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Review Article

Electrosomes as Novel Nanocarrier

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ABSTRACT

Electrosomes are a type of vesicle that hold promise as a drug delivery system due to their unique properties. Electrosomes can encapsulate a wide range of therapeutic agents, including small molecules, proteins, peptides, and nucleic acids. They can also release drugs in a controlled manner, either by diffusion or in response to an external stimulus such as heat or light. In addition, electrosomes can be administered non-invasively and have the potential to improve drug stability, bioavailability, and cost-effectiveness. Despite these advantages, there are also potential disadvantages to consider, including complexity in production, limited scalability, stability concerns, and ethical considerations. Ongoing research is exploring ways to overcome these limitations and improve the effectiveness and safety of electrosomes as a drug delivery system. Electrosomes represent an exciting area of study for pharmaceutical researchers and scientists, with the potential to address many of the challenges of traditional drug delivery systems. Further research is needed to fully understand the potential of electrosomes and their limitations, but their versatility and controlled release capabilities make them a promising platform for drug delivery and other biomedical applications.

INTRODUCTION

Electrosomes are a new and exciting area of research that has potential applications in the pharmaceutical industry. Electrosomes are self-assembled structures made up of amphiphilic molecules, which can be charged by applying an electric field. These structures can be used to deliver drugs or other therapeutic agents to specific areas of the body [1-3].

One potential application of electrosomes in the pharmaceutical industry is for the targeted delivery of drugs to cancer cells. By using electrosomes, it may be possible to deliver higher doses of chemotherapy drugs directly to cancer cells while minimizing damage to healthy cells [4, 5].

Electrosomes may also be used to deliver proteins, peptides, and other biological molecules that are difficult to deliver using traditional drug delivery methods. For example, electrosomes have been used to deliver insulin to treat diabetes. In addition to drug delivery, electrosomes may have other applications in the pharmaceutical industry, such as in the development of new diagnostic tools or as a tool for drug screening and discovery [6-9].

However, it's important to note that electrosomes are still a relatively new area of research, and more work needs to be done to fully understand their potential applications and limitations.

Structure of Electrosomes

Electrosomes are self-assembled structures made up of amphiphilic molecules. These molecules have both hydrophilic (water-loving) and hydrophobic (water-fearing) regions, which allow them to self-assemble into unique structures in response to an applied electric field. The exact structure of electrosomes can vary depending on the type of amphiphilic molecules used and the conditions under which they are assembled. However, electrosomes typically have a core-shell structure, with the hydrophilic portion of the molecules forming the outer shell and the hydrophobic portion forming the inner core [10-12].

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The core of electrosomes can be used to encapsulate drugs or other therapeutic agents, while the outer shell can be modified with targeting ligands to direct the electrosomes to specific cells or tissues. The electric field can be used to control the size, shape, and stability of the electrosomes. This is graphically represented in Fig. 2.

The hydrophilic regions of these amphiphilic molecules are typically polar groups, such as charged or uncharged polar head groups. These head groups are oriented towards the outer surface of the electrosomes, forming a hydrophilic shell around a hydrophobic core. The hydrophobic core can be filled with drugs, peptides, or other therapeutic agents that are insoluble in water [13, 14].

The size and shape of electrosomes can be controlled by varying the strength and frequency of the applied electric field. Typically, electrosomes have sizes ranging from 50 nm to several microns. The stability of electrosomes is also affected by the strength of the electric field, with stronger fields leading to more stable structures [15-17].

The amphiphilic molecules (Fig. 1) used to form electrosomes can also be modified with targeting ligands, such as antibodies or peptides, to direct the electrosomes to specific cells or tissues. These targeting ligands can be attached to the hydrophilic head groups of the amphiphilic molecules.

