WINTER SEMESTER 2024 / 2025

RTG 2756 CYTAC SEMINAR SERIES

TUESDAY, NOVEMBER 19
17:00 IN HS5

CYTAC

RTG 2756

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ACTIVE SOFT MATTER: MODELLING THE MECHANICS OF BIOLOGICAL TISSUE

The deformation and flow properties of biological tissues are important in processes such as embryo development, wound healing and tumour invasion. Indeed, processes such as these spontaneously generate stresses within living tissue via active process at the single cell level. Tissues are also continually subject to external stresses and deformations from surrounding tissues and organs. The success of numerous physiological functions relies on the ability of cells to withstand stress under some conditions, yet to flow collectively under others. Biological tissue is furthermore inherently viscoelastic, with a slow time-dependent mechanics. Despite this rich phenomenology, the mechanisms that govern the transmission of stress within biological tissue, and its response to bulk deformation, remain poorly understood to date. Recent work on simplified vertex models of confluent tissue monolayers has uncovered a spontaneous liquid-to-solid transition tuned by cell shape.

After a pedagogical introduction to the research areas of soft matter physics and rheology (the science of deformation and flow), this talk will describe three recent research projects in modelling the rheology of biological tissue. The first predicts a strain-induced stiffening transition in a sheared tissue [1]. The second elucidates the interplay of external deformations applied to a tissue as a whole with internal active stresses that arise locally at the cellular level, and shows how this interplay leads to a host of fascinating rheological phenomena such as yielding, shear thinning, and continuous or discontinuous shear thickening [2]. The third concerns the formulation of a continuum constitutive model that captures several of these linear and nonlinear rheological phenomena [3].

[1] Shear-driven solidification and nonlinear elasticity in epithelial tissues, J. Huang et al., Physical Review Letters 128 (2022); [2] Discontinuous shear thickening in biological tissue rheology, M. J. Hertaeg, S. M. Fielding and D. Bi, Physical Review X 14 (2024); [3] Constitutive model for the rheology of biological tissue, S. M. Fielding et al., Physical Review E (Letter) 108 (2023).