



Science Arts & Métiers (SAM)

is an open access repository that collects the work of Arts et Métiers ParisTech researchers and makes it freely available over the web where possible.

This is an author-deposited version published in: <http://sam.ensam.eu>
Handle ID: <http://hdl.handle.net/10985/9983>

To cite this version :

Samuel LETELLIER, Azita AHMADI-SENICHAULT, Didier LASSEUX - In-vitro cartilage growth: macroscopic mass transport modelling in a three-phase system - 2009

Any correspondence concerning this service should be sent to the repository

Administrator : archiveouverte@ensam.eu

In-vitro cartilage growth: macroscopic mass transport modelling in a three-phase system

S. Letellier, A. Ahmadi, D. Lasseux

TREFLE - UMR CNRS 8508 - University of Bordeaux - Arts et Métiers ParisTech
Esplanade des Arts et Métiers
33405 Talence Cedex France

ABSTRACT:

Transplantation of engineered tissues is of major interest as an alternative to autogenic alogenic or exogenic grafts. In this study, *in vitro* cartilage cell culture on a fibrous biodegradable polymer scaffold is under concern. The scaffold is first seeded with cells which adhere to the fibres and the system is then grown in a bioreactor. As reported in the literature, hydrodynamics and transport of nutrients and metabolic products during this growth process is of considerable importance, motivating our analysis.

A one-equation macroscopic model was first developed in order to describe macroscopic mass transport during *in vitro* tissue growth using the volume averaging method. This model takes into account a three phase system composed of solid fibres, cell phase and fluid phase and allows determination of the macroscopic quantities as a function of microscopic properties and geometry at any stage of growth.

In a second step, numerical tools for the computation of the effective properties were developed and validated. This validation is carried out using results available in the literature for some sub-classes of our model (namely, diffusion, diffusion/reaction and diffusion/advection problems in 2D systems). The behaviour of the macroscopic dispersion tensor for the complete model (diffusion/reaction/advection) in a three phase configuration is studied and the influence of different parameters such as the volume fractions of the phases, Peclet and Kinetic numbers is discussed.