“Functional Tissue Engineering: Converting Fat to Bone and Cartilage”

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Functional tissue engineering uses physical stimulation to direct cell populations to produce tissue with anatomically and physiologically correct structures and with material properties similar to native tissue. Adipose-derived stem cells (ASC) are a particularly promising cell source for functional tissue engineering applications due to their multilineage differentiation potential and their abundance and ease of harvest relative to many other cell types. However, mechanobiological understanding of human ASC (hASC) is still emerging and many questions remain to be answered. Approaches and mechanisms associated with physical stimuli-induced hASC lineage specification and functional tissue formation comprise an increasingly active area of investigation and much remains to be learned. A primary objective of the Loboa lab is to understand and elucidate the role of physical stimuli on the mechanobiology of hASC and attempt to optimize these effects for functional tissue engineering using hASC. Both computational and empirical approaches are utilized in our investigations of hASC mechanobiology for tissue regeneration. Methods include: 1) application of external physical stimuli via use of custom bioreactor systems that mimic in vivo physical stimuli; 2) finite element analyses of cell-seeded constructs exposed to mechanical load to determine local stresses and strains associated with global strain applications; 3) investigations of mechanotransduction mechanisms associated with hASC response to physical stimuli; and 4) creation of biomimetic 3D scaffolds to induce hASC proliferation and controlled differentiation. By understanding and elucidating mechanical and material environments in vivo, we build and utilize custom bioreactors and three-dimensional culture systems that better replicate these environments; and, promote desired hASC lineage specification and functional tissue engineering in vitro.

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