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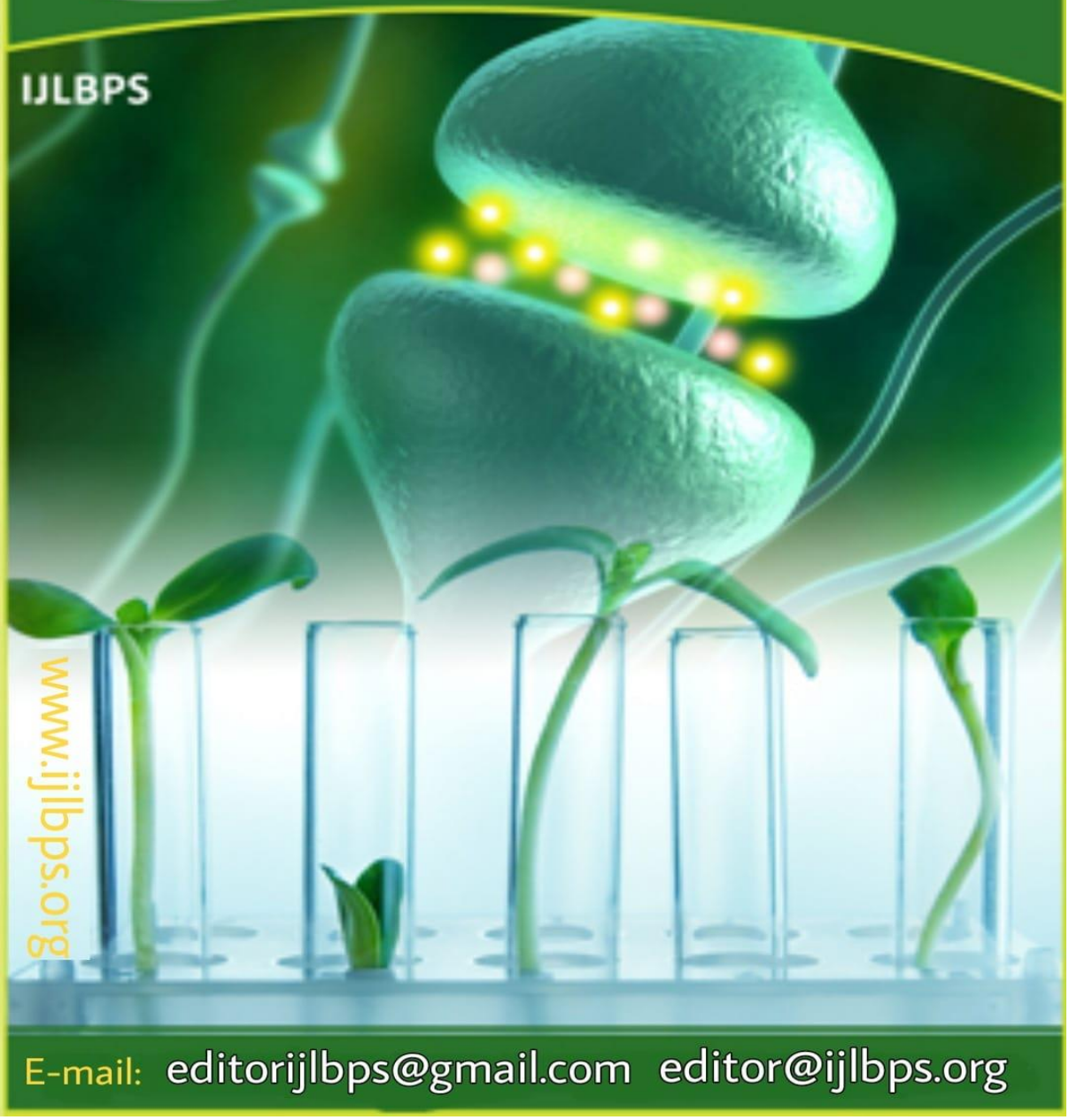

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A New Carrier System Called an Aquasome

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Abstract

The core of aquasomes consists of ceramic carbon naocrystalline particles, which are then covered with either glassy ceroboise or biodegradable calcium phosphate monomer crystalline particles, which are then coated with glassy pyridoxal-5-phosphate. The drugs or enzymes are then chemically attached to the outer covering. Aquasomes are spherical particles with a size of 60-300 nm that are utilized to transport drugs and antibodies. Its ability to transport bioactive compounds including peptides, proteins, hormones, antigens, and genes to their destinations while maintaining the molecules' structural integrity and surface exposure has made it a popular carrier system. Tin oxide, nanocrystalline carbon ceramics (diamonds), and brushite (calcium phosphate dihydrate) are the three major core materials utilized in aquasome production. Since calcium phosphate occurs often in the human body, it is the primary focus of study. The content of aquasomes is released gradually over time using a combination of targeted delivery, molecular sheilding, and delayed release. The aquasome platform ensures the biochemical and structural stability of bioactives.

