Functional Peptides in Nano systems for Biomedical Applications: A short study

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Abstract

Many biomedical applications rely on peptide self-assembled nanostructures. One of the most promising applications among them is drug delivery. Good biocompatibility, low cost, customizable bioactivity, large drug loading capacities, chemical variety, selective targeting, and stimuli sensitive drug delivery at disease locations are just a few of the many benefits of peptide self-assembled nanostructures. Many researchers have looked into peptide self-assembled nanostructures like nanoparticles, nanotubes, nanofibers, and hydrogels for drug delivery applications. The basic mechanisms for self-assembling nanostructures based on peptides of various sorts and structures are introduced and reviewed in this review. The potential drug delivery applications of peptide self-assembled nanostructures, such as anticancer and gene drug delivery, are highlighted. Furthermore, peptide self-assembled nanostructures for drug delivery applications that are targeted and stimulus responsive.

Keywords

Biomedical application, Bioactivity, Drug delivery, PNCs

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1. Introduction

Peptide–nanoparticle conjugates (PNCs) are a useful tool for biomedical applications that have recently emerged. Synergy between the two potential kinds of materials allows for greater control over their biological functions, overcoming the inherent constraints of each material. PNCs have been created for a variety of applications over the years, including medication administration, inhibition of pathogenic biomolecular interactions, molecular imaging, and liquid biopsy [1]. This study gives a complete summary of extant technologies in the broad subject of PNCs that have recently been established, as well as a guideline for investigators who are new to this topic. Peptides have piqued attention in biomedical sectors as a novel material that can demonstrate protein capabilities while also having a high degree of versatility in molecular design. The construction and screening of peptide libraries from random amino acid compositions within a certain macromolecular topology, and the isolation of bioactive sequences from natural proteins based on their three-dimensional (3D) structures, are two current strategies for the discovery of artificial bioactive peptides. The rapid development of efficient binders against a wide range of target molecules is made possible by peptide library screening (e.g. small molecular compounds, peptides, DNAs, RNAs, cells, and inorganic materials) [2]. The top-down method, on the other hand, has an advantage over the bottom-up method in that peptide sequences aiming for a specific binding site on biomacromolecules can be discovered using structural features. Many researchers have discovered that combining peptides with non-biological materials (such as tiny molecular compounds, metal chelates, polymers, and hydrogels) is a viable way to overcome peptides‘ inherent limitations. Nanoparticles (NPs) in particular have demonstrated their ability to serve as conjugate scaffolds that not only increase peptide activity but also incorporate abiotic properties, often resulting in synergistic effects [3]. Peptide-NP conjugates (PNCs) have so been hailed as a promising platform for a number of medicinal applications. Finally, we‘ll offer some insight into research applications that have advanced quickly but still face a number of hurdles in clinical translation [4]. Nanomaterials (sizes ranging from tens to hundreds of nanometers) have unique physico-chemical properties not found in bulk materials. Their ultra-small size and high surface-area-to-volume ratio make them ideal for developing tailored materials that can interact with a wide range of nano- and micro-sized biomaterials. Self-assembly is the most straightforward method for producing peptide-based nanostructures. However, the thermodynamic process‘ spontaneity prevents the creation of nano-scale constructions with precisely controlled shape, size, and composition. Peptide–NP conjugation, on the other hand, gives you more control over the structural properties of nanostructures, allowing you to easily change the overall shape, dimension, and size of the conjugates by building NP scaffolds specifically for your needs. Pharmaceutical drugs must be delivered selectively to specific areas in the body, which is still a huge difficulty [5]. Peptides have lately emerged

as a potent arsenal that could provide modular selectivity to drug delivery systems, allowing for improved performance in the treatment of a wide range of critical health disorders, including cancer and brain ailments. Peptides interact with many biological systems in unique ways, allowing them to be used in a wide range of settings with positive effects. However, peptides' short in vivo half-life period, as well as their poor bio distribution and pharmacokinetics, have limited their use in drug delivery.

2. Conclusion

Multiple functions, such as cell penetration, precise targeting, release responsive mechanism, and endosomal escape patterns, could be incorporated in a single peptide self-assembled nanostructure. Peptide self-assembly poses a number of challenges, including accurately anticipating molecular or higher-order structures, functional properties, and biosafety. Another significant challenge is the high yield of peptide nano-manufacturing. In terms of clinical applications, this is equally crucial. To summarise, peptide self-assembled nanostructures for drug delivery applications hold a lot of promise and, if multidisciplinary efforts are done, are very promising for treating human diseases.

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