Cell & tissue mechanics: From millimeter-scale fracture to nanometer-scale mechanosensitivity

Exposure to mechanical stresses is a normal part of physiology for cells and tissues. For example, intestinal epithelia are stretched during peristaltic movements in the gut, lung alveoli deform during breathing, and endothelia are exposed to pulsatile fluid shear stresses in blood flow. Consequently, maintaining mechanical properties that give cells and tissues a combination of strength and durability is critical for their proper function. This is most apparent in diseased states, where genetic mutations to cytoskeletal and intercellular adhesion proteins alter mechanical properties and result in phenomena associated with cell and tissue mechanical failure. In this talk, I will explore how new experimental tools for characterizing cell and tissue rheology at the millimeter and micron scale are providing new biophysical insights into this unique form of active matter. I will trace these properties to the nanometer scale, where I will present new work that has uncovered how proteins associated with the actin cytoskeleton dynamically organize in a mechanosensitive manner into distinct networks that underly cell and tissue mechanical properties. This combination of experimental tools and analytical techniques from engineering and the physical sciences, with classical molecular biology and biochemistry, is now poised to enable a fundamental understanding of cell mechanics that is rich in complex biophysical phenomena and will guide novel therapeutic strategies.

Andrew R. Harris

My research interests lie at the interface between engineering and the life sciences, using tools from bioengineering, molecular biology and materials science to investigate the fundamental determinants of cytoskeletal organization (as an EMBO and HFSP Postdoctoral Fellow with Prof. Daniel Fletcher at UC Berkeley) and to characterize cell and tissue mechanical properties (as an EPSRC Ph.D. student with Prof. Guillaume Charras at UCL). My future research program will focus on understanding the basis by which tissues become mechanically fragile in diseased states. Using novel mechanical testing setups and molecular engineering, I will engineer complex tissues with defined mechanical characteristics for use in regenerative medicine and dermatology.