

Chemical Engineering Seminars – HT 2009

*Week 6, Wednesday February 25th 2009, 4:00PM-5:00PM
Lecture Room 1, Thom Building, Engineering Science*

Surfaces, Scaffolds and Microdevices for Control of Stem Cell Behaviour and Phenotype

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Abstract

Tissue engineering, through the provision of suitable synthetic cellular microenvironments, aims to repair or replace damaged and diseased tissues and organs. The inherent properties of the scaffolds, which create these microenvironments, are deterministic of the behaviour of cells and the resultant tissue formed during regeneration. Scaffold architecture and porosity, and substrate mechanics, biochemistry, conductivity and lubricity are properties that must be tailorable in order to achieve tunable microenvironments. Using a number of scaffold fabrication methods, focusing in particular on thermally induced phase separation (TIPS), we have processed a range of synthetic thermoplastic and biological polymers into a variety of porous scaffolds of well defined pore architectures with high degrees of interconnectivity. Once processed, however, most (if not all!) biomaterial thermoplastics do not interact specifically with the body, and result in non-specific adsorption and denaturation of plasma proteins when implanted in vivo in their native form. This uncontrolled adsorption event leads to a significant foreign body response, encapsulation and ultimately scar formation. A promising approach to addressing this problem is to modify the polymer at the solid-liquid interface, while leaving the bulk unchanged. We have recently used a number of methodologies, including layer-by-layer (LbL) deposition and block copolymer self assembly, to modify PLGA and other model substrates of varying mechanical properties. When incubated in the presence of various serum and ECM proteins these surfaces have been shown to be non-adherent, however desired proteins may be bound to the surface under appropriate conditions, mediating further self assembly of targeted ECM proteins or peptides. These self assembled surfaces have been shown to elicit specific control over cell attachment, focal adhesion development, cell proliferation and differentiation, and further, outcomes of in vivo animal models have shown that these surfaces can both negate a foreign body immune response and direct stem cell phenotype. Such self assembled surfaces thus provide significant control over the microenvironment 'experienced' by cells, allowing for new insights into cell behaviour, cell fate processes and tissue genesis.

Biography

Justin Cooper-White's research interests are in biomaterials synthesis and processing, surface engineering, tissue engineering, non-Newtonian fluid mechanics and microfluidics. He has authored or co-authored over 170 research publications and presentations and is often asked to present plenary, keynote and invited lectures at national and international conferences. He is currently a group leader of the Australian Institute for Bioengineering and Nanotechnology at the University of Queensland and manages a group of 6 postdoctoral fellows and 14 PhD students. He is a consultant for a number of national and international companies, associate editor of the Korean-Australian Rheology Journal, on the editorial boards of *Rheologica Acta* and the *Open Biomedical Engineering Journal*, and is a reviewer of major international journals. He holds 6 PCT patents in the areas of formulation design for agriproducts, microbioreactors, particle synthesis using microfluidic devices and tissue engineering scaffolds.