Peptide and protein drug delivery: Strategies for enhanced stability and bioavailability.

Basit Demon*

Department of Bioengineering, Rice University, Houston, USA

Introduction

Peptides and proteins have shown tremendous potential as therapeutic agents due to their high specificity and efficacy. However, their translation into clinical applications has been hindered by challenges related to their stability and limited bioavailability. To overcome these obstacles, researchers have developed various strategies for peptide and protein drug delivery, aimed at improving stability, enhancing bioavailability, and ensuring efficient targeting. This article explores the innovative approaches and technologies employed to enhance the delivery of peptides and proteins, thus facilitating their clinical utility.Peptides and proteins are susceptible to degradation by enzymes and harsh environmental conditions, limiting their stability and effectiveness. Several strategies have been developed to enhance their stability during delivery

Chemical modifications Incorporating chemical modifications, such as cyclization, acylation, and PEGylation, can improve peptide and protein stability by protecting them from enzymatic degradation and extending their circulation time.Formulation techniques Utilizing various formulation techniques, such as microencapsulation, liposomal delivery, and nanoparticle-based carriers, can protect peptides and proteins from degradation and provide controlled release, thereby enhancing their stability.

Enzyme inhibitors: Co-administration of enzyme inhibitors can prevent rapid enzymatic degradation of peptides and proteins, thereby increasing their stability and prolonging their therapeutic effects.Peptides and proteins often face challenges in achieving sufficient bioavailability due to poor absorption, low permeability, and rapid clearance from the bloodstream. Several strategies have been developed to enhance their bioavailability:

Enhancing oral delivery: Utilizing permeation enhancers, absorption enhancers, and prodrug approaches can improve the oral bioavailability of peptides and proteins, enabling convenient and patient-friendly administration.

Targeted delivery: Utilizing ligands, antibodies, or nanoparticles as carriers can facilitate targeted delivery, improving site-specific accumulation and uptake of peptides and proteins, thereby enhancing their bioavailability at the desired site of action.

Transporter-mediated delivery: Exploiting specific transporters expressed in various tissues and cells can enhance the cellular uptake and transport of peptides and proteins, thus improving their bioavailability.

Transdermal delivery: Utilizing innovative transdermal delivery systems, such as microneedles and skin patches, can facilitate the efficient and controlled delivery of peptides and proteins across the skin, bypassing barriers of oral administration and enhancing bioavailability.The development of advanced strategies for peptide and protein drug delivery has greatly improved their stability and bioavailability, bringing them closer to clinical translation. These innovative approaches have the potential to revolutionize the treatment of various diseases, including cancer, diabetes, and cardiovascular disorders. However, challenges still exist, such as maintaining target specificity, avoiding immune responses, and optimizing delivery parameters. Future research should focus on refining and tailoring these strategies to meet the specific requirements of different peptides and proteins, while ensuring safety and efficacy.

Conclusion

Peptides and proteins hold significant promise as therapeutic agents, but their effective delivery remains a challenge. Advances in drug delivery strategies have provided innovative solutions to enhance stability and improve bioavailability. The development of chemical modifications, formulation techniques, targeted delivery systems, and transport-mediated approaches has facilitated the clinical translation of peptides and proteins. Continued research and development in this field will pave the way for improved treatment options and the realization of the full potential of peptides and proteins in healthcare.

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***Correspondence to:** Basit Demon, Department of Bioengineering, Rice University, Houston, USA, E-mail: Basit@edu

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