Modeling the development of tissue engineered cartilage

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Introduction
The composition of tissue engineered (TE) cartilage depends to a large extent on the bioreactor configuration, see figure 1. The EU project IMBIOTOR aims at realizing an intelligent bioreactor in which the properties of the TE construct can be tailored using model based control of the complete bioreactor environment. Manipulating global input parameters: Nutrients, growth factors, O$_2$, pH, temperature, time and mechanical stimulation, will yield the local output: Collagen II, proteoglycans, cells, permeability and stiffness.

Objective
- A numerical model that can predict local construct properties as a function of the global input.

Methods
A description of highly coupled phenomena, like mechanical adaptation, solute transport, cell growth and biosynthesis is required, which has to deal with quantitatively ill-defined chondrocyte responses. Figure 2 shows the proposed model.

Results
Figure 3 shows examples of the model’s possibilities.

Conclusions
- Further integration of models for mechanical adaptation, solute transport, cell growth and biosynthesis will lead to significant progress in controlling the development of tissue engineered constructs in bioreactor culture.
- A biphase model is proposed with local permeability and stiffness depending on matrix synthesis and cell growth, which are influenced by deformation and nutrient transport.
- The present model gives a qualitative picture that has to be quantified and validated using experimental data.

References: