2024 Fall Semester Seminar Series

EMBRIO
Emergent Mechanisms in Biology of Robustness, Integration & Organization

Designing Biomaterials for Stem Cell Morphogenesis

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Abstract:

Stem cells respond to many cues from their microenvironment, which may include chemical and mechanical signals. These important cues can be incorporated into biomaterials to control stem cell differentiation and morphogenesis. Here, we discuss our recent efforts to design synthetic biomaterials as a modular platform to direct stem cell fate and morphogenesis into the blood and lymphatic vasculatures. First, we have used multilamellar lipid nanoparticles to rejuvenate vascular progenitor cells and improve their therapeutic potential. By controlling the release kinetic of various bioactive molecules to the surface of vascular progenitor cells, we not only improve cell migration, but also augment their angiogenic potential *in vitro* and *in vivo*. Second, we have used hyaluronic acid (HA)-based hydrogels to promote lymphatic network formation. By tuning the mechanical properties of the hydrogels, we have demonstrated that HA-hydrogels preserve key lymphatic phenotypes and matrix stiffness primes lymphatic tube formation directed by VEGF-C. Finally, we have utilized alternating current (AC) electrospray to encapsulate stem cells and produce granular hydrogels. The electrically induced “tip streaming” mode has enabled high-throughput encapsulation of stem cells with high efficiency and universality. Collectively, these recent advances in biomaterials design and fabrication provides us the opportunity to control stem cell differentiation and morphogenesis for a range of biomedical applications.

Short Bio:

Donny Hanjaya-Putra is an Assistant Professor in the Department of Aerospace and Mechanical Engineering, Bioengineering Graduate Program, and member of the Harper Cancer Research Institute at the University of Notre Dame. His research focuses on the study of thrombosis and hemostasis, stem cell engineering, vascular and lymphatic morphogenesis, as well as synthesis of bio-inspired materials and tissue-engineered constructs. His lab is interested to understand what governs the formation of blood and lymphatic vessels from stem cells and how these insights can be used to develop novel therapies. He has received numerous awards, including NIH Maximizing Investigator’s Research Award (MIRA) R35, NSF CAREER Award, Career Development Award from American Heart Association, CMBE Young Innovator Award, and Siebel Scholar Award. Research projects in his lab are currently being supported by both federal and private funding agencies, including Indiana CTSI, NSF, NIH, ACS, DoD Advanced Regenerative Manufacturing Institute (ARMI) / BioFab USA, and American Heart Association.

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