Heterogeneously Integrated Microsystems for Monitoring of Functional Biosystems

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Abstract:
A key need for advancing precision biomedical monitoring to inform clinical decisions in point-of-care diagnostic, therapeutic and disease modeling settings is the ground-up integration of lab-on-chip, wearable, and implantable microsystems with biofunctional transducers and actuators, so that on-chip detection, stimulation, sampling, and data analytics of biosystems can occur within functional microenvironments. Electromechanical paradigms form an essential toolkit for active biological sample manipulation, spatiotemporally resolved stimulation, and high throughput biophysical detection. This presentation will highlight some opportunities in these areas:
1. Biophysical cytometry and separation of cellular subpopulations: Phenotype-selective isolation and cytometry is a stepping-stone towards multi-omic analysis of cellular subpopulations for systems exhibiting phenotypic plasticity, such as cancer, immune and stem cells, as well as microbiota systems. Biophysical cellular metrics to address this need will be highlighted1-3.
2. Providing active cues to tissue microenvironments: Current in vitro models to recapitulate in vivo function focus on secretory cues under cellular interactions in the tissue microenvironment. We seek to complement this by using micropatterned cell-laden perfusable hydrogels, so that flow and mechanical actuation can provide spatiotemporal cues to the tissue microenvironment4.
3. Soft materials-based micro-sampling and on-demand nanoconfinement for biosensing: Integration of micropatterned soft materials for micro-sampling in wearable biosensing and to enable on-demand nanoconfinement for receptor selection by nanofluidics will be highlighted.
The role of these microsystem platforms in point-of-care diagnostic, multi-omic analysis to target signaling pathways, and for therapeutic assessment in biofunctional environment will be assessed.

Biography:
Nathan Swami serves as Professor of Electrical & Computer Engineering at the University of Virginia, with joint appointments in the Chemistry department and the Cancer Center. His research group envisions vertically integrated microsystems that integrate microfluidic biological sample manipulation and biofabrication to on-chip detection systems for control and in-line data analytics to trigger downstream operations, so that phenotype-selective biological information is obtained to inform clinical decisions. His recent honors include the 2021 Mid-Career Award from the AES Electrophoresis Society of the Federation of Analytical Chemistry & Spectroscopy Societies (FACSS) and the Interdisciplinary Research Award of the VP, Research Office at University of Virginia in 2022. At the University, he also serves as Director of the Soft Material Biofabrication facility (2012-2021). Prior to University of Virginia, he served on the scientific staff of the MEMS group at Motorola Labs and at Clinical Microsensors, Inc., a Caltech start-up interfacing microelectronics to bio-analysis. He seeks to impact diagnostic systems within point-of-care and resource-poor settings for enabling precision medicine.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**
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