

Cell seeding dynamics in a porous scaffold material with applied sensitivity analysis

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In this presentation, we report about ongoing work on in silico research for the better understanding of an experimental study for meniscus regeneration. In essence, this experiment uses a nonwoven scaffold that is colonized by human mesenchymal stem cells and chondrocytes. The mathematical description involves active processes at the cell level, such as cell differentiation and matrix synthesis, that have a strong impact on the resulting tissue structure and quality, while macroscopic effects in turn are important stimuli for the processes at the microscopic level. The corresponding mathematical model consists of a set of coupled nonlinear parabolic partial differential equations where further effects, such as the flow of nutrients through the porous media of the scaffold and the mechanical deformation, can also be taken into account. From the numerical point of view, not only the forward simulation with vastly differing time scales but also the computation of parameter sensitivities represents a big challenge. Besides presenting the results of current simulations of the experiment, the talk concentrates on investigating different approaches for calculating sensitivities. In particular, a classical approach where sensitivities are directly computed is compared to a statistical approach using Sobol' indices. This new approach also utilizes Gaussian processes to metamodel the involved biomechanical model.

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