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Overview on different organic nanomaterials in medical field

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Abstract

There is a vast interest in the development of organic nanomaterials for biomedical applications. With unique properties such as high surface area to volume ratio, stability, inertness, and ease of functionilisation gives a wide range of applications. There is a fast growth on the uses of organic nanomaterials for regeneration of bone, cartilage, skin and dental issues. The application of organic nanomaterials in the field of nanomedicine is unique and futuristic. Organic nanoparticles give numerous advantages that enhance the simplicity of their preparation from biocompatible, biodegradable polymers and their stability in biological fluids during storage. With aim of providing useful insights to help further development efficient and for large scale production, this review paper focus on different types of organic nanomaterials, its properties and applications mainly used in medical sector.

Keywords : Nanoparticles, Nanovesicles, Nanotechnology, Drug delivery

1. INTRODUCTION

Organic materials are made up of organic matter excluding carbon-based materials. Organic nanomaterials use weak non covalent interactions for designing molecules and self assembly, which helps these materials to transform into desired structures. The size of organic nanoparticles ranges from 10 nanometer to 1 micrometer. Organic nanoparticle received little attention compared to in-organic nanoparticles. Over recent years, the pharmaceutical industry has led research in organic nanoparticles. The contributions for nanomedicine have boosted the development of various new organic nanomaterials. The capability of encapsulating or carrying active molecules by “Bottom up” synthesis has seen in the production of protein conjugates, liposomes, DNA delivery vehicles etc.”Top down” approach is an attrition technique in which we use wet nanomilling process to grind large particles. Organic compounds are ultimately soluble in water when compared to inorganic compounds. Organic nanoparticles are environment friendly, and for this reason they are very useful in biological applications.

2. NANOVESICLES

Nanovesicles can be artificially synthesised in a controlled environment. It is a bilipd layer rolled up into a sphericall shell. A small amount of liquid is enclosed and separated from external environment. It usually ranges in the size of 1 to 100 nanometers. These vesicles are formed by molecular self assembly process.

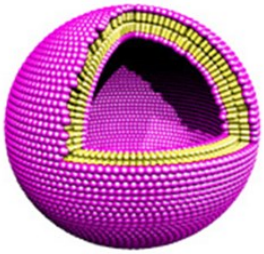

Figure 1- An illustrative view of a nanovesicle

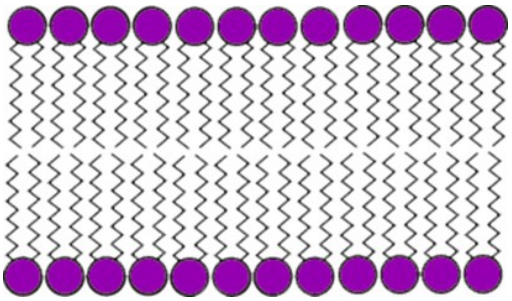

Figure 2- An illustrative view of a bilipid layer

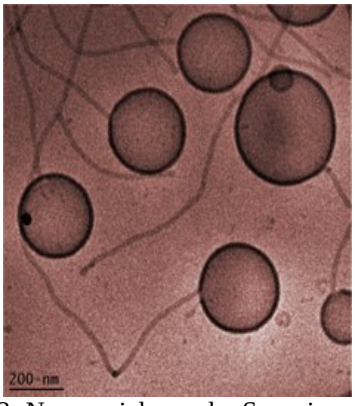

Figure 3- Nanovesicles under Scanning electron microscope

A nanovesicle possesses both hydrophobic and hydrophilic regions. Most of the hydrophilic and lipophilic active molecules are entrapped in nanovesicles. The outer layer of nanovesicles is usually made up of lipid base. Most of the nanovesicles exist in the range of 1-100 nm. It also contains an aqueous layer and a bilayer membrane which is made up of amphiphilic molecules. The amphiphilc molecules usually are lipids and phospholipids. The degree of saturation, charge and length of fatty acids has more influence over physical properties of the vesicles. Different kind of nanovesicles are prepared and utilized for dynamic functionalities. Some of them are liposomes , transferosomes, niosomes, ethosomes,colliodosomes etc.

3. LIPOSOMES

Liposomes are artificially formed nanovesicles. These are made up of non toxic phospholipids and are in spherical shape. The size of liposomes ranges from 25nm to 2500nm. These are usually called as nanoliposomes. Based on the size and layers, liposomes are classified into different broad types.

