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Nanoparticles as Novel Drug Delivery Systems for Cancer Treatment: Curre...

Nanoparticles as Novel Drug Delivery Systems for Cancer Treatment: Current Status and Future Perspectives

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Abstract Cancer continues to pose a significant global health challenge, demanding innovative therapeutic approaches to overcome the limitations of conventional treatments like chemotherapy and radiotherapy. Nanoparticles (NPs) have emerged as promising tools for cancer therapy due to their unique physicochemical properties that enable targeted drug delivery, reduced systemic



toxicity, and enhanced therapeutic efficacy. This comprehensive review delves into the mechanisms of NP-based drug delivery, highlighting both passive and active targeting strategies. It categorizes and discusses diverse NP types, including polymeric, lipid-based, and metallic nanoparticles, emphasizing their applications in enhancing the bioavailability and specificity of anticancer agents. This review also explores the integration of advanced technologies, such as theranostics and artificial intelligence, to optimize NP design and functionality for personalized medicine. However, challenges remain, including issues related to toxicity, drug resistance, and manufacturing scalability. Addressing these barriers requires interdisciplinary research focused on developing stimuli-responsive NPs, improving biocompatibility, and incorporating multimodal therapeutic platforms. Although substantial progress has been made, this review is limited by the paucity of clinical trials validating NP efficacy and safety in diverse patient populations. Future endeavors should prioritize translational research to bridge the gap between preclinical innovations and clinical applications, ensuring that these transformative technologies benefit a broader spectrum of cancer patients. The review underscores the immense potential of NPs in redefining cancer treatment while advocating for sustained research to address existing limitations and unlock their full therapeutic promise.

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