ISSN: 2157-7439
Journal of
Nanomedicine & Nanotechnology
OPEN ACCESS Freely available online
Review Article

Contemporary Progress in Functional Nanomaterials for Drug Delivery Platforms

Juliana Lima*

Department of Biosciences and Oral Diagnosis, Institute of Science and Technology, São Paulo State University, Brazil

ABSTRACT

Contemporary progress in drug delivery platforms has been significantly influenced by the development of functional nanomaterials. These nanomaterials, characterized by their tailored properties and versatile functionalities, offer precise control over drug release, enhanced targeting capabilities, and reduced systemic toxicity. In this article, we review the latest advancements in functional nanomaterials for drug delivery platforms, highlighting their potential applications, challenges, and future directions. By exploring the design principles, targeting strategies, and controlled release mechanisms of these nanomaterials, we aim to provide insights into their transformative impact on drug delivery and the potential for personalized and precision medicine approaches. Despite existing challenges, functional nanomaterials hold great promise for revolutionizing the treatment landscape for various diseases, ultimately improving patient outcomes and quality of life.

Keywords: Nanomaterials, Drug delivery, Functionalization, Targeting, Controlled release, Precision medicine

INTRODUCTION

The field of drug delivery has witnessed remarkable advancements in recent years, largely propelled by the development of functional nanomaterials. These nanomaterials, with dimensions at the nanoscale and tailored properties, have revolutionized the way therapeutic agents are administered, distributed, and released within the body. By harnessing the unique physicochemical properties of nanomaterials, researchers have created innovative drug delivery platforms capable of overcoming longstanding challenges in pharmacotherapy [1,2]. Functional nanomaterials offer several key advantages over conventional drug delivery systems. Firstly, their small size allows for enhanced bioavailability, prolonged circulation time, and improved cellular uptake. Additionally, nanomaterials can be engineered to respond to specific biological cues or stimuli, enabling controlled release of therapeutic payloads at the desired site of action [3-6]. Moreover, the surface of nanomaterials can be functionalized with targeting ligands, such as antibodies or peptides, to achieve precise targeting of diseased tissues or cells while minimizing off-target effects. In this review, we explore the contemporary progress in functional nanomaterials for drug delivery platforms. We examine the design principles, synthesis methods, and characterization techniques employed in the development of these nanomaterials. Furthermore, we highlight the diverse applications of functional nanomaterials in drug delivery, including targeted cancer therapy, treatment of infectious diseases, and management of chronic conditions. Despite the significant advancements made in the field, several challenges remain to be addressed [7,8]. These include concerns related to biocompatibility, scalability, and regulatory approval of nanomaterial-based drug delivery systems. Additionally, the translation of nanomedicines from bench to bedside requires rigorous preclinical and clinical evaluation to ensure safety and efficacy. The field of drug delivery has witnessed significant advancements driven by the development of functional nanomaterials [9,10]. These nanomaterials offer unique properties that enable precise control over drug release, enhanced targeting of specific tissues or cells, and reduced side effects. This article explores the contemporary progress in functional nanomaterials for drug delivery platforms, highlighting their potential applications, challenges, and future directions.

Introduction to functional nanomaterials

Functional nanomaterials are engineered structures with dimensions on the nanometer scale (1-100 nm) and tailored properties for specific applications. These materials can be synthesized from various substances, including polymers, lipids, metals, and ceramics, each offering distinct advantages in drug delivery. The functionalization of nanomaterials allows for the

*Correspondence to: Juliana Lima, Department of Biosciences and Oral Diagnosis, Institute of Science and Technology, São Paulo State University, Brazil, E-mail: julianalima@gmail.com

Received: 01-May-2024, Manuscript No: jnmnt-24-25945, **Editor assigned:** 04- May -2024, Pre QC No: jnmnt-24-25945 (PQ), **Reviewed:** 18- May -2024, QC No: jnmnt-24-25945, **Revised:** 25- May -2024, Manuscript No: jnmnt-24-25945 (R), **Published:** 31- May -2024, DOI: 10.35248/2157-7439.24.15.730.

Citation: Juliana L (2024) Contemporary Progress in Functional Nanomaterials for Drug Delivery Platforms. J Nanomed Nanotech. 15: 730.

incorporation of therapeutic agents, targeting ligands, imaging agents, and stimuli-responsive components, enabling precise control over drug delivery and therapeutic outcomes.