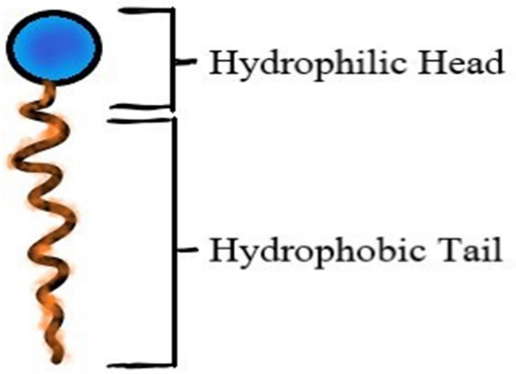

Figure 1: Single Amphiphilic Molecule

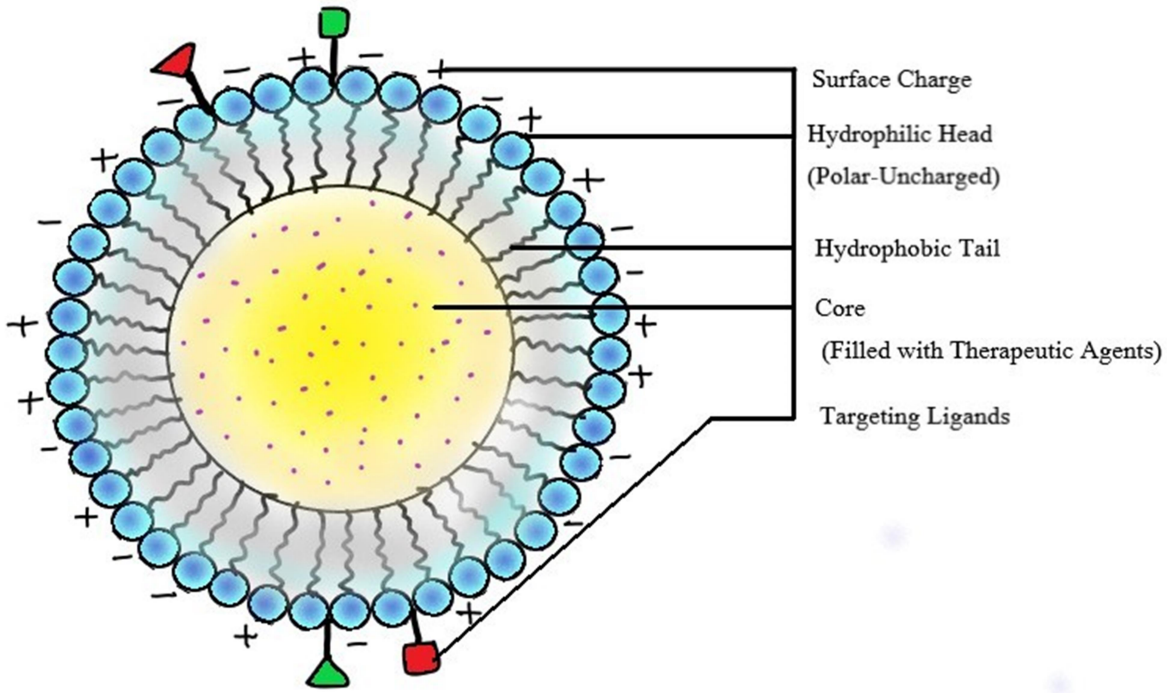

Figure 2: Structure of Electrosome

PREPARATION OF ELECTROSOMES

Electrosomes can be prepared using a variety of methods, depending on the specific application and the type of amphiphilic molecules being used [18-20]. Here is a general overview of the steps involved in the preparation of electrosomes:

1. Selection of amphiphilic molecules: The first step in preparing electrosomes is to

select appropriate amphiphilic molecules that can self-assemble in response to an applied electric field. These molecules typically have a hydrophilic head group and a hydrophobic tail. Commonly used amphiphilic molecules include lipids, surfactants, and block copolymers.

2. Preparation of solution: The amphiphilic molecules are dissolved in a suitable solvent to form a solution. The concentration of the solution is typically optimized to ensure the formation of stable electrosomes.
3. Application of electric field: The solution is then subjected to an applied electric field, which induces the self-assembly of the amphiphilic molecules into electrosomes. The electric field can be generated using various methods, such as a direct current (DC) electric field or an alternating current (AC) electric field.
4. Characterization: The electrosomes are then characterized to determine their size, shape, stability, and drug loading capacity. This can be done using techniques such as dynamic light scattering, transmission electron microscopy, or atomic force microscopy.
5. Modification of electrosomes: The electrosomes can be further modified by adding targeting ligands, such as antibodies or peptides, to direct the electrosomes to specific cells or tissues [21, 22].

