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Polypeptide Polymers: Advanced Synthesis and Biomedical Applications

The Polypeptide polymers, featuring peptide backbones with excellent biocompatibility and biodegradability, are widely used in biomedicine. Their efficient, rapid, and controllable synthesis remains a key challenge. Recent research advances in NCA ring-opening polymerization (ROP) have enabled novel synthesis strategies and expanded biomedical applications.

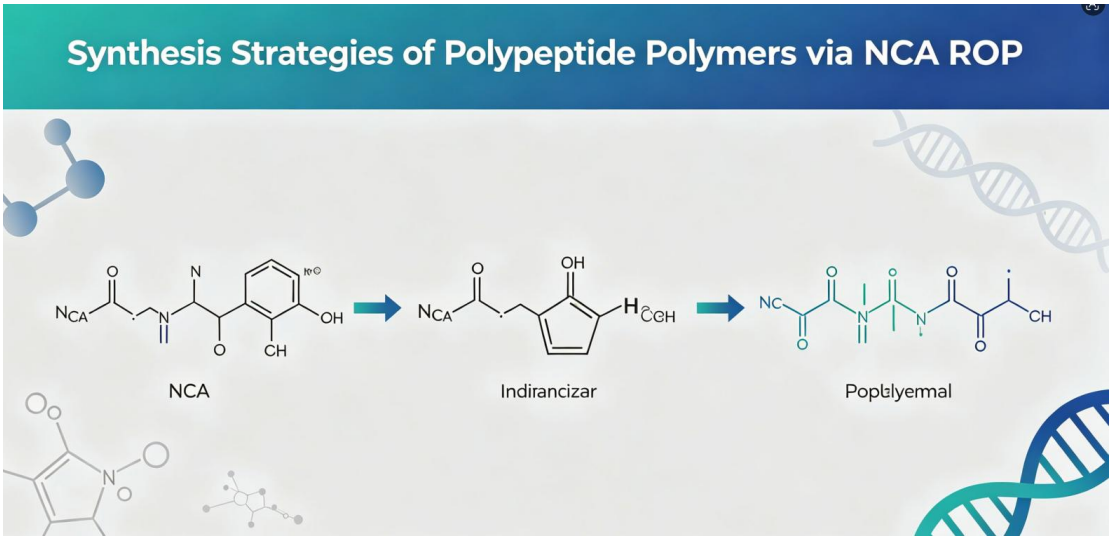
1.Research Background

Polypeptide polymers combine protein-like functionality with polymer processability. Traditional synthesis methods, including solid-phase and solution coupling, suffer from low yield, high cost, and limited chain length. NCA ROP has emerged as the most promising route for high-molecular-weight polypeptides. However, conventional NCA polymerization requires strict anhydrous conditions and suffers from poor control. Novel initiators and catalysts are urgently needed.

2.Research Purpose and Significance

This work systematically summarizes NCA monomer synthesis,

novel polymerization mechanisms, and emerging initiating/catalytic systems. It also reviews applications in antibacterial materials, drug delivery, and tissue engineering. The findings provide guidance for designing efficient, controllable polypeptide synthesis routes and promoting their industrial and clinical translation.



3.Research Content

- NCA Synthesis: Traditional Fuchs–Farthing methods are improved using flow chemistry and moisture-tolerant strategies, enabling fast, mild NCA production.
- Novel NCA Polymerization: Advanced initiating systems (amines, organosilanes, organic catalysts, carboxylate salts) enable fast, controlled polymerization under mild, even open-air conditions.
- Biomedical Applications:
- Antibacterial: Mimic antimicrobial peptides, effective against drug-resistant bacteria.
- Drug Delivery: Self-assembled nanoparticles enhance solubility and

targeted release.

- Tissue Engineering: Biocompatible hydrogels and 3D-printable scaffolds support tissue regeneration.

4.Conclusion & Outlook

NCA-based synthesis has significantly advanced polypeptide polymer preparation, enabling mild, fast, and controllable routes. Polypeptides show great potential in antibacterial materials, drug delivery, and tissue engineering. Future efforts will focus on precise sequence control, scalable green synthesis, and expanding biomedical applications, driving polypeptide polymers toward broader clinical and industrial impact.