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Electrically Conductive Cardiac Microtissues

There are an estimated 23 million people with heart failure worldwide, with 1-year mortality rate of 30% following onset. Loss of cardiomyocytes (CMs) from myocardial infarction results in remodeling and abnormal stress distribution throughout the tissue, leading to increased morbidity.

Regenerative medicine and tissue engineering strategies offer promising new treatment options for patients facing heart failure. Self-assembled cellular microtissues have improved survival, metabolic activity and cellular integration compared to single cell delivery. Embedding cardiac tissues with electrically conductive nanomaterials has shown enhanced cell contraction and expression of gap junctions. However, these options still do not come close to replicating the properties of native myocardium and result in poor tissue-level functionalities and lack of integration with the host myocardium. Thus, there is still an unmet critical need to develop treatment strategies for long-term regeneration of injured myocardium.

Researchers at Arizona State University, in collaboration with a colleague at the VA, have developed biocompatible electrically conductive cardiac microtissues for functional regeneration and repair of infarcted myocardium. Functionalized gold nanowires (GNWs) decorate the intercellular microenvironment of the microtissues to enhanced structural integrity. These microtissues can be injected within the infarcted region of the myocardium to restore lost tissue function and ultimately prevent heart failure. A desirable microenvironment can be created with these microtissues to enhance the functionalities of cardiac cells and to better integrate with the native heart tissues.

These microtissues simultaneously enhance cell-cell coupling, cellular engraftment and electromechanical integration with the host myocardium while supporting neovascular formation to provide a comprehensive approach to myocardial replacement therapy.

Potential Applications

- Regeneration of infarcted myocardium
- Repair of infarcted myocardium

- Disease modeling

Benefits and Advantages

- Increased biocompatibility with decreased cytotoxicity

Modified surface properties to decrease intracellular uptake

- Enhanced spheroid structural integrity
- Increased GNW-cell interactions enhance the structural integrity of the microtissues
- The materials have high electrical conductive and easy fabrication and modification processes
- Minimally invasive – injectable directly to the infarcted zone via catheter

o Does not require the chest cavity to be opened

- High affinity for cell adhesion and spreading

For more information about the inventor(s) and their research, please see Dr. Nikkhah's laboratory webpage