Tailoring nanomaterials for drug delivery

One of the key advantages of functional nanomaterials is their ability to be tailored to meet specific requirements for drug delivery. By adjusting parameters such as size, shape, surface chemistry, and payload encapsulation, researchers can optimize nanomaterials to achieve desired drug release kinetics, biodistribution, and pharmacokinetics. For example, polymeric nanoparticles can be modified to prolong circulation time in the bloodstream, while lipid nanoparticles can be engineered to enhance cellular uptake and intracellular drug release.

Enhanced targeting and accumulation

Functional nanomaterials offer enhanced targeting capabilities, enabling the selective delivery of drugs to diseased tissues or cells while minimizing off-target effects. Targeting ligands, such as antibodies, peptides, or small molecules, can be conjugated to the surface of nanoparticles to recognize specific receptors or biomarkers overexpressed in diseased tissues. This targeted approach improves drug accumulation at the site of action, leading to increased therapeutic efficacy and reduced systemic toxicity.

Controlled drug release

Precise control over drug release is a hallmark feature of functional nanomaterials for drug delivery. Stimuli-responsive nanocarriers can release therapeutic agents in response to external stimuli such as pH, temperature, light, or enzymatic activity present in the diseased microenvironment. This on-demand drug release strategy enhances therapeutic efficacy, minimizes premature drug leakage, and reduces the risk of adverse effects associated with systemic drug exposure.

Applications in disease treatment

Functional nanomaterials have shown promise in the treatment of various diseases, including cancer, infectious diseases, neurological disorders, and inflammatory conditions. In cancer therapy, nanomedicines can selectively target tumor cells, overcome multidrug resistance, and deliver synergistic drug combinations for improved treatment outcomes. In infectious diseases, nanocarriers can enhance the bioavailability of antimicrobial agents and facilitate intracellular drug delivery to infected cells. Moreover, in neurological disorders, nanomaterials can bypass the blood-brain barrier and deliver therapeutics to the central nervous system, offering new avenues for neuroprotection and neuroregeneration.

CONCLUSION

Functional nanomaterials hold immense promise as versatile platforms for drug delivery, offering enhanced targeting, controlled release, and improved therapeutic outcomes. With continued research, innovation, and interdisciplinary collaboration, functional nanomaterials are poised to revolutionize the field of drug delivery and pave the way for personalized and precision medicine approaches. By addressing existing challenges and exploring new avenues for application, functional nanomaterials have the potential to transform the treatment landscape for a wide range of diseases, ultimately improving patient care and quality of life.

REFERENCES

1. Poole C P, Owens F J. Introduction to nanotechnology. 2003.
2. Fulekar M. Nanotechnology: importance and applications. IK International Pvt Ltd. 2010.
3. KaradeV, Waifalkar P, Dongle T, Sahoo S C, Kollu P, Patil P et al. Greener synthesis of magnetite nanoparticles using green tea extract and their magnetic properties. Mater Res Express. 2017; 4(9): 096102.
4. Almomani F, Bhosale R, Khraisheh M, Almomani T. Heavy metal ions removal from industrial wastewater using magnetic nanoparticles (MNP). Appl Surf Sci. 2020; 506: 144924.
5. Zulfiqar N. Effect of adding surfactant additives (sodium lauryl sulphate) in water on the performance of flat plate solar distillation system for the purification of water. 2023.
6. Alfredo V, Isaías J, Hernandez E, Perez S, Angelica L, Landeros Sanchez B. Synthesis and characterization of magnetite nanoparticles for photocatalysis of nitrobenzene. J Saudi Chem Soc. 2020; 24(2): 223-235.
7. Avasthi A, Caro C, Pozo-Torres E, Leal M P, García-Martín M L. Magnetic Nanoparticles as MRI Contrast Agents. Topics in current chemistry.2020; 378(3): 40.
8. Liu S, Yu B, Wang S, Shen Y, Cong H. Preparation, surface functionalization and application of Fe3O4 magnetic nanoparticles. Adv. Colloid Interface Sci. 2020; 102165.
9. Mirza S, Ahmad M S, Shah A, Ateeq M. Magnetic nanoparticles: drug delivery and bioimaging applications. 2020; 189-213.
10. Iravani S, Korbekandi H, Mirmohammadi S V, Zolfaghari B. Synthesis of silver nanoparticles: chemical, physical and biological methods. Int J Pharm Sci. 2014; 9(6): 385.