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Advancements in Nanostructured Drug Delivery Systems: A Commentary on Multifunctional Approaches for Cancer and Inflammatory Disease Treatment

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Commentary

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Abstract

Nanostructured drug delivery systems (NDDS) represent a transformative advancement in medical science, offering innovative solutions for the treatment of cancer and inflammatory diseases. These systems utilize nanoscale materials to enhance the efficacy and specificity of drug delivery, allowing for targeted therapy that minimizes side effects. By improving the bioavailability of therapeutic agents, NDDS can significantly increase treatment effectiveness. Furthermore, their ability to navigate biological barriers opens new avenues for overcoming challenges in conventional drug delivery methods.

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In recent decades, the successful development of nanotechnology, especially the emergence of new nanomaterials, has provided new ideas and potential methods for diagnosing and treating many major diseases [1]. Developments in nanostructured drug delivery systems mark a breakthrough in the treatment of a number of illnesses, including inflammatory and cancerous conditions. Utilizing the unique properties of nanomaterials, these systems improve drug efficacy, target specificity, and therapeutic outcomes while reducing side effects [2, 3]. Integrating nanotechnology into drug delivery systems enhances absorption rates and therapeutic effects, marking a significant advancement in pharmaceutical applications [4]. Nanotechnology involves creating materials at the nanoscale using natural, synthetic, or semisynthetic polymers, lipids, and metal materials [5]. Research indicates that nanostructures, such as nanoparticles (NPs), exhibit enhanced cellular uptake compared to their micro-sized counterparts, effectively facilitating targeted therapy delivery to disease sites [6-8]. Fig.1 illustrates the type of NDDS cancer cell.

As a result, new formulations such as liposomal and polymeric carriers have become more well-known because they provide ways to encapsulate therapeutic molecules, preventing early degradation and guaranteeing continuous release at the targeted locations [9]. Moreover, multifunctionality is increasingly recognized as a key method for delivering drugs using nanostructures. Researchers are concentrating on developing carriers that can simultaneously perform several functions, including therapeutic delivery, imaging, and controlled release. For example, DNA nanostructures have been developed as drug delivery vehicles capable of carrying chemotherapeutic agents alongside imaging agents for enhanced diagnostic capabilities [10]. The advent of artificial intelligence (AI) in conjunction with nanotechnology furthers customization and optimization in drug delivery systems. AI models can be employed to analyze patient data and design precision nanoparticles that not only enhance targeting but also optimize dosage and treatment regimens based on individual patient profiles [11, 12].

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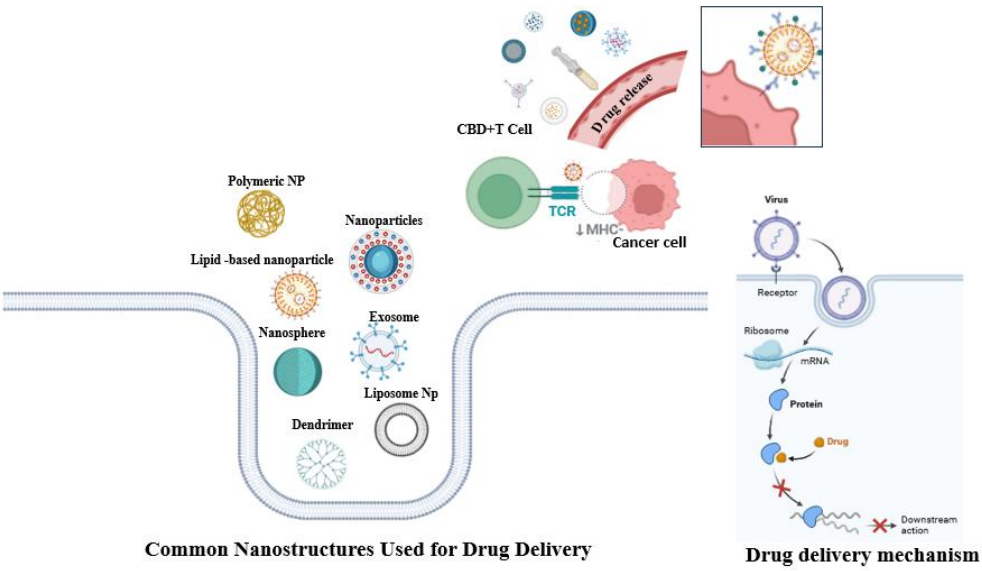

Fig.1. Mechanism Nanostructure drug delivery system for cancer cell.

In addition, investigating new nanomaterials, such as biodegradable polymers and biomimetic particles, offers ways to tackle therapeutic issues such as systemic toxicity and insufficient bioavailability. Studies indicate that engineered nanoparticles can significantly improve the targeting capabilities of drugs to specific tissues, such as tumors while minimizing adverse effects on healthy cells [13].

In inflammatory diseases, similar principles hold, as targeted delivery can reduce systemic inflammation and enhance the effectiveness of localized treatment. Anti-inflammatory drugs can be delivered efficiently according to the specific nature of nanocarriers, which reduces the possibility of systemic side effects [13, 14]. As findings validate the effectiveness and safety of these novel delivery systems, ongoing research is poised to refine and expand their applications in clinical settings.

In conclusion, advancements in nanostructured drug delivery systems introduce a multifaceted approach to treating cancer and inflammatory diseases. As researchers continue to explore the synergy between nanotechnology, AI, and personalized medicine, the potential to improve therapeutic outcomes and patient experiences becomes increasingly tangible.

Authors' contribution

Jaleh Varshosaz: Conceptualization, Writing—Original Draft Preparation, Writing—Review and Editing.

Declaration of competing interest

The authors declare that there are no competing interests.

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Data availability

Unused data for this work.

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