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.