Printing and Rerouting of Elastic and Protease Responsive Shape Memory Hydrogel Filaments (REFRESH)

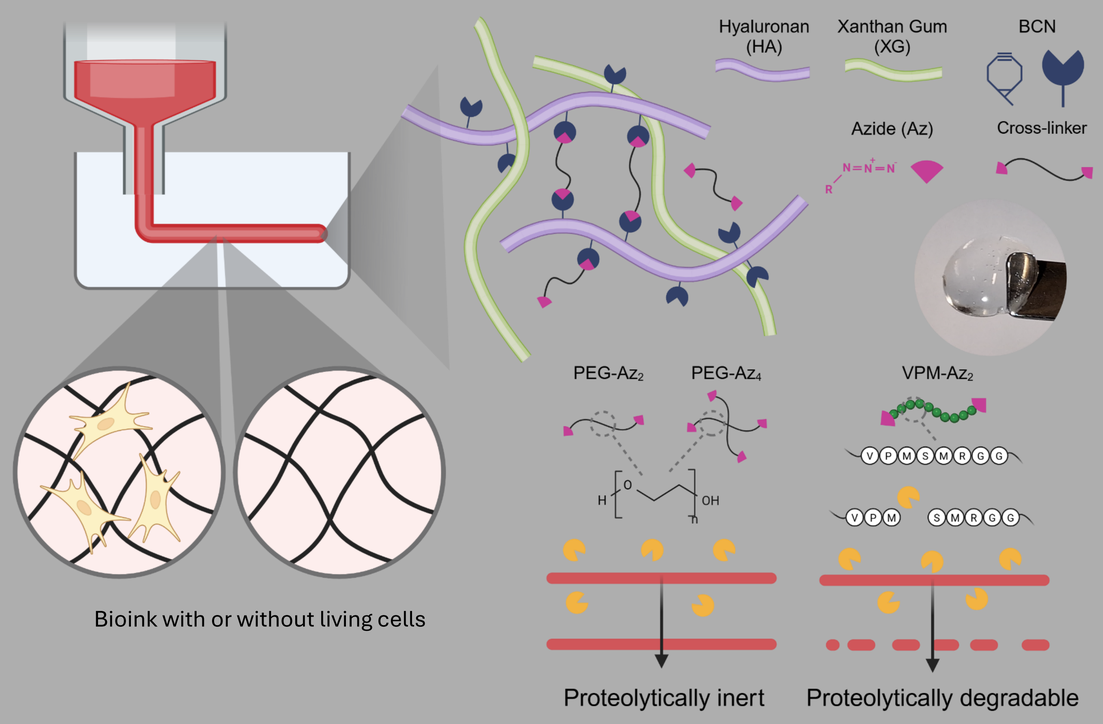
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Introduction

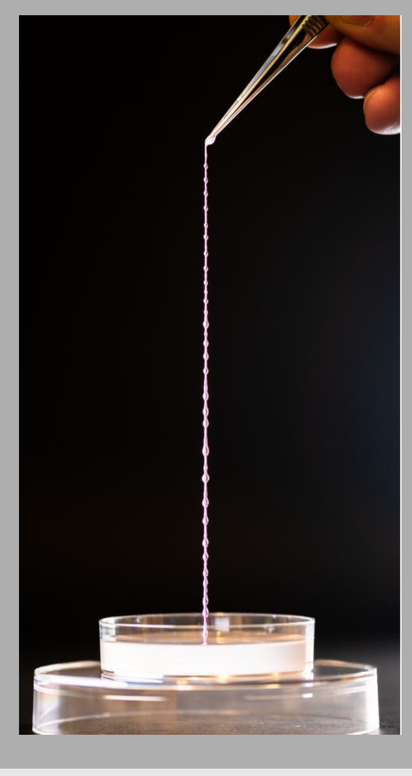
Creating filamentous hydrogel constructs that are both mechanically stable and adaptable remains an important goal in tissue engineering. Biofabrication of complex, cell-laden fibrillar architectures requires strategies—combining both methods and materials—that preserve elasticity and shape fidelity while maintaining high cell viability within well-defined geometries.

