Using Induced Pluripotent Stem Cells (IPSC) to Repair and Regenerate Necrotic and Damaged Myocardial Tissue

Lauren Morris

Lauren’s passion for the medical field began long before she became a cardiovascular surgeon at the age of six and performed a coronary artery bypass grafting on her mother. That is, with a $10 Fisher Price Medical Kit. At least that’s what she believes she was aiming to do. It was something to do with her father, who was in the medical field. Lauren always told her mother, “I want to fix broken hearts” as soon became increasingly obvious. Following CAD and myocardial infarction, structural damage and function impairment is often irreversible, and heart failure ensues. The heart has an age-related block in its ability to redevelop new myocardial cells, so that impaired cells are not replaced in the latter half of life, specifically when they are most essential. A typical patient with heart failure has lost approximately over a billion cardiac cells.

An exciting development in the field of cardiovascular regenerative medicine is regenerating adult somatic cells into IPSCs and coaxing their differentiation into functional cardiomyocytes. The approach to produce IPSCs involves using patient somatic cells and introducing the genes that encode for critical transcription factors, proteins, which themselves regulate the proper functioning of other genes necessary for the early steps in embryonic development. To differentiate into cardiac lineages, the IPSCs are exposed to chemical or physical signals including growth factors, cell culture substrate, co-culture environments, three-dimensional cultures, and signal inhibition. Cardiac lineages created by IPSCs, however, resemble the cardiac cells of an infant, rather than adult heart cells. To properly function in adult hearts, the new cardiac cells must “mature” to survive within the persistently beating setting. Scientists have generated the technology to transform these immature cardiac cells, but very few cardiac cells derived from stem cells integrate into the normal heart tissue as mature cardiac cells. To fully mature, including smooth muscle cells, endothelial cells, cardiac progenitors, and cardiomyocytes. Thus, the IPSCs can serve as an alternative treatment for repairing and regenerating cardiac muscle.

Approach

Of the five billion cardiac cells, each one is responsible for pulsing in unison as an instrumentalist is playing in symphony in an orchestra. However, following CAD and associated myocardial infarction, structural damage and function impairment is often irreversible, and heart failure ensues. The heart has an age-related block in its ability to redevelop new myocardial cells, so that impaired cells are not replaced in the latter half of life, specifically when they are most essential. A typical patient with heart failure has lost approximately over a billion cardiac cells.

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The process of decellularization, donor hearts are bathed in detergent dissolving away cells, leaving a scaffold of connective tissue. In cell fractionation, the heart’s scaffold material is broken into individual components while still preserving individual functional detail of each component in hopes of rebuilding the setting that enable the immature cardiac cells derived from IPSCs to mature. Provided with these methods, it is possible to construct real adult heart tissue in the laboratory, as well as transplanting these patient-specific heart cells into the heart. It is necessary to observe the scar tissue over time to determine the effectiveness of this alternative treatment method.

References

Evidently, IPSCs technology holds tremendous promises and advantages for therapeutic cardiovascular regeneration. Although immune rejection – the body’s immune system recognizes the implanted cells as foreign and attacks them – serves as a barrier to the therapeutic application of cell-based therapies, IPSCs allows for the creation of cell lines that are genetically customized to a patient. Thus, the issue of immune rejection is overcome. Another critical advantage of IPSCs is that they are not derived from human embryos, a major ethical consideration. The ability to reprogram adult cells means that scientists also permit scientists to sidestep other controversial methods including somatic cell nuclear transfer, also known as cloning.