Engineering mitochondrial transfer from mesenchymal stromal cells to annulus fibrosus tissue as a repair strategy for intervertebral disc degeneration

The interverbal disc is the donut-shaped tissue that lies between vertebra of the spine. Its main function is to absorb shock and transmit load to adjacent vertebra. Although intervertebral disc degeneration accounts for over 400 million cases of back pain globally, there are currently no clinically available treatment options that restore the structural or mechanical properties of the native disc. Mesenchymal stromal cells (MSCs) have been shown to help heal the intervertebral disc both in animal models and humans. However, the mechanisms employed by MSCs to help regenerate disc tissue are not fully understood.

Mitochondrial transfer is a phenomenon in which MSCs donate their mitochondria to diseased or injured cells through extracellular vesicles, cell extensions, or cell fusion. Mitochondrial transfer has been shown by other groups to prevent cell death and reduce inflammation in multiple disease models including tendinopathy and acute lung injury. The Bonassar Lab (BME/MAE) in combination with the Hartl Group at Weill Cornell Hospital is studying the effect of MSC mitochondrial transfer on disc cells, with the goal being to determine a method of increasing mitochondrial transfer for improved therapeutic outcomes.

Undergraduates who join the team will have the opportunity to investigate whether mitochondrial transfer is possible in disc tissue explants as has been seen in direct 2D coculture. Students will learn about and apply a combination of laboratory techniques including cell culture, tissue culture, primary cell and tissue isolation, cellular staining, lentiviral transduction, confocal microscopy, and image analysis.

This project is well-suited for individuals excited to learn about biology, regenerative medicine, and cellular engineering. Basic cell biology knowledge, intro to programming/coding, and ImageJ experience are preferred.

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