Grant Summary: Injectable Hydrogel–Stem Cell Therapy for Myocardial Repair

Project Title: Biomimetic Injectable Hydrogel for Mesenchymal Stem Cell Delivery to Repair Post-Infarct Myocardium

Summary:
Myocardial infarction (MI) results in the rapid loss of cardiomyocytes, scar formation, and long-term ventricular dysfunction. Current clinical interventions—including percutaneous coronary intervention and pharmacotherapy—limit further ischemic damage but cannot regenerate lost myocardium. This project proposes the development and validation of an injectable, biomimetic hydrogel designed to deliver mesenchymal stem cells (MSCs) directly into infarcted tissue to enhance cardiac repair.

The hydrogel formulation is engineered to mimic native myocardial stiffness (10–20 kPa), support cell viability, and provide sustained retention in the hostile post-MI microenvironment. By encapsulating MSCs within a mechanically tuned, ECM-like scaffold, the approach improves survival, paracrine signaling, and localized therapeutic effect. Preliminary data in analogous systems demonstrate >80% MSC viability and >70% retention at the injection site, compared to <10% with traditional bolus injection.

This proposal aims to (1) optimize hydrogel crosslinking chemistry to maximize MSC survival and engraftment; (2) evaluate structural integration and anti-remodeling effects in small-animal MI models; and (3) characterize functional improvements in ejection fraction, scar thickness, and inflammatory markers. The long-term goal is to develop a regenerative therapeutic platform that overcomes the limitations of current post-MI treatments and advances the clinical translation of biomaterial-assisted cell therapies.

Impact:
Successful completion of this work will provide a scalable strategy for tissue regeneration after MI, addressing a critical unmet clinical need for therapies that restore rather than stabilize cardiac function. The technology also establishes a broadly applicable framework for using biomaterial–cell combinations to regenerate soft tissues affected by ischemia, trauma, or degenerative disease.