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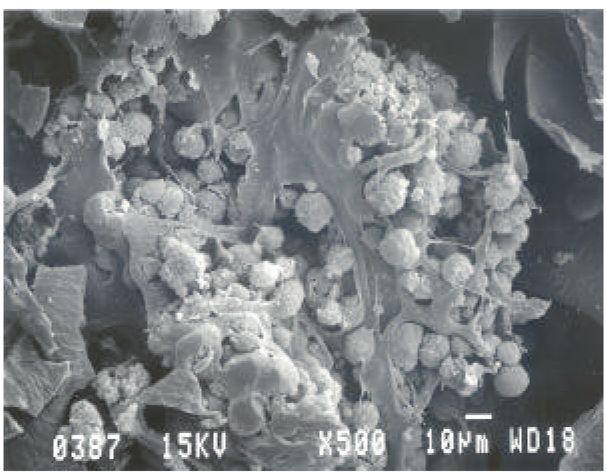
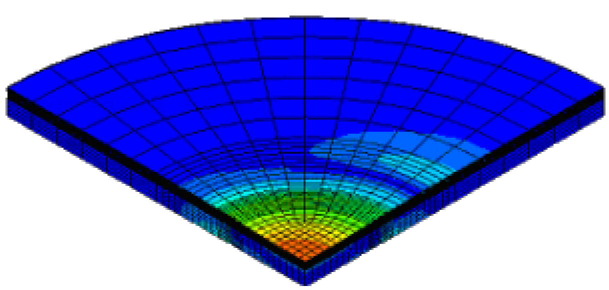
"Cartilage Repair and Computational Modeling"

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 focusses 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 invivo while other scaffold geometries and stimuli are being developed.

Computational tools in biomechanics provide an efficient way to assess biomechanical behavior of tissues and/or structures without physical experimentation. Finite element analysis 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 the computational modelling tool known as finite element analysis to understand the biomechanical function of different musculoskeletal tissues. Primary interests are in normal and repair cartilage mechanics. These analyses provide the means to assess how mechanical properties, both linear and nonlinear, contribute to overall cartilage function. Additionally, comparison of the behavior of normal articular surfaces with surfaces comprising a region of repair cartilage (with inferior properties) enables determining the functions that are specifically altered. These analyses also allow for evaluation of different repair techniques, once the properties of the generated repair tissue are known. This information leads us to develop better reparative methods.



Scanning electron microscopic evidence of cellular retention and proliferation in tissue engineered constructs (funded by NIH).



Stress contours of a simulated repaired articular surface with different (inferior) material properties of cartilage, depicting high levels (red) in specific zones.