

# Physical Phenomena Associated With The Decellularization Process Modeling With Coupled PDE

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## Abstract

Decellularization is one of the efficient processes of tissue engineering to obtain a natural scaffold known as an extracellular matrix (ECM); Obtaining an intact ECM is very important in solving one of the greatest challenges of bioengineering, which is the construction of new organs and tissues. The decellularization allows to obtain a natural scaffold preserving its structure from the elimination of the cells, in this work the biochemical process is simulated that consists of passing through a organ toy model deionized wáter.

For the decellularization process it is necessary to study the interaction of the fluid flow into and around a scaffold, it is the key to the adequate modeling of the phenomenon. Numerical methods that use computational fluid dynamics (CFD) are common to solve the problem.

The main objective was to do the analysis of the intestine as a porous matrix subjected to a flow, first using CFD, then coupled the phenomenon with heat transfer in fluids, these protocols require that the fluid / organ is at a certain temperature.

In this work, an ideal intestinal model with isotropic and homogeneous cylindrical geometry was designed and simulated using the free flow modulus and porous media, the above considerations were made due to the complexity of the organ in question and with properties of intestine (porosity, Permeability, density, Young's modulus). The problem is a coupling of fluid physics, perfusion states, heat transfer, and porous media modeling.

The software used to perform this simulation was COMSOL Multiphysics that model phenomena using its modules which are based on partial differential equations (PDE)(CDF, Heat Transfer and General Form PDE), and uses the solution finite element method, discretizing the domain (geometry) in subdomains, in each of solve the algebraic equations obtained by Galerkin's weak integral integration for the discrete subcomponents, for ours we case use the fine mesh and steady state solution like solution del sistema.

The proposed mathematical model describes the flow of fluid through the gut. This is Darcy's law and the Navier Stokes equations. The gut-fluid interaction shows the fluid profiles through the interstices of the porous geometry. The decellularization protocol used requires Perfusion per flows, therefore the experimental Darcy-Thomson approximation is used to model low velocity flow rates. The Navier Stokes equations were used for laminar flow because the Reynolds number is much smaller than 2100, according to the properties of the water and in addition for different values of fluid velocity a temperature distribution within the Bioreactor was found, being the speed of 0.01 mm / s which is closer to the desired temperature (4 ° C).

In addition, a temporal analysis of the behavior of the fluids (deionized water) through the scaffold was carried out. We also compared the penetration profiles of the fluid in the porous matrix for different velocities and times. Finally it is obtained that the predominant mechanism in the transference of heat is the conductive one, which increases when the perfusion flow decreases.