Novel Plant-Derived Scaffolds Influence Cellular Mechanotransduction and Differentiation

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There is a significant global need for tissue engineering scaffolds that are comparable to human tissue. Interestingly, the plant kingdom presents a striking similarity to human tissues, especially in critical structures such as porosity, vasculature, and fibers. Because plant tissue presents such a complex surface topography, I investigated the effect of these inherent mechanical cues on the culture of human mesenchymal stem cells (MSCs). Two different microtopographies (i.e., porous and fibrous) were isolated from celery tissues and compared to a similarly stiff and porous hydrogel substrate. Interestingly, the MSCs heavily responded to the topographical cues of their plant environment. In fibrous celery tissue, which closely resembles skeletal muscle, the cultured MSCs assumed a cell shape and behavior that was more like muscle cells. On the other hand, cells cultured on porous celery resembled bone. The cells' behavioral patterns continued in differentiation. MSCs on fibrous tissue were significantly more likely to differentiate into early muscle tissue, while those on porous tissue committed to a bony lineage. As compared to the hydrogel control, both plant tissues demonstrated upregulated markers of mechanosensing, and ultimately higher levels of differentiation. These results indicate the benefits of naturally occurring plant structures in directing MSC behavior. Ultimately, the desired cell responses for tissue engineering were upregulated on plant scaffolds as compared to an alternative substrate. This suggests that plant scaffolds may be an accessible and conducive option for guiding cell behavior in future tissue engineering.

Awards Won:
First Award of $5,000
National Anti-Vivisection Society: Third Award of $2,500