Amphiphilic Polymer-peptide Nanostructures as Antimicrobial Systems

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Antimicrobial peptides (AMPs) are naturally occurring cationic amphiphilic molecules that have attracted increasing attention as potential alternatives to conventional antibiotics due to their broad-spectrum antimicrobial activity and their ability to disrupt microbial membranes through electrostatic and amphiphilic interactions.[1] Because they act at the membrane level, bacteria have a limited ability to develop resistance against them. However, their biomedical application is often limited by susceptibility to enzymatic degradation, possible cytotoxicity, and poor stability under physiological conditions. To overcome these limitations, significant efforts have focused on engineering AMP-derived systems and incorporating them into polymeric carriers to enhance stability and improve therapeutic performance.
Effective bacterial membrane disruption requires a balance between cationic and hydrophobic domains. While positively charged residues promote electrostatic interactions with negatively charged bacterial envelopes, hydrophobic segments facilitate insertion into lipid bilayers.
In this work, amphiphilic polymers were investigated as transport platforms for antimicrobial peptides. The strategy of polymer-peptide co-assembly in aqueous media was explored by appropriately tuning the amphiphilicity of the assembling components.The hybrid nanostructures were obtained via nanoprecipitation and characterized by dynamic light scattering under different conditions, including pH and presence of cosolvents. Poly(glycerol adipates) (PGA) and amphiphilic polydiacetylenes (PDA) will be explored as tunable amphiphilic systems. PGA is a degradable and bio-based polymer widely used for drug delivery.[2] Amphiphilic PDAs have stimuli-responsive optical properties and ability to form vesicles or micelles thanks to the presence of a polar head and hydrophobic alkyl chains.[3] Results showed how this strategy represents a promising approach for generating hybrid materials with potential applications in antimicrobial systems and biomaterials.

Keywords:
Antimicrobial peptides, Amphiphilic polymers, Hybrid nanostructures, Drug delivery, Antimicrobial materials

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