Commentary

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American Journal of Pharmacology and Pharmacotherapeutics
ISSN 2393-8862

2023
Vol.10 No.3:161

Liposome Delivery: Enhancing Drug Efficacy and Minimizing Side Effects

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Received date: August 18, 2023, Manuscript No. IPAPP-23-18024; **Editor assigned date:** August 21, 2023, PreQC No. IPAPP-23-18024 (PQ); **Reviewed date:** September 04, 2023, QC No. IPAPP-23-18024; **Revised date:** September 11, 2023, Manuscript No. IPAPP-23-18024 (R); **Published date:** September 18, 2023, DOI: 10.36648/2393-8862.10.3.161

Citation: Kiani M (2023) Liposome Delivery: Enhancing Drug Efficacy and Minimizing Side Effects. Am J Pharmacol Pharmacother Vol.10 No. 3: 161.

Description

Nanoparticle drug delivery systems are engineered technologies that use nanoparticles for the targeted delivery and controlled release of therapeutic agents. The modern form of a drug delivery system should minimize side-effects and reduce both dosage and dosage frequency. Recently, nanoparticles have aroused attention due to their potential application for effective drug delivery.

Nanomaterials exhibit different chemical and physical properties or biological effects compared to larger-scale counterparts that can be beneficial for drug delivery systems. Some important advantages of nanoparticles are their high surface-area-to-volume ratio, chemical and geometric tunability, and their ability to interact with biomolecules to facilitate uptake across the cell membrane. The large surface area also has a large affinity for drugs and small molecules, like ligands or antibodies, for targeting and controlled release purposes.

Nanoparticles refer to a large family of materials both organic and inorganic. Each material has uniquely tunable properties and thus can be selectively designed for specific applications. Despite the many advantages of nanoparticles, there are also many challenges, including but not exclusive to nanotoxicity, bio distribution and accumulation, and the clearance of nanoparticles by human body.

The national institute of biomedical imaging and bioengineering has issued the following prospects for future research in nanoparticle drug delivery systems crossing the Blood-Brain Barrier (BBB) in brain diseases and disorders; enhancing targeted intracellular delivery to ensure the treatments reach the correct structures inside cells; combining diagnosis and treatment.

The development of new drug systems is time-consuming it takes approximately seven years to complete fundamental research and development before advancing to preclinical animal studies.

Liposome Delivery

Liposomes are spherical vesicles composed of synthetic or natural phospholipids that self-assemble in aqueous solution in sizes ranging from tens of nanometers to micrometers. The resulting vesicle, which has an aqueous core surrounded by a hydrophobic membrane, can be loaded with a wide variety of hydrophobic or hydrophilic molecules for therapeutic purposes.

Liposomes are typically synthesized with naturally occurring phospholipids, mainly phosphatidylcholine. Cholesterol is often included in the formulation to adjust the rigidity of the membrane and to increase stability. The molecular cargo is loaded through liposome formation in aqueous solution, solvent exchange mechanisms, or pH gradients methods various molecules can also be chemically conjugated to the surface of the liposome to alter recognition properties. One typical modification is conjugating Polyethylene Glycol (PEG) to the vesicle surface.

Nanoparticle albumin-bound technology utilizes the protein albumin as a carrier for hydrophobic chemotherapy drugs through noncovalent binding. Because albumin is already a natural carrier of hydrophobic particles and is able to transcytoses molecules bound to itself, albumin composed nanoparticles have become an effective strategy for the treatment of many diseases in clinical research.

Drug Delivery System

An ideal drug delivery system should have effective targeting and controlled release. The two main targeting strategies are passive targeting and active targeting. Passive targeting depends on the fact that tumors have abnormally structured blood vessels that favour accumulation of relatively large macromolecules and nanoparticles. This so-called enhanced permeability and retention effect allows the drug-carrier be transported specifically to the tumor cells.

Controlled drug release systems can be achieved through several methods. Rate-programmed drug delivery systems are tuned to the diffusivity of active agents across the membrane. Another delivery-release mechanism is activation-modulated drug delivery, where the release is triggered by environmental stimuli. The stimuli can be external, such as the introduction of a chemical activators or activation by light or electromagnetic fields, or biological such as pH, temperature, and osmotic pressure which can vary widely throughout the body.

Drug delivery strategies of inorganic nanoparticles are dependent on material properties. The active targeting of

inorganic nanoparticle drug carriers is often achieved by surface functionalization with specific ligands of nanoparticles. For example, the inorganic multifunctional nano vehicle is able to accomplish tumor optical imaging and therapy simultaneously. It can be directed to the location of cancer cells with sustained release behaviour.