Tata Institute of Fundamental Research

Survey No. 36/P, Gopanpally Village, Serilingampally, Ranga Reddy Dist., Hyderabad – 500 046

Seminar

Mechanics-based computational models for single-cell and monolayer mechanobiology

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Cellular homeostasis is maintained by a complex interplay of biochemical and biophysical processes. The mechanobiology of cells, which refers to how cells sense and respond to mechanical cues, plays a crucial role in various physiological and pathological conditions. Understanding how cells respond to mechanical forces is essential for elucidating processes such as tissue development, wound healing, and disease progression. Recent advances in experimental techniques such as atomic force microscopy, traction force microscopy, and live-cell imaging have provided valuable insights into the biomechanical properties of cells and their responses to external forces. However, the complexity of cellular systems necessitates using computational approaches to model and predict cellular behaviour experiencing a variety of mechano-chemical stimuli.

In this talk, I will present a mechanics-based computational model deciphering the role of uni-axial cyclic stretch in actin-stress fibre reorientation. Extending the modelling framework from single-cell to monolayer of cells, I will discuss the role of mechanics in deriving novel insights into the biological behaviour of epithelial and endothelial cell monolayers. In particular, I will highlight the response of endoplasmic reticulum in epithelial cells and VE-cadherins in endothelial cells when subjected to geometrical and mechanical stimuli. I will also briefly discuss how computational models help in understanding tissue-level mechanobiology, in the context of oncology and ophthalmology. I will conclude by emphasizing how collaboration between experimentalists and modellers can lead to a deeper understanding of cell and tissue mechanobiology.

Tuesday, Jun 24th 2025

11:30 Hrs (Tea / Coffee 11:15 Hrs)

Seminar Hall, TIFRH