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Lipid Nanocarriers as Precision Delivery Systems for Brain Tumors

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Abstract

Brain tumors, particularly glioblastomas, represent the most complicated cancers to treat and manage due to their highly invasive nature and the protective barriers of the brain, including the blood-brain barrier (BBB). The efficacy of currently available treatments, viz., radiotherapy, chemotherapy, and immunotherapy, are frequently limited by major side effects, drug resistance, and restricted drug penetration into the brain. Lipid nanoparticles (LNPs) have emerged as a promising and targeted delivery system for brain tumors. Lipid nanocarriers have gained tremendous attention for brain tumor therapeutics due to multiple drug encapsulation abilities, controlled release, better biocompatibility, and ability to cross the BBB. Herein, a detailed analysis of the design, mechanisms, and therapeutic benefits of LNPs in brain tumor treatment is discussed. Moreover, we also discuss the safety issues and clinical developments of LNPs and their current and future challenges. Further, we also focused on the clinical transformation of LNPs in brain tumor therapy by eliminating side effects and engineering the LNPs to overcome the related biological barriers, which provide personalized, affordable, and low-risk treatment options.

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