Student Speech Contest 2025

Impact of Nanocarrier Morphology, Molecular Weight and Hydrophobicity of Drugs on Encapsulation Efficiency

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Project.

Topic / keyword. Lipid-Coated Hollow Mesoporous Silica Particles for Encapsulation of Hydrophobic Drugs

Abstract.

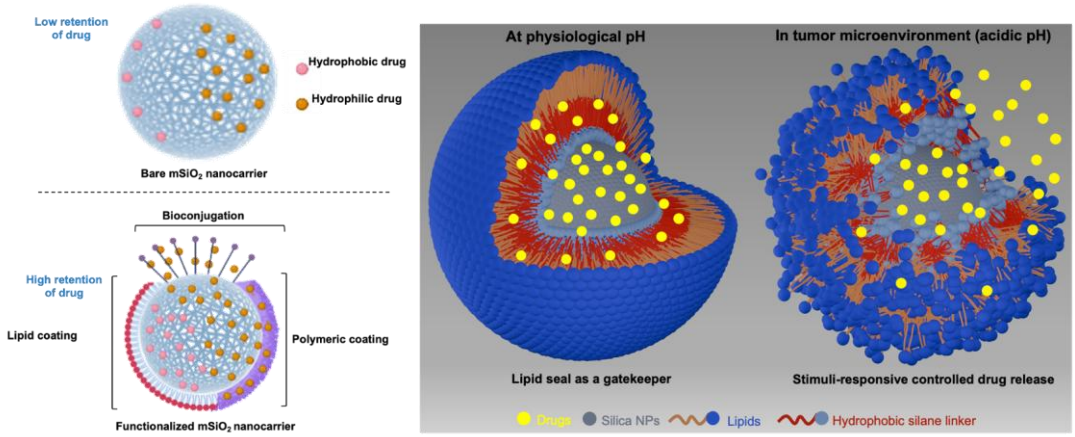

Figure 1. Enhance drug entrapment and controlled release through bioconjugation on mesoporous silica nanocarriers. The implementation of bioconjugation and polymeric or lipid coating for achieving high drug retention, followed by a controlled and sustained drug.

Hydrophobic drugs play a critical role in targeting membrane-associated receptors and enzymes; however, their poor aqueous solubility limits systemic bioavailability and therapeutic efficacy. To address these limitations, we designed a series of biocompatible mesoporous silica nanocarriers with varied morphologies (cubes, capsules, and spheres; 60 and 300 nm) and tailored their surfaces using octadecyltrimethoxysilane to

render them hydrophobic. These functionalized bioceramic carriers achieved drug loading efficiencies of up to 80% for hydrophobic drugs. However, rapid and uncontrolled release was observed within 6 hours. To mitigate this, a pH-sensitive lipid coating was applied, significantly extending release profiles up to 72 hours. Our findings also revealed that nanocarrier shape and size markedly influenced drug loading and release kinetics. Additionally, the molecular weight and hydrophobicity of the encapsulated drugs impacted their entrapment and sustained delivery. This study demonstrates the potential of engineered silica-based bioceramic systems—further optimized with lipid overlayers—for improved delivery of hydrophobic therapeutics, offering promising solutions for enhanced drug bioavailability and circulation half-life.

References.

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