Advancements in Engineering Techniques for Myocardial Tissue Regeneration

The number of people affected by cardiac problems every year is rising globally and one of the many actions taken to address this broad concern is employing tissue engineering techniques for cardiac tissue repair and regeneration. Although, there are limitations in the ability of human cardiomyocytes to regenerate completely, yet several tissue engineering strategies using hydrogels, have been deployed over the years, to overcome this limitation.

One such step is the development of a blend of collagen-fibrin based hydrogel, seeded with cardiomyocytes derived from human pluripotent stem cells, which revealed that hydrogel protein content and the population of cell seeding plays a critical role in myocardial tissue regeneration [172]. Medical literature shows the development of 3D bio-printed gelatin-based hydrogels, which are micro channeled to help promote heart cell growth by maintaining native cardiomyocytes and at the same time utilizing mesenchymal stem cells to affect cardiac regeneration [173]. Nonetheless, more extensive research must be conducted to overcome contemporary drawbacks in cardiac tissue growth.

The notion of immuno- isolation was developed to protect the foreign graft material form the host immune response and to avoid complications befalling due to immune suppression. Immuno- isolation devices were designed to establish a physical barrier with the newly grafted tissues to limit their contact with host immune cells. For a graft material to be viable and functional, the device should be fabricated as such, to allow sufficient diffusion of nutrients, endocrine factors, and oxygen to the implanted tissues to sustain extended interaction with the environment [176].

The excellent biocompatibility and structural properties of smart hydrogels to mimic extracellular matrix(ECM) biology have been utilized by researchers to create injectable hydrogel matrices for delivering islets cells in the site of transplantation in the treatment of type 1 diabetes[177].

Encapsulating these islet cells in hydrogel microspheres (microgels) before transplantation into diabetic recipients can establish an adequate immuno-isolation barrier to depreciate allogeneic rejection. Synthetic hydrogel macromers like PEG-4MAL (4-arm polyethylene glycol terminated with maleimides)can serve as an ideal candidate for immuno-isolation applications since it can be easily altered with thiolated bioactive molecules, allowing precise control of islet microenvironment [178].

Although the advancements in cell therapy, nanotechnology, biotechnology, genetic engineering, and immunology have recognized potential means of using hydrogels in accomplishing long-term viability and functionality of transplanted islet cells, many hurdles are yet to be crossed, such as islet cell apoptosis, the need of immunosuppressive drugs, and managing immune reactions for successful therapeutic results [177].