UC San Diego
JACOBS SCHOOL OF ENGINEERING
NanoEngineering

UCSD NANO & CHEMICAL ENGINEERING

SPECIAL SEMINAR

March 8th 2023

Seminar Presentation: 9:30am – 10:30am

SME Room 248

"The many phases of a cell"

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Abstract: Cells routinely orchestrate reactions, interactions, and transport amongst billions of biomolecules in a crowded environment to perform the diverse tasks that underpin life. Rather than occurring in a well-mixed milieu, biomolecules self-organize into dozens of membrane-lacking compartments called condensates that enable key biological functions and are aberrant in disease. I will begin my talk by introducing phase transitions as an emerging paradigm underlying condensate assembly and function in cells. I will then highlight challenges that limit our understanding of condensates, which unlike equilibrium oil-water mixtures, are highly multicomponent, multiphasic biomolecular assemblies that are driven out of equilibrium by fluxes and forces. Through specific examples, I will propose an interdisciplinary and collaborative approach that advances our understanding of condensates by bridging non-equilibrium thermodynamics, physical chemistry, and complex fluids in the cellular context. In the first part of my talk, I will discuss past/ongoing work that links condensates to regulation of gene expression and focus on the emerging role of non-equilibrium RNA synthesis in genome/nuclear organization. In the second part, I will discuss complementary efforts to build quantitative physical frameworks that enable prediction and design of emergent multiphase behavior in multicomponent fluids. I will conclude with a brief summary and discussion of exciting future directions and opportunities for translation.

Educational Development and Training: The science I will highlight in my talk emphasizes the power of collaborations and bridging disciplinary approaches. Through specific examples, I will show that we can leverage core themes from chemical engineering, such as thermodynamics, transport, and kinetics, to learn principles by which living cells control and manipulate the various processes that underpin life. Finally, I will highlight the power of seeking and adopting differing perspectives to tackle difficult challenges in collaborative teams. Together, I will share my outlook on how we can make progress towards improving human health and engineering life by embracing diverse approaches.

Biosketch: Krishna Shrinivas is currently an NSF-Simons Fellow of Quantitative Biology at Harvard University, where he leads an independent and highly collaborative research program. He previously obtained a PhD in Chemical Engineering and Masters in Chemical Engineering Practice from MIT in 2020, where he trained in the lab of Arup K. Chakraborty. Before that, he obtained his B.Technology (Honors) in ChemE from IIT-Madras in 2014. Krishna is broadly interested in investigating and engineering biomolecular self-organization in living cells, with a specific focus on elucidating the role of phase transitions. Towards this, he bridges approaches rooted in chemical/ biomolecular engineering and soft matter physics in the cellular context, integrating theory centered on thermodynamics and complex fluids, computation rooted in molecular simulation, and experimental data (with diverse collaborators).