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Multi-Functional Injectable Alginate-Collagen Hydrogel for Targeted Therapeutic Delivery

The Stanford team developed a versatile injectable alginate-collagen hydrogel, a significant advancement in regenerative medicine and targeted therapeutic delivery. Designed to be both clinically applicable and cost-effective, this hydrogel bridges the gap between sophisticated lab-based formulations and real-world medical use. Its versatility and biocompatibility make it highly suitable for delivering cells and drugs with precision, offering a practical and high-performance tool for vascular tissue engineering and minimally invasive treatments.

This optimized hydrogel formulation addresses key limitations of previous alginate-based systems,including premature gelation, inconsistent flow properties, and catheter delivery inefficiencies. The optimized formulation ensures smooth and reliable injection and offers several major benefits. It enhances vascular regeneration by promoting endothelial cell growth and angiogenesis. It also enables sustained localized antibiotic delivery for infection prevention and supports reliable catheter-based delivery without clogging. Together, these innovations greatly improve the precision and effectiveness of hydrogel-based treatments in clinical settings.

Stage of Development: Research - in vitro

Applications

- **Regenerative medicine and bioprinting:** endothelial cell delivery to promote neovascularization in ischemic or wounded tissues.
- **Localized antibiotic delivery:** controlled and sustained antibiotic release to prevent infections post-surgery and surgical site infections.

- **Catheter-based delivery systems:** optimized formulation ensures smooth, precise delivery through standard catheter systems without clogging or high-force requirements.

Advantages

- **Optimized endothelial support:** promotes endothelial adhesion, proliferation, and angiogenic differentiation, creating a functional environment for vascular regeneration.
- **Localized and prolonged antibiotic release:** ensures sustained therapeutic delivery over extended periods at target sites while avoiding systemic side effects.
- **Seamless catheter-based delivery:** achieves smooth flowability with delayed gelation, ensuring accurate placement without clogging or excessive injection force.
- **Customizable hydrogel properties:** tunable CaSOâ,„ and collagen levels allow fine control over viscosity, degradation, and mechanical stability.
- **Versatile applications:** functions as a delivery platform for cells, antibiotics, and bioactive agents while also serving as a bioink for 3D bioprinting.
- **Cost-effective and clinically friendly:** compatible with existing syringe-based and catheter systems, simplifying procedures and reducing procedural costs.

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