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Liposomal Delivery: Advancing Pancreatic Cancer Therapy

Sofia Nordin*

Department of Tumor Microenvironment, Lund University, Lund 221 00, Sweden

Introduction

Liposomal drug delivery systems are demonstrating significant potential in addressing the complex challenges inherent in pancreatic cancer treatment, notably overcoming drug resistance and improving tumor penetration. Liposomes, functioning as nanocarriers, are capable of encapsulating chemotherapeutic agents, thereby enhancing their solubility and stability. This targeted delivery approach aims to direct these agents specifically to the tumor site, leading to improved therapeutic efficacy. By preferentially accumulating liposomes within the tumor microenvironment, their use can minimize systemic toxicity. This preferential accumulation is often explained by the enhanced permeability and retention (EPR) effect observed in tumors. Ongoing research is actively focused on optimizing liposome composition and surface modifications for active targeting strategies. Furthermore, the exploration of combination therapies is a key area of investigation to enhance treatment outcomes for patients diagnosed with pancreatic cancer. Engineered liposomes are a subject of intense development, with the goal of improving the delivery of therapeutics directly into the pancreatic tumor microenvironment. Strategies under examination include surface functionalization with specific ligands designed to target receptors overexpressed on pancreatic cancer cells or stromal components. This targeted methodology is intended to increase drug accumulation within the tumor, consequently boosting efficacy and reducing unwanted off-target effects.

Description

Liposomal drug delivery systems are showcasing considerable promise in overcoming the multifaceted challenges associated with pancreatic cancer treatment, particularly in addressing drug resistance and poor tumor penetration. These advanced nanocarriers possess the capability to effectively encapsulate chemotherapeutic agents, leading to improvements in their solubility, stability, and targeted delivery to the tumor site. This innovative approach can significantly enhance therapeutic efficacy while concurrently minimizing systemic toxicity through the preferential accumulation of liposomes in the tumor microenvironment, exploiting the well-established enhanced permeability and retention (EPR) effect. Extensive ongoing research is dedicated to optimizing liposome composition and exploring surface modifications for active targeting. Simultaneously, the development and evaluation of combination therapies are paramount to improving outcomes for individuals battling pancreatic cancer. Engineered liposomes are being meticulously developed with the specific aim of enhancing the delivery of therapeutics into the pancreatic tumor microenvironment. Key strategies being explored involve the surface functionalization of these liposomes with specific ligands that target particular receptors which are overexpressed on pancreatic cancer cells or stromal components within the tumor. This targeted approach is designed to improve the accumulation of drugs within the tumor, thereby increasing therapeutic efficacy and reducing the incidence of off-target effects. Moreover, the design of these liposomes takes into account their interaction with the dense stroma, a characteristic feature of pancreatic cancer, seeking novel ways to improve penetration and facilitate drug release at the precise disease site. The intricate tumor microenvironment of pancreatic cancer presents substantial barriers to the effective delivery of conventional drugs. Liposomes emerge as a highly promising solution by encapsulating therapeutic drugs and navigating this complex milieu. Current research is actively investigating stimuli-responsive liposomes, which are engineered to release their therapeutic payload upon encountering specific triggers present within the tumor, such as localized pH changes or specific enzyme activities. This controlled release mechanism is designed to optimize drug concentration at the tumor site, thereby enhancing therapeutic impact and concurrently minimizing damage to surrounding healthy tissues.

Conclusion

Liposomal drug delivery systems offer a promising approach to enhance pancreatic cancer treatment by improving drug solubility, stability, and targeted delivery to tumors. These nanocarriers can overcome challenges like drug resistance and poor tumor penetration by exploiting the EPR effect and utilizing strategies like surface functionalization for active targeting. Research also focuses on stimuli-responsive liposomes for controlled drug release, biodegradable formulations for safety, and theranostic liposomes for combined imaging and therapy. Combination therapies involving liposomes are being explored to enhance synergistic effects and overcome the immunosuppressive tumor microenvironment. Manufacturing considerations are also crucial for successful clinical translation.

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Conflict of Interest

None.

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Address for Correspondence: Sofia, Nordin, Department of Tumor Microenvironment, Lund University, Lund 221 00, Sweden, E-mail: sofia.nordin@lu.se

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