Here, we introduce Rerouting of Free-Floating Suspended Hydrogel Filaments (REFRESH) as a versatile bioprinting strategy that utilizes aqueous two-phase system (ATPS)-compatible, ECM-mimicking hydrogels for generating elastic hydrogel filaments. REFRESH enables the creation of cell-laden filaments with tunable mechanical and biochemical properties that can be manually reconfigured into complex architectures.

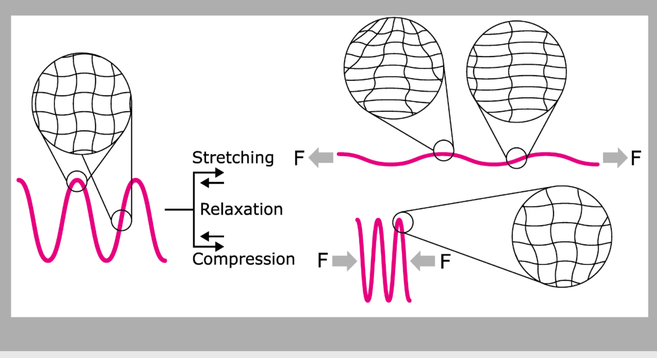
REFRESH method and cross-linking chemistry

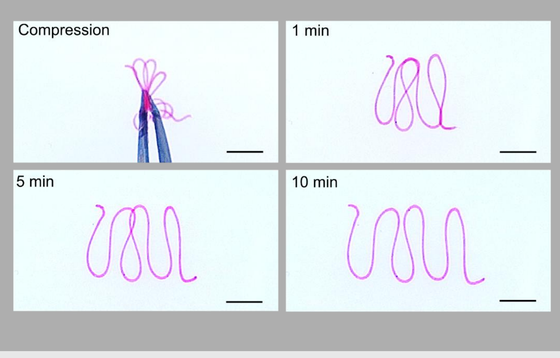


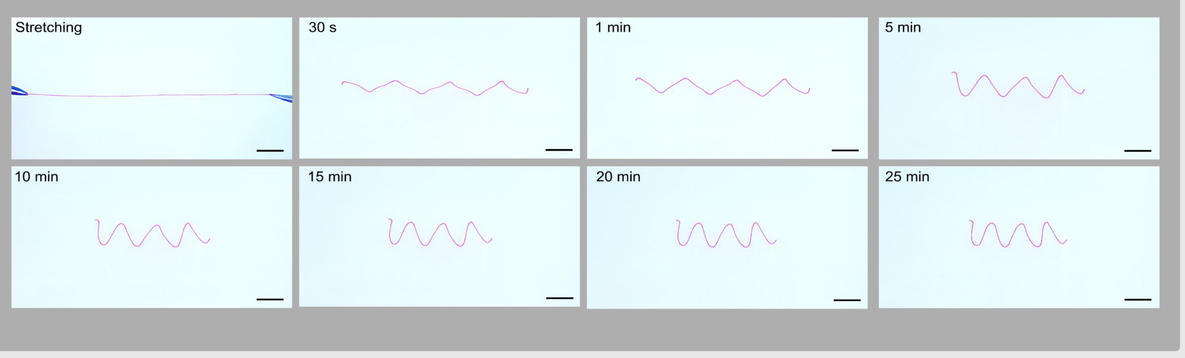
