MONASH University
Engineering

PhD Research Project

Biomechanics of stem cells growing on synthetic, chemically defined polymer coatings

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Description

The modulus of a material has been shown to be relevant as a physical cue for the control of stem cell fate outcomes. For example a number of researchers have shown that the stiffness of a cell culture surface can have dramatic influences on the differentiation of both adult and pluripotent stem cells. For example mesenchymal stem cells grown on hydrogels of different stiffness differentiate preferentially into cells of defined tissues such as bone and fat. These studies have mainly been carried out on hydrogel substrates that are not really suitable for large-scale expansion of cells for therapy. From a large-scale culture point of view, however, a more tractable approach for cell manufacture may be to coat existing cell couture materials such as plates, flasks and microcarrier particles. In order to achieve the desired outcome, i.e. control of cell fate and properties, however, the coating must have the required mechanical properties (i.e. like that of certain hydrogels). This study will investigate the impact of coating thickness and crosslinking density on the net mechanical properties and relate the effect that those properties have on cellular response. We will compare the outcomes to hydrogel culture systems, on which the cellular responses have been well studied.

This project will involve preparing polymeric surface coatings using surface initiated, controlled free radical polymerisation approaches and characterising the coatings using advanced techniques such as atomic force microscopy, X-ray photoelectron spectroscopy, ellipsometry and X-ray and neutron reflectivity techniques. The project will also involve the preparation of well-defined hydrogel systems and the culture and characterisation of mesenchymal and pluripotent stem cells. In addition we will use super high resolution imaging techniques to examine cell material interactions in some detail.