Understanding cell-cell and cell-material interactions in 2D and 3D for tissue engineering applications

This PhD work discusses about the various challenges and recent developments in the field of tissue engineering. A simple model to co-culture cells without the use of tiresome lithographic techniques was developed by utilizing the cell-material interactions. The findings showed that by fabricating micro-patterns of micrometers depth, the cell-material interactions can be enhanced along the corners of fabricated geometry. This forces the cells to initially migrate and align along the corners. By letting the cells to occupy the corners, the study demonstrated how this type of phenomenon provides an easy way to generate voids that can be utilized for culture of another cell type. Further, the difference in the morphology of the cells present at the corners *vs* the center as seen in the previous study was utilized to guide a biological process such as differentiation of human mesenchymal stem cells into multiple lineage within the same geometrical pattern. Further, substrate controlled differentiation of cells into multiple lineages without the use of exogenous factors was investigated and an attempt has been made to control the differentiation by controlling the scaffold chemistry in 3D. Further, to seek application of modulating the biological process and more specifically cellular adhesions in tissue engineering, a micro patterned dressing was designed and the efficacy of these patterns towards enhancing the process of wound healing was demonstrated.