REFRESH Filament



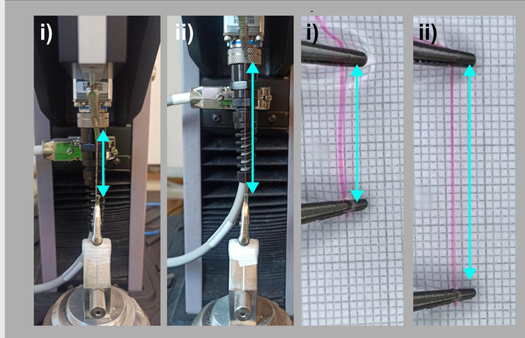
Shape memory function

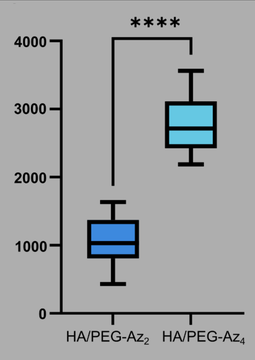


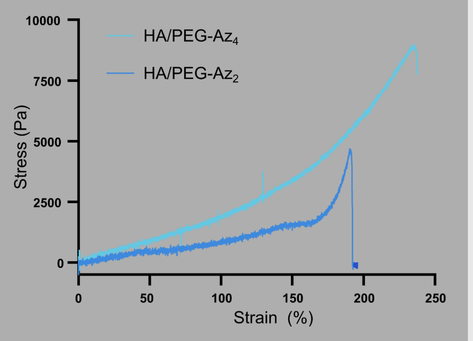


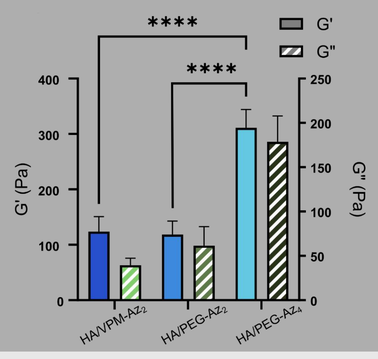


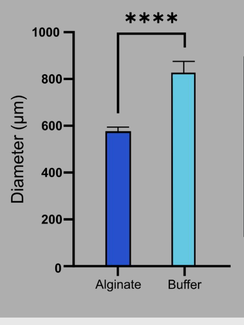
Mechanical properties

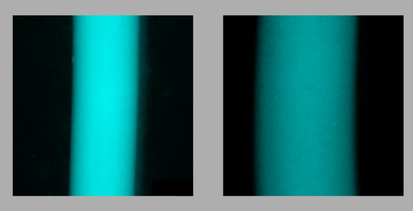




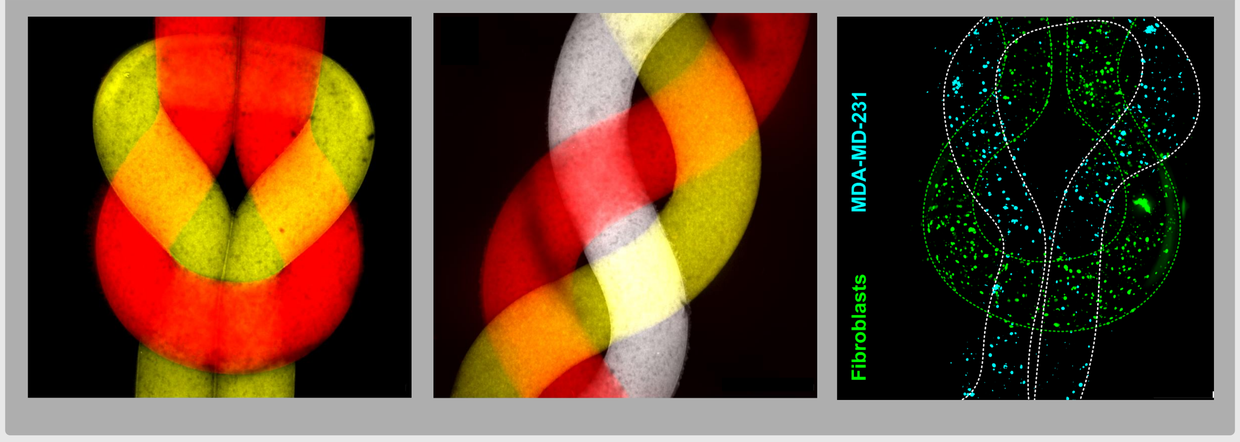




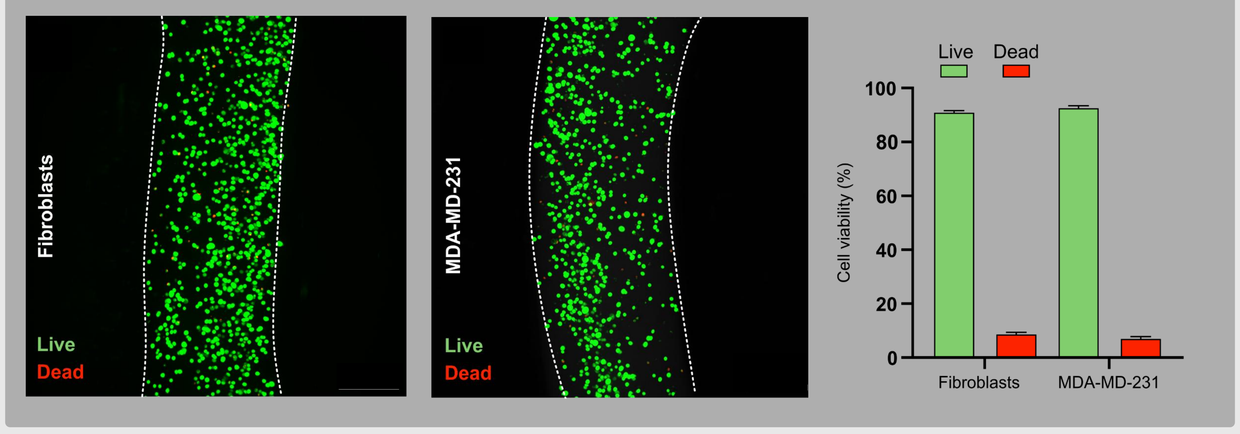




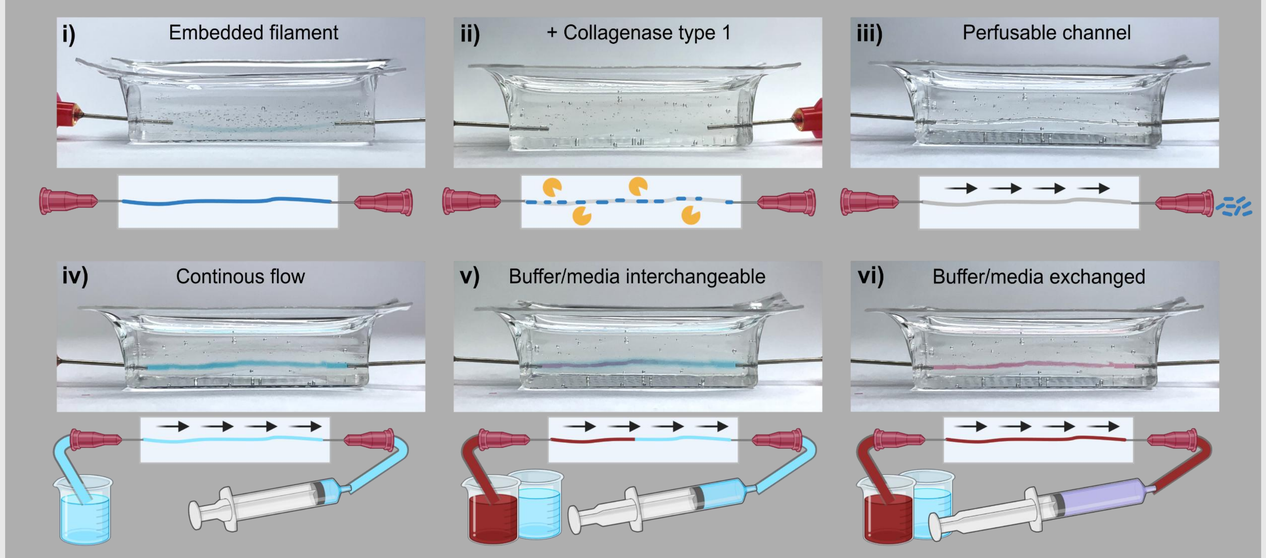
Rerouting into 3D shapes



Cell viability



Enzymatic degradation of filament into perfusable channel



Conclusion

The REFRESH approach enables the fabrication of elastic, shape-memory hydrogel filaments that can be rerouted and reconfigured after printing while maintaining high cell viability. By combining ATPS-mediated stabilization with tunable hydrogel chemistry, this method broadens the design space of extrusion-based biofabrication.

REFRESH provides a versatile platform for constructing complex hydrogel architectures and perfusable channels, offering new opportunities for engineered tissue models and advanced biofabrication strategies.

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