Keywords: Aquasomes, Carrer system

Introduction

The water-like properties of aquasomes, also known as "bodies of water," help to preserve and target bio-active molecules like peptide and protein hormones, antigens, and genes by keeping them in their native conformations while exposing as much of their surfaces as possible. Nir Kossovsky was the first to create "aquasomes," which are ceramic nanoparticles stabilized by carbohydrates. The pharmacologically active molecule is absorbed onto the carbohydrate surface of preformed nanoparticles by co-polymerization, diffusion, or adsorption.1

The three-layer structure seen here is self-assembled through weak connections. Three physiochemical processes drive the "self-assembly of macromolecule" principle: 1)contact between charged groups; this interaction promotes the distant approach of self-assembly subunits. Charge group contributes to the stability of protein tertiary structures. Protein secondary structures like alpha helices and beta sheets are stabilized by hydrogen bonds and the resulting dehydration effect. Hydrophilic molecules establish hydrogen bonds, giving the surrounding water a high level of order. Molecular self-assembly and dehydration occur in the case of hydrophobic molecules, which cannot establish hydrogen bonds, since their ability to reject water helps to arrange the moiety to the surrounding environment, and because organized water reduces the degree of entropy and is thermodynamically unfavorable.

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tain their conformation during self-assembly thanks to the softness provided by the external hydrogen bonds responsible for the hardness of the molecule, and the softness provided by the internal van der Waals forces responsible for the maintenance of internal secondary structures. Because self-assembly changes biological activity, van der Waals must be attenuated. Sugars aid molecular plasticity in aquasomes. Molecular verification and maximum pharmaceutical efficacy are both preserved in aquasomes. Proteins undergo rreversible denaturation when exposed to dry

conditions and are even unstable in their aqueous function properly.Proteins' watery structures are maintained during dehydration thanks to the hydroxyl groups on oligomer, which interact with the protein's polar and charged groups in the same manner as water does. These hydroxyl-rich disaccharides serve to replenish the water normally found surrounding polar residues in proteins, allowing them to function normally even when water is not present. A glassy aqueous state is generated by the free bound mobility associated with a rich hydroxyl component, which in turn forms a unique hydrogen binding substrate.

Aquasomes: Their Synthesis 5

I. Self-Assembly Guidelines

The term "self assembly" refers to the phenomenon in which the individual components of a finished product take on its final two- or three-dimensional structural orientations without any external guidance. The interactions of charged groups, dehydration effects, and structural stability govern the self-assembly of macromolecules in the aqueous environment, whether for the purpose of creating smart nanostructure materials or in the course of natural
biochemistry.

First, charged-pair interactions: charged-pair interactions allow self-assembling subunits to state, despite normailly possessing the following characteristics of active molecules: a unique three-dimensional conformation, freedom of internal molecular rearrangement induced by molecular interactions, and freedom of bulk movement. Denaturation occurs in the aqueous state due to changes in pH, temperature, solvents, and salts. Bioactives are shielded in aquasomes. Aquasomes seem to be a worthwhile carrier, since the carbohydrate coating inhibits the damaging denaturing interaction between the drug and the solid carriers, which may occur with other carriers such as prodrugs and liposomes.

Disaccharides' Important Role: - Aquasomes need on carbohydrate for their three-layer structure to approach from great distances. Charge group contributes to the stability of protein tertiary structures. Most biological and synthetic surfaces have a charge polarity due to inherent chemical groups or adsorbed ions from the biological environment. In reality, most compounds of biological significance are amphoteric. Amino, carboxyl, sulfate, and phosphate groups, among others, interact through electrostatic forces to allow for distant self-assembly of subunits. First, self-assembly requires the component subunits to interact across large distances, starting at an intermolecular distance of around 15 nm. Long-range forces exerted by hydrophobic materials may reach distances of up to 25 nm. Proteins' folded tertiary structures are supported in part by charged groups.

Hydrogen bonds aid in base pair matching and stabilize secondary protein structure, including alpha helices and beta sheets, via a process called dehydration. Hydrophilic molecules establish hydrogen bonds, giving the surrounding water a high level of order. Molecular self-assembly and dehydration occur in the case of hydrophobic molecules, which cannot establish hydrogen bonds, since their ability to reject water helps to arrange the moiety to the surrounding environment, and because organized water reduces the degree of entropy and is thermodynamically unfavorable.

