06-006

COMPUTATIONAL STUDY OF THE INFLUENCE OF HYDROGEL-BASED MATRICES ON THE DISTRIBUTION OF GLUCOSE IN A MICROFLUIDIC DEVICE USED IN BIOLOGICAL ASSAYS.

Bonifácio, E.D.(1); Gonzáles-torres, L.A.(1); Guimarães, M.V.(2); Souza, M.P.(2); Guimarães, G.(2); Araújo, C.A.(2); Yoshida, D.M.(3);
(1) UFVJM; (2) UFU; (3) ;

Tissue engineering (TE) refers to a field that use the combination of cells and engineering techniques to improve or replace biological tissue. This field continues to advance with the improvement of scaffold fabrication techniques, discovery of new biomaterials and so on. TE is based on the use of a biodegradable porous scaffold for the formation of new viable tissue or biomedical studies in vitro. Hydrogels are commonly used for in vitro studies and tissue engineering purpose, particularly because of their properties. The main feature of the scaffold is biomimetic as possible the microenvironment of cells, for example, in terms of mechanical properties and morphology. Therefore, the architectural properties, i.e, the pore size, porosity, pore interconnectivity - referred to as tortuosity - and permeability play critical role in terms of delivery of nutrients and removing waste. The nutrient transport through the scaffold is one of the most important and critical issue to be addressed. In vitro models based on microfluidic devices represent an alternative to study several biological processes in a more reproducible and controllable method. Furthermore, computational methods enable the simulation of different conditions, which reduce the amount of experiment and, therefore, saving time and cost. In this context, this work focused on the gradient of nutrient, particularly glucose, through two different scaffolds, i.e, collagen I and fibrin hydrogel, inside a microchip using computational modeling. Therefore, in this work, we developed a finite element model of convection-diffusion transport to estimate the spatiotemporal distribution of glucose across the hydrogel-based matrices in microfluidic chips. A finite element model using a two-dimensional geometry was developed. The geometry was based on the commonly microchip used in biological assays, which is composed of two lateral channels and a central chamber. For all simulations, we consider a central chamber filled with the hydrogels that are used to recreate the microenvironment in vivo. Patterns of glucose concentration were investigated for different combinations of boundary conditions. The numerical prediction demonstrates the spatiotemporal pattern of glucose on a microchip is strongly dependent on the porosity and permeability. Porosity influenced importantly on patterns when diffusion is the main transport mechanism. Permeability is the most influencing parameter when fluid flow is present. These models allow study microfluidics-based systems without the need of physical components, understand the processes involved in several biological processes as well as provide the important factors in order to optimize the experimental trials.