



BIOENGINEERING

UNIVERSITY of WASHINGTON

A Department of the College of Engineering & School of Medicine

BIOEN 509 – DEPARTMENTAL SEMINAR SERIES

Thursday, May 5 2011, 12:30-1:20 PM

Foege Bioengineering Building N130A

Biomimetic Nanopatterns as Enabling Tools for Analysis and Control of Cell Function and Tissue Regeneration

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Living tissues are intricate ensembles of cells of different types embedded in complex and well defined structures of extracellular matrix (ECM). However, most of our knowledge about cell function is based on experimentation with cells on flat, infinitely rigid surfaces of the tissue culture dishes and flasks. The ability to create synthetic soft nanostructures that mimic architectural and mechanical features of ECM microenvironment holds a considerable promise for advancing diverse biomedical fields, ranging from fundamental cell biology to tissue engineering and bio-prosthetics. In this talk, I will present nanoscale and microscale engineering approaches to control cell-material interfaces for advanced tissue engineering and cell biological applications. Inspired by ultrastructural analysis of the native tissue, I will focus on three different settings in physiological and pathological contexts, in which controlling cell-ECM interactions on the nanoscale can have dramatic consequences: epithelial wound healing, cancer cell invasion, and cardiac tissue engineering. As novel approaches to address these problems, we have recently developed scalable, nanotopographically-controlled model tissue constructs such as microfabricated epithelial wound healing model, structurally defined tumor invasion model, aligned myocardium mimicking the in vivo ventricular organization, and tissue engineered cardiac stem cell patch. Using these tools in combination with traditional molecular and cell biology approaches, I will highlight how these biomimetic tissue culture models enabled by micro and nanotechnologies help to gain better understanding of ECM control of stem cell function and tissue regeneration, and allow us to establish general principles for development of more precise and defined scaffolds for tissue engineering.

Dr. Deok-Ho Kim is an assistant professor in the Department of Bioengineering, a member of the Institute for Stem Cell and Regenerative Medicine, and the Center for Cardiovascular Biology at the University of Washington. He received the B.S. from POSTECH (1998), the M.S. degree from Seoul National University (2000), in Mechanical Engineering, and the Ph.D. degree in Biomedical Engineering from the Johns Hopkins University School of Medicine (2010). From March 2000 to June 2005, he worked as a research scientist at the Korea Institute of Science and Technology (KIST), including his 7 months academic visit at the Swiss Federal Institute of Technology at Zurich (ETH-Zurich). His research focuses on micro and nanoengineering of the cell microenvironment for stem cell bioengineering and tissue regeneration, and development of micro- and nanofabricated biomaterials and functional tissue engineering constructs for regenerative and therapeutic medicine. He has published 33 peer-reviewed articles in journals such as PNAS, Advanced Materials, Lab on a Chip, Annual Review of Biomedical Engineering, and Biomaterials, filed 10 patents issued or pending, and given +40 invited lectures. Among the award he has received are American Heart Association Predoctoral Fellowship (2008), Samsung Humantech Thesis Award (2009), and the Harold M. Weintraub Award in Biological Sciences (2010).



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