FLORIDA INTERNATIONAL UNIVERSITY
Department of Biomedical Engineering

STATEMENT OF PURPOSE

Computational Enhanced Mesh Design in Tissue Engineering: Measuring Wall Shear Stress in Cell/Scaffolds

Bioreactors are used as cell culture systems for temporary growth and maintenance of *tissue-engineered* constructs that serve as three-dimensional templates for initial cell attachment and subsequent tissue formation. The bioreactors' dynamic environment is known to play a crucial role on the cellular components synthesis like glycosaminoglycans (GAG). Systematic research of the Wall Shear Stress (WSS) effects on the microcarrier shape has been limited. Hence, direct qualitative and quantitative correlations for WSS values were performed by analyzing shear stress values distribution overall the constructs surfaces. Computational Fluid Dynamics (CFD) models were simulated under Couette flow conditions using CFDRC® software under windows platform. The aforementioned software memory requirements increased during three-dimensional models implementations. Each one of the converged models consumed approximately 30 hours to finish, and a maximum of two models can be run simultaneously. Only one RAM memory-enhanced computer (2.5 GB of RAM) has been currently used, therefore to run several models it is projected to take several weeks. Currently, a single module is been utilized to study the hydrodynamic forces on the scaffold periphery, i.e., flow module; but mass transfer studies within the cell construct would require even higher memory as a result of coupled module demands. Thus, parallelization of the models is estimated to reduce memory consumption and run time. Nonetheless to analyze results, the development of subroutines compiled by COMPAQ VISUAL FORTRAN solver is also required. Subroutine programming provides the quantification of specific areas of the scaffold in terms of WSS, allowing for precise comparisons between different scaffold geometries. Therefore, by implementing high performance computing (HPC) to simulate the bioreactors hydrodynamic forces, a greater quantity of complex models would be computed in less time. Results of this research will allow for a detailed understanding of the effect of hydrodynamic forces and nutrient mass transfer on the surface of scaffolds (as well as within) that affect the cell growth and further tissue formation. Hence, Cyber-Infrastructure advantages are invaluable in the applicability of the new and composite simulations first to enrich the knowledge on bioreactor complex fluid flow and second to design more efficient and hydrodynamic scaffolds for enhanced tissue growth understanding.

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