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Mechano-molecular Interplay: A Multiscale Approach to Mechanically Driven Diseases

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Describing the mechanical properties of cells at the nanoscale is essential for understanding mechanosensitive diseases and cancer development. Super-Resolution Microscopy (SRM) methods provide powerful tools for studying these mechanisms with high spatial resolution. In this work, we propose the use of Single Molecule Localization Microscopy (SMLM) and MINFLUX (Minimal photon fluxes) microscopy, which allows us to achieve an effective resolution of less than 10 nm, to investigate cytoskeletal organization and mechanosensing. We propose both conventional SMLM and MINFLUX microscopy to characterize the nanoscale organization of the cytoskeletal network in different cellular systems, focusing on mechanosensitive diseases where cell mechanics and cytoskeletal dynamics are closely interconnected. Furthermore, we explore the potential of integrating Super-Resolution Microscopy with methods for measuring tractions on the cell surface. Specifically, Traction Force Microscopy (TFM) is a powerful tool for measuring the displacement field within an extracellular matrix (ECM) in vitro. The proposed techniques can be applied to several key research areas, ranging from mechanical diseases (associated with actin mutations) to cancer research, where investigating the mechanical properties of cancer cells and their migration abilities could provide valuable insights into metastasis.