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BioSyM Seminar Series 2017

BioSyM BIOSYSTEMS AND MICROMECHANICS

Topographical Regulations on Cell Behaviors for Tissue Engineering Applications

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Date : 23rd February 2017, Thursday
Time : 4 pm to 5 pm
Venue : BioSyM Meeting Room, Level 4, Enterprise Wing, 1 CREATE Way, University Town

Abstract

Stem cells respond to both physical and biochemical changes in their stem cell niche. An ideal scaffold for tissue engineering application should mimic the microenvironment for natural tissue development and present the appropriate biochemical and topographical cues in a spatially controlled manner. Studies have shown that physical forces from the substrate topography play a role in stem cell proliferation, migration and cell fate determination. Our research group is interested in studying the interactions of adult and pluripotent stem cells with nanotopography, the mechanism of the topography-induced cell behavior and how to apply this knowledge to direct stem cell differentiation for tissue engineering applications. In this presentation, nanotopography-regulation on adult and embryonic stem cells (ESCs) will be presented as examples of applying nanotopography in stem cell regulation.

A Multi ARChitectural (MARC) chip containing fields of various geometries and size was developed to investigate the influence of topography geometry on differentiation. Human ESCs and murine neural progenitor cells grown on anisotropic patterns derived a significantly higher percentage of Tuj1 and MAP2 positive cells, while isotropic patterns enhanced glial differentiation.

In attempt to understand the sensing mechanisms for nanotopography, we investigated the differentiation of human mesenchymal stem cell (hMSC) and demonstrated the nanotopography-induced differentiation through cell mechanotransduction is modulated by the integrin-activated focal adhesion kinase (FAK). In addition, our mechanistic study confirmed that this regulation was dependent upon actomyosin contractility, suggesting a direct force-dependent mechanism. The temporal presentation of topography also plays a significant role in the differentiation. In a study of the effect of temporal presentation of topography during hESC neuronal differentiation, our results suggested that the topography contact during the differentiation period is necessary and significant for topography-induced differentiation.

Examples of nanotopography-modulation on cell behaviors for tissue-engineering applications will be discussed in the last part of the presentation.

Short Biography

Evelyn Yim received her Ph.D. in the Biomedical Engineering at the Johns Hopkins University before performing undergoing her post-doctoral training at the Johns Hopkins School of Medicine and in the Department of Biomedical Engineering at Duke University. Between 2007 and 2015 Evelyn worked in Singapore, where she held a joint appointment from the National University of Singapore, as faculty in the departments of Biomedical Engineering and Surgery, and the Mechanobiology Institute Singapore, a Research Center of Excellence supported by the National Research Foundation Singapore, as a principle investigator studying how chemical and biomechanical cues influence stem cell behavior.

Evelyn joined the Department of Chemical Engineering at the University of Waterloo in 2016. Experienced with nanofabrication technologies and stem cell culture, Evelyn and her group are interested to apply the knowledge biomaterial-stem cell interaction to direct stem cell differentiation and tissue regeneration for neural, vascular and corneal tissue engineering.