetrical architecture. They consist of a central core, branching units and terminal functional groups. The core together with the internal units, determine the environment of the nanocavities and consequently their solubilizing properties, whereas the external groups the solubility and chemical behaviour of these polymers. Targeting effectiveness is affected by attaching targeting ligands at the external surface of dendrimers, while their stability and protection from the Mononuclear Phagocyte System (MPS) is being achieved by functionalization of the dendrimers with polyethylene glycol chains (PEG). Liquid Crystals combine the properties of both liquid

and solid states. They can be made to form different geometries, with alternative polar and non-polar layers (i.e., a lamellar phase) where aqueous drug solutions can be included. [32,33]

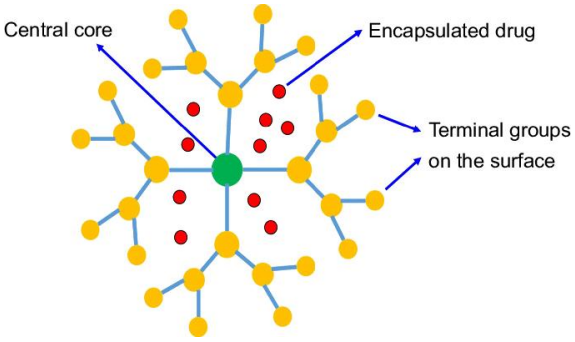

Fig. 8 Structure of dendrimers

Hydrogels: Hydrogels are three-dimensional, hydrophilic, polymeric networks capable of imbibing large amounts of water or biological fluids. The networks are composed of homopolymers or copolymers, and are insoluble due to the presence of chemical crosslinks (tie-points, junctions), or physical crosslinks, such as entanglements or crystallites. Hydrogels exhibit a thermodynamic compatibility with water, which allows them to swell in aqueous media. They are used to regulate drug release in reservoir-based, controlled release systems or as carriers in swellable and swelling-controlled release devices. On the forefront of controlled drug delivery, hydrogels as enviro-intelligent and stimuli-sensitive gel systems modulate release in response to pH, temperature, ionic strength, electric field, or specific analyte concentration differences. In these systems, release can be designed to occur within specific areas of the body (e.g., within a certain pH of the digestive tract) or also via specific sites (adhesive or cell-receptor specific gels via tethered chains from the hydrogel surface). Hydrogels as drug delivery systems can be very promising materials if combined with the technique of molecular imprinting. [34,35]

Classification of hydrogels

- Based on the methods of preparation- Homopolymeric Hydrogel, Co-polymeric hydrogel, Inter Penetrating Network,
- Stimuli-sensitive hydrogels- Temperature-sensitive hydrogels, pH-sensitive hydrogels, Dual pH-thermal sensitive systems
- Based on mechanism of release-Diffusion controlled, swelling controlled.

Advantages of Hydrogels

- Biocompatible, biodegradable and can be injected
- Hydrogels possess wide degree of flexibility similar to natural tissue.
- Have good transport properties and easy to modify.[34]

Solid lipid nanoparticles:

(SLNs) are a new pharmaceutical delivery system or pharmaceutical formulation.

The conventional approaches such as use of permeation enhancers, surface modification, prodrug synthesis, complex formation and colloidal lipid carrier based strategies have been developed for the delivery of drugs to intestinal lymphatics. In addition, polymeric nanoparticles, self-emulsifying delivery systems, liposomes, microemulsions, micellar solutions and recently solid lipid nanoparticles *(SLN)* have been exploited as probable possibilities as carriers for oral intestinal lymphatic delivery.[25]

A solid lipid nanoparticle is typically spherical with an average diameter between 10 and 1000 nanometers. Solid lipid nanoparticles possess a solid lipid core matrix that can solubilize lipophilic molecules. The lipid core is stabilized by surfactants (emulsifiers). The term lipid is used here in a broader sense and includes triglycerides (e.g. tristearin), diglycerides (e.g.glycerolbahenate), monoglycerides (e.g. glycerol monostearate), fatty acids (e.g. stearic acid), steroids (e.g. cholesterol), and waxes (e.g. cetyl palmitate). All classes of emulsifiers (with respect to charge and molecular weight) have been used to stabilize the lipid dispersion. It has been found that the combination of emulsifiers might prevent particle agglomeration more efficiently.[36,37]

Emulsions:

Emulsion is a biphasic system in which one phase is intimately disperse in the other phase in the form of minute droplets in ranging in diameter from 0.1µm to 100 µm. In emulsion, one phase is always water or

aqueous phase, and the other phase is oily liquid, i.e. non aqueous. Among them, the microemulsion is also called nanoemulsion, and the sub-micro-emulsion is called liquid emulsion. Microemulsion is a clear, thermodyanamically stable, frequently in combination with a co-surfactant.

