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An experimental-numerical investigation on the effects of macroporous scaffold geometry on cell culture parameters

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Abstract:

Introduction: Perfused bioreactors have been demonstrated to be effective in the delivery of nutrients and in the removal of waste products to and from the interior of cell-populated three-dimensional scaffolds. In this paper, a perfused bioreactor hosting a macroporous scaffold provided with a channel is used to investigate transport phenomena and culture parameters on cell growth.
Methods: MG63 human osteosarcoma cells were seeded on macroporous poly(ε-caprolactone) scaffolds provided with a channel. The scaffolds were cultured in a perfused bioreactor and in static conditions for 5 days. Cell viability and growth were assessed while the concentration of oxygen, glucose and lactate were measured. An in silico, multiphysics, numerical model was set up to study the fluid dynamics and the mass transport of the nutrients in the perfused bioreactor hosting different scaffold geometries.
Results: The experimental and numerical results indicated that the specific cell metabolic activity in scaffolds cultured under perfusion was 30 % greater than scaffolds cultured under static conditions. In addition, the scaffold provided with a channel enabled the shear stress to be controlled, the initial seeding density to be retained, and adequate mass transport and waste removal.
Conclusion: We show that the macroporous scaffold provided with a channel cultured in a macroscale bioreactor can be a robust reference experimental model system to systematically investigate and assess crucial culture parameters. We also show that such an experimental model system can be employed as a simplified "representative unit" to improve performance of both perfused culture systems and hollow, fiber-integrated scaffolds for large-scale tissue engineering.

Keywords: Macroporous scaffold, perfused bioreactor, poly(ε-caprolactone), shear stress