The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	***:***	26 August, 2021
Time	***:***	2:00 pm
Zoom Link	***:***	https://cuhk.zoom.us/j/95009818975?pwd=UzVZdnR2OVhmZForOVRITzg1UkNtQT09
Meeting ID	***:***	950 0981 8975
Password	***:***	130212

Title: Modulating Cellular Membrane Deformation by Microfluidics

Cell membrane, primarily consisting of phospholipid bilayers, is in charge of separating the cells from the extracellular environment, regulating the size and shape of cells, and dynamically controlling the cellular deformability. Several techniques such as micropipette aspiration, atomic force microscopy and optical tweezer have been developed to physically perturb the cellular membrane for the investigations of cell mechanics. However, these strategies suffer from low throughput, high-cost and complex operational procedures. Therefore, microfluidics-based approaches capable of modulating the global deformation of the cellular membrane on large scale have recently received significant attentions in the field. This thesis is aimed at exploring the capability of microfluidics in modulating different degrees of membrane deformation for biomedical applications. The possibility of selective disruption of cellular membrane was demonstrated by modulating a threshold shear stress for the disruption of cellular membrane while keeping the subcellular organelles, namely mitochondria, intact. The optimal threshold stress was empirically determined for the model cell lines of different membrane stiffness, including human embryonic kidney cells (HEK293), mouse myoblast cell line (C2C12) and human derived neuroblastoma SH-SY5Y. Results showed that the microfluidics-based approach was able to yield 40% more functional mitochondria compared to the traditional Dounce homogenizer-based approach. Subsequently, the membrane deformation was modulated either transiently or extendedly to create pores on red blood cells (RBCs) membrane for the delivery of protein payloads. At the optimal condition, the loading efficiency of a model protein, namely the enhanced green fluorescent protein into mouse RBCs was about 2.5- and 4-fold high compared to the widely adapted osmotic entrapment using transient and extended deformation, respectively. Throughout the process, the heterogeneity in cellular mechanical properties was observed interfering with the payload loading efficiency. We, therefore, established a real-time deformability measurement platform for characterizing the mechanical properties of cells. Preliminary investigations showed a positive correlation between the deformability and payload loading efficiency with the model mouse RBCs. Continuous efforts along the line are expected to advance the development of microfluidics-based cellular deformation platforms for biomedical applications such as the extraction of subcellular organelles, intracellular delivery and disease diagnostics based on cellular mechanics.

***** ALL ARE WELCOME *****

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