Advantages of emulsion-based formulations:

- It can release the drug for a long time because it is packed in the inner phase and makes direct.
- contact with the body and other tissues.
- As a result of the lipophilic drugs being made into o/w/o emulsion, the droplets of oil are phagocytosised by macrophages and increase its concentration in liver, spleen and kidney.
- As the emulsion contains herbal formulation, it will increase the stability of hydrolyzed formulated material and improve the penetrability of drug into skin and mucous.
- The new type, viz., Elemenum emulsion, is used as an anti-cancer drug and causes no harm to the heart and liver.[38,39].

Evaluation Parameters: The nanoparticles are generally evaluated for the following:

1. Size and morphology
2. Specific surface
3. Surface charge and electrophoretic mobility
4. Density of nanoparticles
5. Molecular weight
6. Nanoparticle recovery and drug incorporation efficiency
7. In vitro release[40]

Future Prospects and Opportunities

The field of drug delivery systems has been evolving rapidly, and novel approaches are continuously being developed to enhance the efficacy, safety, and patient compliance of pharmaceuticals. In India, the future prospects and opportunities in novel drug delivery systems are promising, driven by several factors:

1. **Advanced Technologies:** Continued advancements in nanotechnology, microfabrication, and biotechnology are leading to the development of innovative drug delivery systems. Nano-carriers, liposomes, microspheres, and implants are some examples that offer targeted and controlled drug release.
2. **Biologics and Biosimilars:** The rise of biologics and biosimilars has opened up opportunities for novel drug delivery systems. Improved methods of administering these complex molecules, such as sustained-release formulations and targeted delivery, can enhance their therapeutic effectiveness.
3. **Personalized Medicine:** The trend towards personalized medicine creates a demand for drug delivery systems that can be tailored to individual patient characteristics. This involves technologies like 3D printing for customized dosage forms and implantable devices for long-term drug delivery.
4. **Government Initiatives:** Government initiatives to promote the pharmaceutical and biotechnology sectors, such as 'Make in India' and other supportive policies, can encourage research and development in novel drug delivery systems.
5. **Increasing Chronic Diseases:** The growing prevalence of chronic diseases in India, such as diabetes, cardiovascular diseases, and cancer, provides a significant market for drug delivery systems that can offer sustained release and targeted therapy.
6. **Patient Compliance:** Improving patient compliance is a key focus in healthcare. Novel drug delivery systems that simplify dosing regimens, reduce side effects, and enhance convenience can significantly improve patient adherence to prescribed medications.
7. **Global Collaborations:** Collaboration with global pharmaceutical companies, research institutions, and regulatory bodies can facilitate the exchange of knowledge, technology, and funding, fostering the development and adoption of novel drug delivery systems in India.
8. **Research and Development Investments:** Increased investments in research and development by pharmaceutical companies and academic institutions can drive innovation in drug delivery technologies. This can lead to the discovery of new and improved formulations for existing drugs.
9. **Market Expansion:** As the pharmaceutical market in India expands, there is a growing need for differentiated products. Novel drug delivery systems can provide a competitive edge for pharmaceutical companies looking to diversify their product portfolios.

10. **Regulatory Support:** Supportive regulatory frameworks that encourage the development and commercialization of novel drug delivery systems can boost investment and innovation in this sector.

The future of novel drug delivery systems in India is promising, with opportunities arising from technological advancements, healthcare needs, government initiatives, and a growing pharmaceutical market. Collaboration, research investments, and a favorable regulatory environment will be crucial in realizing the full potential of these opportunities.

Conclusion

New technologies have been developed to treat various diseases. The way a drug is administered can have a significant impact on its efficacy. Some drugs have an optimum concentration range within which they provide the greatest benefit, and concentrations above or below this range can be toxic or provide no therapeutic benefit at all. The use of drug delivery systems in drug development has given many people hope in the fields of pharmacology and medical research. Novel drug delivery and drug targeting are new techniques in pharmaceutical science. the conclusion of a novel drug delivery system should provide a comprehensive overview of its efficacy, safety, patient benefits, and potential for advancing healthcare practices, while also acknowledging areas for further research and development.

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