

## Stem cells and regenerative medicine for osteoarthritis

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Tissue engineering is a rapidly growing field that seeks to repair or replace tissues and organs using combinations of cells, biomaterials, and/or biologically active molecules. Despite many advances, significant challenges still remain in the replacement or repair of tissues that primarily serve a biomechanical function, such as articular cartilage. An important consideration in the long-term success of such biomechanically functional tissue replacements is a more thorough investigation of the influence of biomechanical factors, such as the design and characterization of the mechanical properties of biomaterial scaffolds and the use of biophysical stimuli to control cell differentiation and metabolism [1]. Using principles of "functional tissue engineering" [2], we have developed novel biomimetic scaffold designs based on techniques for three-dimensional weaving of biocompatible fibers. A microscale weaving technique was utilized to generate anisotropic 3-D woven structures as the basis for composite scaffolds [3]. These scaffolds exhibited mechanical properties that were similar to those of native articular cartilage, as measured by compressive, tensile, and shear testing. Such porous composite scaffolds can be engineered with initial properties that reproduce the anisotropy, viscoelasticity, and tension-compression nonlinearity of native articular cartilage. In combination with human adipose-derived adult stem (hADAS) cells [4], we have developed cartilage constructs with the potential for load-bearing immediately after implantation *in vivo*, with biological support for cell-based tissue regeneration without requiring cultivation *in vitro*. Recapitulating the biomechanical properties of the tissue, in addition to providing developmental biological cues to the stem cells, may provide new advances in the engineering of functional tissue replacements.

Acknowledgments: NIH AR49294, AR50245, and the Coulter Foundation.

References: [1] Butler DL, Goldstein SA, Guilak F. *J Biomech Eng.* 122:570, 2000. [2] Guilak F, Butler DL, Goldstein SA. *Clin Orthop Rel Res.* 391S:295, 2001. [3] Moutos FT, Freed LE, Guilak F. *Nat Mat*, in press, 2007. [4] Estes BT, Wu AW, Guilak F. *Arthritis Rheum.* 54:1222, 2006.