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Cartilage Regeneration in Cell-Seeded Scaffolds: An ODE Modeling Approach. Preliminary report.

Articular cartilage is the hydrated orthopaedic soft tissue that lines the surfaces of bones in diarthrodial joints (i.e. knee, shoulder, hip). Cartilage degeneration due to osteoarthritis or injury can lead to osteochondral defects in the cartilage, and cartilage have a limited capacity for self-repair. In recent years, the use of nutrient-rich hydrogels and scaffolds seeded with chondrocytes as potential biomaterials for tissue regeneration and repair has seen wide interest, but the optimal combination of diverse factors required to successfully regenerate articular cartilage is not known.

Obtaining spatial data is difficult, and cartilage regeneration occurs on time scales that span many weeks to several months. As a result, many experimentalists have measured only scalar system variables such as scaffold or collagen dry mass at a small number of time points. An ODE modeling approach appears to be a natural choice for analysis of dynamic evolution of these system variables. These ODE models can be calibrated using experimental data by way of a nonlinear least squares approach, and a parametric analysis can be performed to quantify the effects of model parameters on a regeneration time for a targeted value of linked ECM. (Received September 22, 2010)