Biomathematics seminar
Tuesday 9/11/07
Speaker : Eunjung Kim

Title : Computational modeling of multiphasic micromechanics in articular cartilage

Abstract:

Articular cartilage is a connective tissue that lines the surface of bones in diarthroidal joints and serves as a low-friction and load-bearing material for joint motion. Articular cartilage is comprised primarily of interstitial water that saturates a solid extracellular matrix (ECM). Cartilage ECM is maintained by sparsely populated cells, called chondrocytes. Since cartilage is avascular and aneural, the metabolic activities of chondrocytes are highly dependent on mechanical characteristics of the local extracellular environment. Computational models will be presented to analyze the multiphasic micromechanical environment of chondrocytes in articular cartilage. A transient finite element model of biphasic cell-matrix interactions was developed to characterize the microscale stress-strain environment in articular cartilage subjected to dynamic compressive loading. The microscale biphasic FEM was employed to analyze effects of frequency under cyclic 1% strain. For frequencies in the range of 0.01Hz to 1.0Hz, intracellular axial strains exhibited up to a 15-fold increase in magnitude relative to the 1% applied macroscopic strain. Solid stress was reduced by up to 35% as a result of biphasic mechanical transduction to the cell. Proposed axisymmetric elastic boundary and finite element methods to model in situ chondron deformation under equilibrated deformation of a cartilage explant will also be discussed. Specifically, the computational models of the forward problem will be used to solve the inverse problem of determining PCM properties via analysis of data from a recently developed novel fluorescence imaging technique.