- Multilammelllar vesicles->500nm
- Oligolamellar vesicles- 100nm to 1000nm
- Unilamellar vesicles- >20 nm
- Multivesicular vesicles->1000nm

The unilamellar vesicles are further classified into:

- Small unilamellar vesicles (SUV) - 20nm to 100 nm
- Medium unilamellar vesicles (MUV)- >100nm
- Large unilamellar vesicles (LUV)- 100nm to 1000nm
- Gaint unilamellar vesicles (GUV)->1000nm

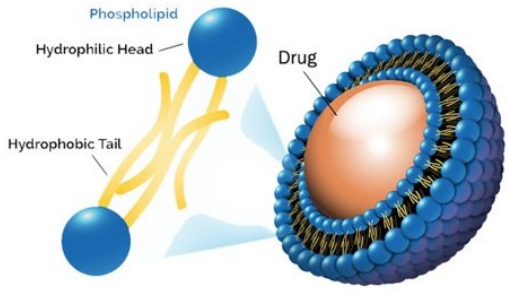

Figure 4- Liposomes

The synthesis of liposomes happen when it is introduced to an aqueous system.Due to hydrophobic force, the amphiphilic part of lipid components aggregates. From this aggregates, liposomes can be formed by the application external energy. Phospholipids and cholesterol are the major components of liposome preparation. Preparation of liposomes can be done either by mechanical dispersion or by solvent dispersion.

Mechanical dispersion methods:

- Lipid hydration method
- Micro emulsification
- Sonication
- French pressure cell method
- Membrane extrusion
- Dried reconstituted vesicles
- Freeze-thaw method

Solvent dispersion methods:

- Ethanol injection method
- Ether infusion method
- Double emulsification
- Reverse phase evaporation
- Detergent removal method

But for the preparation of stable liposomes we need to follow some regulations. It should be prepared and processed using fresh, purified lipid and solvents. For the preparation and storage, high temperature and excessive shearing stress should be avoided. Those liposomes which are subjected to freeze drying should be coupled with lyo-protectant. Low oxygen content and neutral pH should be during preparation.

Applications of liposomes

- Greatly used in pharmaceuticals,cosmetic products and food products.
- Mainly used as carriers for numerous molecules which having curing, preventing and treating effects.
- Antioxidents, antimicrobials,flavors and bio active elements can able to be encapsulated with liposomes.
- Used in infection treatment systems, vaccine systems, anticancer therapies, gene delivery.

4. TRANSFEROSOMES

Transferosomes are artificial vectors used in drug delivery system. It is made up of phospholipids and surfactants and is in vesicle structure. Transferosomes are mainly used in transdermal drug delivery. They generally aggregate in aqueous solvent to form bilayers into nanovesicles. Transferosomes has a structure consisting of hydrophobic and hydrophilic moieties. The self optimizing deformability of certain transferosome membrane makes them adaptable to ambient tress. Transferosomes can pass through narrow constriction with less loss. Due to this high deformability penetration of intact vesicles are easy.

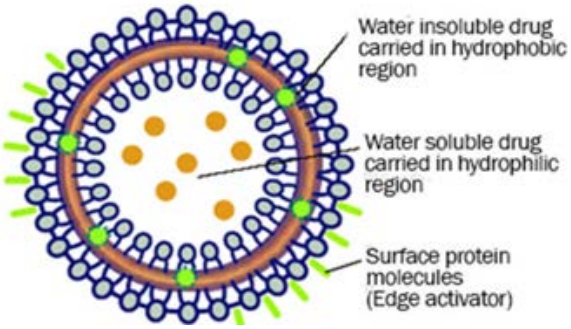

Figure 5- Transferosomes

The preparation of tranasferosomes is done by combining phospholipids and amphiphilic surfactanats. At reduced pressure, the solvent is removed by rotary vaccum evaporation. The thin layers liquid formed are hydrated using aqueous solvent at 60rpm. Thus formed vesicles are made to swell for few hours at room temperature. After few hours, these vesicles are sonicated at room temperature to get uniform and miniature vesicles.

