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Optimizing the Morphology and Flow Patterns of Scaffold Perfusion Systems for Effective Cell Deposition Using Computational Fluid Dynamics

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Abstract : A bioreactor is an engineered system that supports a biologically active environment. Along the years, the advancements in bioreactors have been widely accepted all over the world for varied applications ranging from sewage treatment to tissue cloning. Driven by tissue and organ shortage, tissue engineering has emerged as an alternative to transplantation for the reconstruction of lost or damaged organs. In this study, Computational fluid dynamics (CFD) has been used to model porous medium flow in scaffolds (taken from the literature) with different flow patterns. A detailed analysis of different scaffold geometries and their influence on cell deposition in the perfusion system is been carried out using Computational fluid dynamics (CFD). Considering the fact that, the scaffold should mimic the organs or tissues structures in a three-dimensional manner, certain assumptions were made accordingly. The research on scaffolds has been extensively carried out in different bioreactors. However, there has been less focus on the morphology of the scaffolds and the flow patterns in which the perfusion system is laid upon. The objective of this paper is to employ a computational approach using CFD simulation to determine the optimal morphology and the anisotropic measurements of the various samples of scaffolds. Using predictive computational modelling approach, variables which exert dominant effects on the cell deposition within the scaffold were prioritised and corresponding changes in morphology of scaffold and flow patterns in the perfusion systems are made. A Eulerian approach was carried on in multiple CFD simulations, and it is observed that the morphological and topological changes in the scaffold perfusion system are of great importance in the commercial applications of scaffolds.

Keywords : cell seeding, CFD, flow patterns, modelling, perfusion systems, scaffold
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