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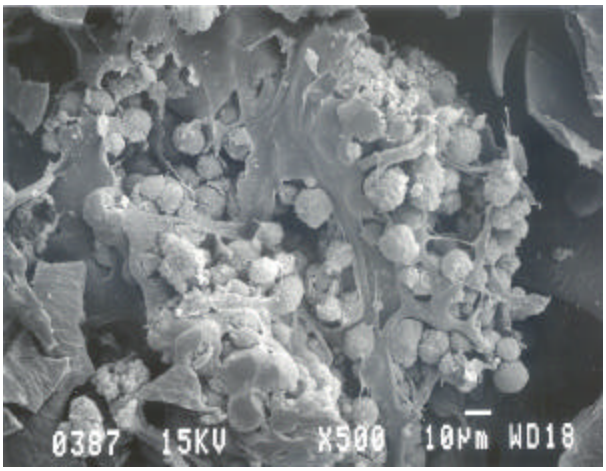
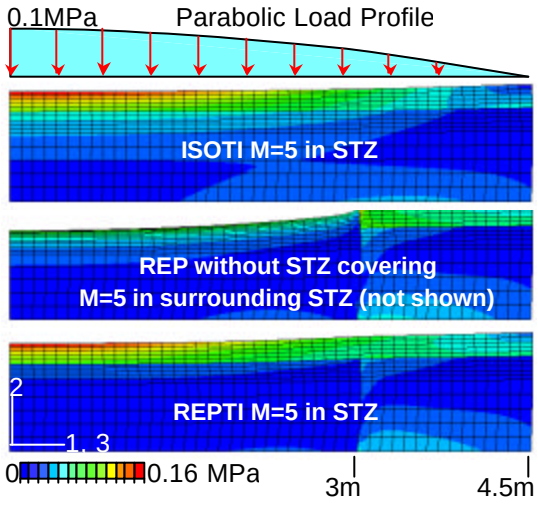
"Cartilage Repair and Computational Modeling"

Unlike other connective tissues, articular cartilage appears to have a limited capacity for intrinsic repair once injured or degenerated. Damage to the tissue in diarthrodial joints is thus believed to be progressive with significant pain and joint dysfunction resulting. The Orthopaedic Research Laboratory at Virginia Commonwealth University is focused on the ex vivo creation of tissue engineered constructs seeded with appropriate cells and stimulated to differentiate along a chondrocytic lineage and produce matrix products indigenous to cartilage. These seeded scaffolds are being evaluated in vivo while other constructs and stimuli are under investigation.

Computational tools in biomechanics provide a powerful way to assess biomechanical behavior of tissues and/or structures without physical experimentation and to provide information not obtainable by any other means. One such tool, finite element analysis (FEA) in solid mechanics, links the deformation (strain) that a structure or tissue undergoes due to the loads (stress) applied to it. The Orthopaedic Research Laboratory at Virginia Commonwealth University applies FEA to understand the biomechanical function of different musculoskeletal tissues with primary interest in normal and repair cartilage mechanics. These analyses provide the means to assess how mechanical properties contribute to overall function. Additionally, comparison of the behavior of normal articular surfaces with degenerated or repairing surfaces enables determining the biomechanical functions that are specifically altered. Finally, these analyses allow for evaluation of different repair techniques and lead us to develop better reparative methods.



Scanning electron microscopic evidence of cellular retention and proliferation in tissue engineered constructs.
(funded by NIH; Wayne et al: In vivo response of PLA/Alginate scaffolds and bone marrow-derived cells for cartilage tissue engineering, Tissue Engineering, 11(5-6): 2005).



Stress contours of simulated repaired articular surfaces with different (inferior) material properties of cartilage, depicting high levels (red) in specific zones.
(Owen, Wayne: Influence of a superficial tangential zone over repairing cartilage defects – Implications for tissue engineering. Biomechanics and Modelling in Mechanobiology (BMMB), 2005.