***Continuum mixture models for extracellular matrix regeneration in cartilage tissue engineering***
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Articular cartilage physiology is regulated by specialized cells called chondrocytes that maintain homeostasis in the tissue. The chondroyctes are sparsely distributed within a porous and fibrous extracellular matrix (ECM) comprised of cross-linked collagen and proteoglycan macromolecules.  ECM degeneration due to osteoarthritis can lead to complete degradation of cartilage surfaces, necessitating joint replacement. Since cartilage is avascular and aneural, metabolic activity in the tissue is highly dependent on the local biophysical, biochemical and biomechanical environment of its cells.

Chondrocytes or mesenchymal stem cells can be seeded in biocompatible and degradable biopolymer or hydrogel scaffolds to initiate ECM regeneration and, ultimately, to engineer new tissues. In such systems, biosynthetic activity of the cells in response to their local environment results in regeneration and accumulation of ECM constituents concurrent with degradation of the surrounding scaffold material.  While trial-and-error approaches have had some success, there is a need for more systematic, mechano-biological approaches to model, quantify and assess the relative importance of the diverse, coupled, phenomena involved in tissue regeneration.

Mixture models will be presented for cell-mediated interactions between biosynthesis of ECM constituents and accumulation of linked ECM in cell-seeded scaffolds. Both ODE-based (temporal) models for evolution of average apparent densities and PDE-based (spatio-temporal) models will be presented for variables including unlinked ECM, linked ECM and scaffold. Of particular interest is the role of evolving porosity in the engineered construct which is known to affect transport and accumulation of ECM constituents. These models provide a quantitative framework for evaluating and optimizing the design of engineered cell-scaffold systems and guiding strategies for articular cartilage tissue engineering.