3. Structural Stability: The hardness and softness of a molecule and the maintenance of internal secondary structures are determined by the interaction between charged groups and Hydrogen bonds, which are largely external to the molecule, and by van der waals forces, which are largely internal to the molecule and experienced by hydrophobic molecules. Buffering van der Waals forces is necessary because self-assembly changes biological activity. Sugars aid molecular plasticity in aquasomes. The somewhat hydrophobic molecule areas that are protected from water are subjected to Van der Waals forces, which play a minor but crucial function in preserving molecular shape during self-assembly. The contact between polypeptides and carbohydrates and related polyhydroxyloligomers is mediated in part by Van der Waals forces, which are mostly internal to the molecule but are nonetheless detectable. Energy minima assumed during conformational denaturation often limit reversal of molecular shape changes after significant contact.

Method of Preparation of Aquasomes

The eneral procedure consists of an inorganic core formation, which will be coated with Lactose forming the polyhydroxylated core that finally will be loaded by model drug .By using the principle of self-assembly, the aquasomes are prepared in three steps i.e., preparation of core, coating of core, and immobilization of drug molecule.

1. Preparation of the core: The first step of aquasome preparation is the fabrication of the ceramic core. The process of ceramic core preparation depends on the selection of the materials for core. These ceramic cores can be fabricated by colloidal precipitation and sonication, inverted rnagnetron sputtering, plasma condensation and other processes. For the core, ceramic materials were widely used because ceramics are structurally the most regular materials known. Being crystalline, the high degree of order in ceramics ensures that any surface modification will have only a limitedeffect on the nature of the atoms below the surface layer and thus the bulk properties of the ceramic will be preserved. The high degree of order also ensures that the surfaces will exhibit high level of surface energy that will favor the binding of polyhydroxy oligomeric surface film. Two ceramic cores that are most often used are diamond and calcium phosphate.

2. Carbohydrate coatings: The second step involves coating by carbohydrate on the surface of ceramic cores. There are number of processes to enable the carbohydrate (polyhy-droxy oligomers) coating to adsorb epitaxially on to the surface of the nano-crystalline ceramic cores. The processes generally entail the addition of polyhydroxy oligomer to a dispersion of meticulously cleaned ceramics in ultra pure water, sonication and then lyophilization to promote the largely irreversible adsorption of carbohydrate on to the ceramic surfaces. Excess and readily desorbing carbohydrate is removed by stir cell ultra-filtration. The commonly used coating materials are cellobiose, citrate, pyridoxal-5-phosphate, sucrose and trehalose.

3. Immobilization of drugs: The surface modified nano-crystalline cores provide the solid phase for the subsequent nondenaturing self assembly for broad range of biochemically active molecules. The drug can be loaded by partial adsorption.

Properties:

Aquasomes due to their size and structure stability, avoid clearance by reticuloendothelial system or degradation by other environmental challenges.

In normal system, calcium phosphate is biodegradable. Biodegradation in vivo achieved by monocytes and multicellular cells called osteoclast.

Two types of phagocytosis reported, either crystals taken up alone and then dissolved in cytoplasm after disappearance of phagosome membrane or dissolution after formation of heterophagosome.

Aquasomes possess large size and active surface hence canbe efficiently loaded with substantial amounts of agents through ionic, non co-valent bonds, van der waals forces and entropic forces. As solid particles dispersed in aqueous environment, exhibit physical properties of colloids.

Application:

1) Because haemoglobin's release of oxygen is conformationally sensitive, aquasomes as a red blood cell replacement have haemoglobin immobilized on the oligomer surface. This method has been shown to minimize toxicity, increase hemoglobin

concentration to 80%, and facilitate the delivery of blood in a non-linear fashion that is analogous to that of normal blood cells.

2) 1) The proper antibody, the goal of vaccine treatment, must be activated by conformationally specific target molecules in aquasomes utilized as vaccines for delivery of viral antigen, such as Epstein-Barr and Immunodeficiency Virus.

3) 2) Aquasomes, a five-layered composition consisting of a ceramic core, polyoxyoligomeric film, therapeutic gene segment, extra carbohydrate film, and a targeting layer of conformationally conserved viral membrane protein, have been employed for effective targeted intracellular gene therapy.

4) Because medication action is conformationally specific, aquasomes for drug delivery have been created for drugs like insulin.Toxicity was not detected, and there was no decrease in bioactivity compared to intravenously administered doses.

5) Because enzyme activity varies with molecular conformation and pigments' aesthetic characteristics are sensitive to molecular conformation, aquasomes are also employed for delivering enzymes like DNAase and colours/dyes.

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