5. NIOSOMES

A noisome is non ionic surfactant based vesicle. Through modification in chemical composition of liposomes the niosomal structure is developed. Niosomes contain cholesterol as an excipient along the surfactants. The size of niosomes ranges from 10 nm to 100 nm. Niosomes are usually microscopic lamellar structures.

Classification of niosomes :

- Small unilamellar vesicles-0.025 to 0.5 micrometer
- Small multilamellar vesicles-0.05 to 0.01 micrometer
- Large unilamellar vesicles-0.01 micrometer

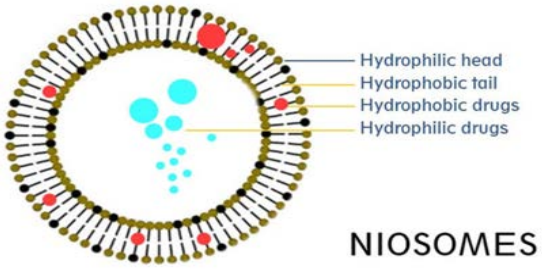

Figure 6- Niosomes

Niosomes can be prepared using different techniques:

- Hand shaking method
- Microfluidization
- Sonication
- Ether injection method
- Multiple membrane extrusion method
- Transmembrane pH gradient drug uptake process
- The bubble method
- Development of niosomes from proniosomes

Niosomes are prepared by mixing cholesterol and surfactant in a specified ratio and dissolved in a medium of organic solvents. For the removal of organic phase, the mixture is subjected to rotary vaccum evaporation. This results in the formation of thin layer cholesterol and surfactants. When drugs are added to the aqueous medium, vesicular structures which is in the range of nano to micro is formed. Through the sonication process, the size of the drugs is reduced. Through the process of dialysis, centrifugation or gel filteration, the entrapped drug is further removed from vesicles. Niosomes are comparatively stable than other vesicles in drug entrapment.Niosomes which are formed of cholesterol and non surfactant are biodegradable and biocompatible. They are non immunogenic and comparatively cost effective. Although niosomes have various applications, the physical instability is one the major drawbacks.

Applications of niosomes:

- Niosomes are applied in various therapeutically sector.
- Niosomes help in carrying and delivering wide range of drugs.
- Sustained drug delivery nature of noisome helps in incorporating them in different disease treatments.
- Niosomes help in delivering peptide and proteins greatly.
- Niosome function as a gene delivery vectors due to their multi beneficial nature.
- Niosomes help in DNA vaccination.
- Niosomes can be used in anti-neoplastic treatment.
- Due to the size and less penetrating action across the epithelium and connective tissue,they are highly specified for localised drug.
- Niosomes are potential carriers of haemoglobin.
- Niosomes utilised as adjuvents in the delivery of antigens to study the immune response.

6. ETHOSOMES

Ethosomes are lipid vascular system embodying ethanol in relatively high concentration. Ethanol,phospholipids,water are the major components of ethosomes. They are soft malleable vesicles, size ranges from 10 nanometer to micrometer. The high amount of ethanol makes them to penetrate easily through skin barrier.

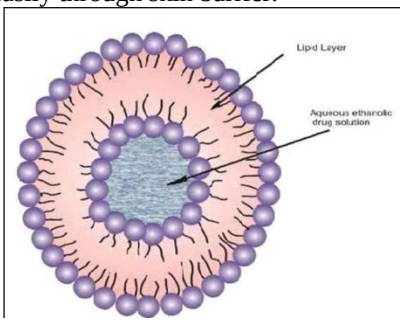

Figure 7 : Ethosomes

The effect of ethosomes on lipids results in the change of integrity of lipid layer in the stratum corneum paves way to new openings.Ethosomes move forward to penetrate and permeate through newly developed pathways. Due to penetration pathway, lipids of ethosomes fuse with lipid of skin and drug carried in the ethosomes are released. The released drug is further absorbed and reaches the blood stream through transdermal absorption. Ethosomes can be prepared by different methods. Cold method, classical method, mechanical dispersion method,hot method are these methods. Phospholipid, polyglycol,cholesterol,alchohol and gel forming agents are the important components of ethosomes. The output of ethosome based products is developed in a semi-solid form, usually as a gel or cream based form. Ethosomes enhance the penetration through skin easily and group of drugs can be delivered transdermally with the help of ethosomes. Ethosomes can deliver drugs into the deep layer of skin.