Advantages

Electrosomes have several advantages as a platform for drug delivery and other biomedical applications, including:

1. Targeted drug delivery: Electrosomes can be modified with targeting ligands, such as antibodies or peptides, to selectively deliver drugs to specific cells or tissues. This can improve the efficacy of drug therapy while reducing side effects.
2. High drug loading capacity: The hydrophobic core of electrosomes can accommodate high amounts of drugs or other therapeutic agents, allowing for efficient drug delivery.
3. Precise control over size and shape: The size and shape of electrosomes can be precisely controlled by varying the strength and frequency of the applied electric field, allowing for tailored drug delivery.
4. Stability: Electrosomes can be stabilized by the applied electric field, making them more resistant to degradation and improving their shelf-life.
5. Biocompatibility: Electrosomes are typically composed of biocompatible materials, such as lipids or polymers, which reduce the risk of toxicity and immunogenicity.
6. Non-invasive: Electrosomes can be administered non-invasively, such as by injection or oral administration, reducing the need for invasive procedures.
7. Versatility: Electrosomes can be used to deliver a wide range of therapeutic agents, including small molecules, proteins, peptides, and nucleic acids. This versatility makes them useful for a variety of applications in drug delivery and gene therapy.
8. Enhanced drug stability: The hydrophobic core of electrosomes can protect drugs from degradation and oxidation, improving their stability and increasing their shelf-life.
9. Improved bioavailability: Electrosomes can improve the bioavailability of drugs by increasing their solubility and absorption in the body.
10. Controlled release: Electrosomes can be designed to release drugs in a controlled manner, either by diffusion or by response to an external stimulus such as heat or light. This allows for sustained drug release and can reduce the need for frequent dosing.
11. Easy to manufacture: The preparation of electrosomes is a relatively simple process, and can be easily scaled up for large-scale production.
12. Cost-effective: The use of electrosomes for drug delivery can be cost-effective compared to other delivery systems, such as nanoparticles, due to the low cost of the raw materials and the ease of manufacturing.

Disadvantages

While electrosomes have many potential advantages as a drug delivery system, there are also some potential disadvantages that should be considered:

1. ***Complexity:*** Electrosomes preparation can be a complex process, and may require specialized equipment or expertise. This can

increase the cost of production and limit their accessibility.

2. ***Limited Scalability:*** The production of electrosomes is typically limited to small batches, which may not be suitable for large-scale manufacturing.

3. ***Stability Concerns:*** Electrosomes can be unstable and prone to aggregation, which can affect their drug delivery properties and reduce their shelf-life.

4. ***Immunogenicity:*** Electrosomes composed of certain materials, such as cationic lipids, may be immunogenic and stimulate an immune response in the body.

5. ***Safety Concerns:*** The long-term safety of electrosomes is not well established, and further research is needed to determine their potential toxicity and side effects.

6. ***Lack of FDA approval:*** Electrosomes are a relatively new technology and have not yet been approved by the US Food and Drug Administration (FDA) for use in humans.

7. ***Limited tissue penetration:*** Electrosomes may have limited ability to penetrate certain types of tissues or cells, which could limit their effectiveness for certain applications.

8. ***Difficulty targeting certain cells or tissues:*** While electrosomes can be modified with targeting ligands to improve their specificity, it can be challenging to target certain cells or tissues that are not easily accessible or have limited expression of the targeting molecule.

9. ***Limited drug compatibility:*** Electrosomes may not be compatible with certain drugs or therapeutic agents, which could limit their effectiveness for certain applications.

10. ***Ethical concerns:*** The use of electrosomes for drug delivery and other biomedical applications raises ethical concerns related to safety, informed consent, and privacy.

Future Prospect

In addition to all the uses, electrosomes can also be modified to serve as imaging agents or diagnostic tools, allowing for non-invasive monitoring of disease progression and treatment response or they can be used to deliver nucleic acids, such as siRNA or DNA, for gene therapy applications and they can be combined with nanorobotics technology to create complex systems for targeted drug delivery and other biomedical applications [23-26].

CONCLUSION

In conclusion, electrosomes hold great potential as a drug delivery system due to their unique properties, including their ability to encapsulate a wide range of therapeutic agents, controlled release capabilities, and non-invasive administration. The advantages of electrosomes also include improved drug stability, enhanced bioavailability, and cost-effectiveness. However, there are also potential disadvantages to consider, such as limited scalability, stability concerns, and ethical considerations. Further research is needed to fully understand the potential of electrosomes and address any limitations, but their versatility and potential to improve drug delivery make them an exciting area of study for pharmaceutical researchers and scientists.

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