UNC MCALLISTER HEART INSTITUTE & Joint Department of BIOMEDICAL ENGINEERING UNC CHAPEL HILL NC STATE UNIVERSITY

Fall 2020 Seminar Series Jointly Present

"Towards heart and kidney on-a-chip"

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Dr. Milica Radisic is a Professor at the University of Toronto, Canada Research Chair in Functional Cardiovascular Tissue Engineering and a Senior Scientist at the Toronto General Research Institute. She is also the Associate Chair-Research for the Department of Chemical Engineering and Applied Chemistry at the University of Toronto, Director of the NSERC CREATE Training Program in Organ-on-a-Chip Engineering & Entrepreneurship and Director of Ontario-Quebec Center for Organ-on-a-Cho Engineering. She obtained B.Eng. from McMaster University, and Ph.D. form the Massachusetts Institute of Technology. She is a Fellow of the Royal Society of Canada-Academy of Science, Canadian Academy of Engineering, the American Institute for Medical & Biological Engineering and Tissue Engineering & Regenerative Medicine Society. She received numerous awards and fellowships, including MIT Technology Review Top 35 Innovators under 35. She was a recipient of the Professional Engineers Ontario-Young Engineer Medal in 2011, Engineers Canada Young Engineer Achievement Award in 2012, Queen Elizabeth II Diamond Jubilee Medal in 2013, NSERC E.W.R Steacie Fellowship in 2014, YWC Toronto Woman of Distinction Award in 2018, and OPEA Research & Development Medal in 2019 to name a few. Her research focuses on organ-on-a-chip engineering and development of new biomaterials that promote healing and attenuate scarring. She developed new methods to mature iPSC derived cardiac tissues using electrical stimulation. Currently, she holds research funding from CIHR, NSERC, CFI, ORF, NIH, and the Heart and Stroke Foundation. She is an Associate Editor for ACS Biomaterials Science & Engineering, a member of the Editorial Board of Tissue Engineering, Advanced Drug Delivery Reviews, Regenerative Biomaterials, Advanced Biosystems, Journal of Molecular and Cellular Cardiology and eLife. She serves on review panels for Canadian Institutes of Health Research and the National Institutes of Health. She is actively involved with BMES (Cardiovascular Track Chair in 2013 and 2104) and TERMIS-AM (Council member, Chair of the Membership Committee). She was a co-organizer of a 2017 Keystone Symposium, "Engineered Cells and Tissues as Platforms for Discovery and Therapy". She served on the Board of Directors for Ontario Society of Professional Engineers and currently serves on the Board of Directors of Canadian Biomaterials Society. Her research findings were presented in over 200 research papers, reviews and book chapters with h-index of 61 and over 13,000 citations. Her publications appear in prestigious journals such as: Cell, Nature Materials, Nature Methods, Nature Protocols, Nature Communications, PNAS etc. In 2014, she co-founded an award winning company TARA Biosystems that uses matured human engineered heart tissues in drug development. TARA currently tests drugs for major pharmaceutical companies. In 2017, she founded Quthero Inc, a company focused on disrupting the skin regeneration and wound healing market through the use of proprietary Q-gel to promote scar-free wound healing.

ABSTRACT

Recent advances in human pluripotent stem cell (hPSC) biology enable derivation of essentially any cell type in the human body, and development of three-dimensional (3D) tissue models for drug discovery, safety testing, disease modelling and regenerative medicine applications. However, limitations related to cell maturation, vascularization, cellular fidelity and inter-organ communication still remain. Relying on an engineering approach, microfluidics and microfabrication techniques our laboratory has developed new technologies aimed at overcoming them. Since native heart tissue is unable to regenerate after injury, induced pluripotent stem cells (iPSC) represent a promising source for human cardiomyocytes. Here, biological wire (Biowire) technology will be described, developed to specifically enhance maturation levels of hPSC based cardiac tissues, by controlling tissue geometry and electrical field stimulation regime (Nunes et al Nature Methods 2013, Zao et al Cell 2019). We will describe new applications of the Biowire technology in engineering a specifically atrial and specifically ventricular cardiac tissues, safety testing of small molecule kinase inhibitors, potential new cancer drugs, and modelling of left ventricular hypertrophy using patient derived cells. For probing of more complex physiological questions, dependent on the flow of culture media or blood, incorporation of vasculature is required, most commonly performed in organ-on-a-chip devices. Current organ-on-a-chip devices are limited by the presence of non-physiological materials such as glass and drug-absorbing PDMS as well as the necessity for specialized equipment such as vacuum lines and fluid pumps that inherently limit their throughput. An overview of two new technologies, AngioChip (Zhang et al Nature Materials 2016) and inVADE (Lai et al Advanced Functional Materials 2017) will be presented, that overcome the noted limitations and enable engineering of vascularized liver, heart and kidney as well as studies of cancer metastasis. These platforms enable facile operation and imaging in a set-up resembling a 96-well plate. Using polymer engineering, we were able to marry two seemingly opposing criteria in these platforms, permeability and mechanical stability, to engineer vasculature suitable for biological discovery and direct surgical anastomosis to the host vasculature.

Friday, September 18th
12:00 Noon

Seminar will be presented virtually via Zoom:

https://go.unc.edu/f3QHx