Application of ethosomes:

- Drugs based on ethosomes do have high patient compliance due to their simple nature of applications.
- Ethosomes are relatively simple to manufacture and they turn on industries to work with them.
- Ethosomes have applications in pharmaceuticals and cosmeceuticals.

7. COLLOIDOSOMES

Colloidosomes are entrapped colloidal particles into emulsion droplets organised into capsular structure. Colloidosomes are formed on the basics of “Pickering Emulsion”,an emulsion surrounded by solid particles between two phases. These colloidosomes are in the range of micrometer to nanometer. Colloidosomes synthesis

initiates like vesicles. Through self assembly process microencapsulation of emulsion droplets are formed after interaction of solid particles. Finally through sintering process,particles tend to develop solid organised colloidosomes.

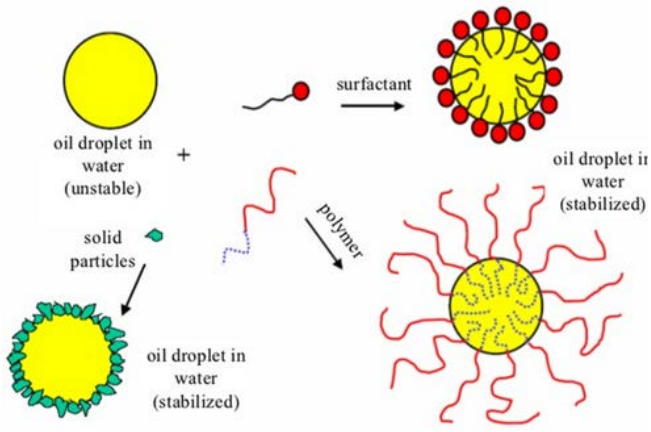

Figure 8: Colloidosomes

Colloidosomes are widely used in microencapsulation technique. Long term retention of small molecules and their encapsulation is achieved owing to their characteristics. They are very efficient due to their properties like mechanical strength, permeability, and compatibility in controlling the vesicles. The most unique form of colloidosomes is the precise control, which makes the strategic design of the vesicles to construct with ease.

Applications of colloidosomes:

- Colloidosomes are mainly used in industries and medicinal fields as encapsulating agents.
- Colloidosomes has major application in tumor therapy.
- Colloidosomes in antimicrobial,antifungal and antiviral therapy.
- Colloidosomes in cosmetic and dermatology.
- Colloidosomes in enzyme immobilisation.
- Colloidosomes in DNA delivery.

8. BILOSOMES

When vesicles like liposomes and niosomes added with bile salts will results in bilosomes. Bilosomes are specially designed to reduce the barrier in the vesicular drug delivery. Bile salts helps in membrane stabilisation in bilosomes. Dissolution problems and enzyme degradation in vesicles in stomach led to synthesis of bilosomes to remove these barriers. Based on the interaction of non ionic surfactants in the aqueous environment,bilosomes are formed. By the addition of bile salts,it improves the membrane stability of vesicles.

Bilosomes are prepared by pricnciple of emulsion formation, whereas the synthesis of bilosomes is similar to niosome and liposomes. Bilosomes can increase mucous penetration and oral penetration. It allows smaller entities of antigen to be effective and also tend to increase the antigen efficacy. Bilosomes do not require live pathogens and it remove the cold chain requirement for preparation of vaccines. Moreover bilosomes are less toxic.

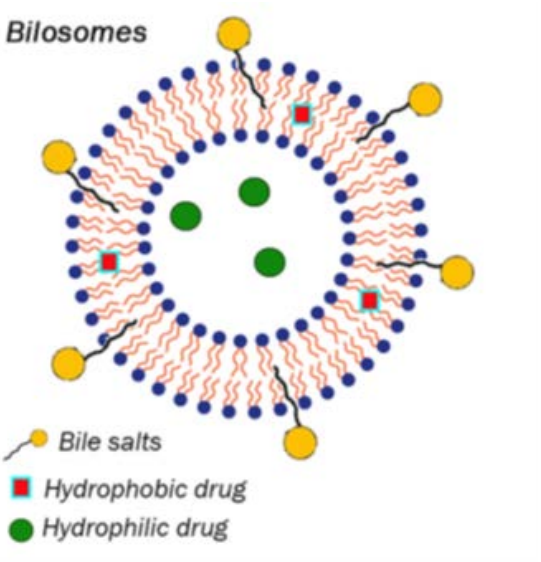

Figure 9: Bilosomes

Applications of bilosome:

- Bilosomes are effective in delivery of vaccines.
- Bilosomes can be applied in the delivery of biological therapeutics and traditional small drugs.
- Bilosomes can be used in oral immunisation against Hepatitis B.
- Bilosomes can be used as an immunological stability against tetanus toxoid.

