UTSA Earth and Planetary Sciences

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Seminar Presentation

By

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"Enable Multiscale Bioseparation by Microscale Non-equilibrium Ion and Fluid Transport "

Abstract

How to achieve high-throughput and on-demand manipulation of biological entities from nucleic acids to whole organisms is a key challenge in biomedical research and industry. This obstacle also curbs the development of personalized medicine, the future direction of healthcare. For instance, it is critical to have high-yield extraction of specific molecule biomarkers from clinical samples so as to enable liquid biopsy-based diagnostics; similarly, it is imperative to develop high-throughput sorting of cells and organisms to render large-scale genetic and drug screening economical and accessible.

In this talk, I will discuss how non-equilibrium electrokinetic and interfacial phenomena enable the design of multiscale bioseparation technologies by controlling microscale ion and fluid transport. I will then introduce how these technologies advance two emerging topics in bioengineering: point-of-care disease screening and systems neuroscience. First, to realize high-yield sample pretreatment of molecular liquid biopsy, I develop an electric-field driven ionic transistor device to allow dynamic local control of ion and analyte concentrations for molecular separation, which enables a new scheme of continuous field-flow fractionation to purify short nucleic acids (miRNA) from raw physiological samples for cancer screening. Second, to reveal individual-specific gene interaction that regulates neuronal functions, I design an electrokinetically-enhanced microfluidic array platform for high-speed molecule delivery, which achieves rapid single-molecule fluorescence in situ hybridization (smFISH) for spatial mRNA imaging in multicellular model organisms, C. elegans. Next, to enable user-friendly, multifunctional phenotyping assays for whole animal-level mutant and drug screening, I invent a unique capillary force-driven, open-microfluidic technology for ultra-simple isolation and high-throughput imaging of live organisms. Finally, I will introduce the current projects in my lab combining microfluidic fundamentals and systems model organisms to develop technologies for regenerative tissue engineering and environmental monitoring.