2026 lecture series

300th LBB Seminar

Precision Design and Programming Trap-and-Kill Peptide Nanonets for Novel Antimicrobial Therapy

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会場：東京科学大学 総合研究院 生体材料工学研究所

第二会議室 22 号館（１階）

Abstract: Antimicrobial peptides (AMPs) are traditionally developed as molecular drugs that disrupt membranes or bind intracellular targets; here we introduce a different paradigm in which peptides are engineered as environmentally activated supramolecular materials that eradicate bacteria through localized self-assembly rather than classical biochemical inhibition. We identified β-hairpin peptides that remain disordered under physiological conditions but undergo pathogen-triggered folding upon recognizing bacterial surface motifs such as lipopolysaccharide, initiating fibrillar growth directly on the microbial envelope to form extracellular “nanonets” that immobilize pathogens while exerting bactericidal activity and endotoxin sequestration. A central finding is that nanonet architecture is a programmable design parameter: residue-level modifications tune assembly to yield dense bactericidal meshes or looser trap-only structures, demonstrating that higher-order organization, not peptide potency alone, governs antimicrobial outcome, while confinement within these assemblies suppresses bacterial motility and enhances antibiotic susceptibility. The translational potential of peptide nanonets is immense ranging from their function as medical device surface coating to anti-biofilm and anti-fouling materials, demonstrating how this platform programs on-demand, bacteria-triggered nanonet formation at the material interface, spatially coupling capture, killing, and inflammatory attenuation. Overall, we aim to develop a multimodal peptide-based platform to address surface-associated microbial infections and its associated inflammation.

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