CONCLUSION AND PERSPECTIVE

Organic nanomaterial, for their miniature size, has the potential for wide application in medical field. They also play an important role in the development of biotechnological applications and promise to take immense new and emerging applications in the coming years. Deformable vesicles can be a novel solution to many targeted drug treatment. Due to the unique properties of each organic nanoparticle, future of many risky treated ailments is in safe hands.

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Conflict of interest

The author declares no conflict of interest.

REFERENCES

1. Schreier H., Bovwstra J., Liposomes and Niosomes as Topical Drug Carriers: Dermal and Transdermal Drug Delivery, Journal of Control Release 1994;30:1-15.
2. Bhatia A, Kumar R. Tamoxifen in topical liposomes: development, characterization and in-vitro evaluation. J Pharma Sci 2004; 7(2):252-259.
3. Jadou A, Preat V. Electrically enhanced transdermal delivery of domperidone, Int J Pharma1997; 154(2):229-234.
4. . Cevc G. Isothermal lipid phase. Transitions Chemistry and Physics of Lipids 1991; 57:293-299.
5. . Schatzlein A, Cevc G. Skin penetration by phospholipids vesicles, Transfersomes as visualized by means of the Confocal Scanning Laser Microscopy, in characterization, metabolism, and novel biological applications. Champaign. AOCS Press 1995; 191-209.

6. S. Bhaskaran and P. Lakshmi, “Comparative evaluation of niosome formulations prepared by different techniques,” Acta Pharmaceutica Sciencia, vol. 51, no. 27, p. 32, 2009.
7. C. W. Fong, “Permeability of the blood–brain barrier: molecular mechanism of transport of drugs and physiologically important compounds,” Journal of Membrane Biology, vol. 248, no. 4, pp. 651–669, 2015.
8. G. Bozzuto and A. Molinari, “Liposomes as nanomedical devices,” International Journal of Nanomedicine, vol. 10, p. 975, 2015
9. Maghraby GM., Williams AC., Barry BW., Oestradiol Skin Delivery from Ultra deformable liposomes: Refinement of Surfactant Concentration, International Journal of Pharmaceutics 2000;63-74.
10. Dhurve R., Kashyap N., Mishra A., Kumar Pathak A., A Holistic Review on Ethosome: A Promising Drug Delivery System for Topical Fungal Disease, International Journal of Pharmaceutical & Biological Archives 2014;5,5:13-26.
11. Biju SS., Sushama T., Mishra PR., Khar PR., Vesicular Systems: An Overview, Indian Journal of Pharmaceutical Sciences 2006;682: 141-153.
12. Keen, P. H., Slater, N. K., and Routh, A. F. (2014). Encapsulation of amylase in colloidosomes. Langmuir 30, 1939–1948. doi: 10.1021/la4047897
13. Sander, J. S., and Studart, A. R. (2011). Monodisperse functional colloidosomes with tailored nanoparticle shells. Langmuir 27, 3301–3307. doi: 10.1021/la1035344
14. Hasan S 2015 A Review on Nanoparticles : Their Synthesis and Types Biosynthesis : Mechanism 4 9–11
15. Cho E J, Holback H, Liu K C, Abouelmagd S A, Park J and Yeo Y 2013 Nanoparticle characterization : State of the art , challenges , and emerging technologies Shinde N C, Keskar N J and Argade P D Research Journal of Pharmaceutical , Biological and Chemical Sciences REVIEW ARTICLE Nanoparticles : Advances in Drug Delivery Systems 3 922–9
16. Douliez JP, Martin N, Beneyton T, et al. Preparation of swellable hydrogel-containing colloidosomes from aqueous two-phase Pickering emulsion droplets. Angew Chem. 2018;130:7906–7910.
17. Transfersomes, http://en.wikipedia.org/wiki/Transfersome, From Wikipedia, the free encyclopedia.