1900-Pos
Cortical Oscillations as a Model for Studying Cytoskeleton Regulation During Cell Spreading
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Cell spreading and attachment are integral to multiple physiological processes including wound healing, immune cell-antigen recognition, and tumor cell metastasis. We have discovered that Swiss 3T3 fibroblasts and CHO cells undergo periodic oscillations of the cell body during cell spreading that last from .5 hours after attachment to 1.5 hours and longer. The amplitude and duration of the oscillating phenotype are increased when microtubules are depolymerized. Previously we developed a mechanochemical ODE model describing a possible negative feedback from actomyosin based contractility to stretch-activated calcium channels in propagating cell oscillations. Cortical oscillations provide an ideal model for studying cytoskeleton regulation because the oscillation mechanism is easily quantifiable through the relative phase, amplitude, and period of native oscillations vs. those that have experienced perturbations. Further, we examine the spatiotemporal distribution of $[Ca^{2+}_i]$ during cell oscillations. We propose that the interplay of the calcium and Rho A pathways both contribute to the propagation of cortical oscillations, with high levels of active Rho A replacing the need for highly dynamic calcium signaling.

1901-Pos
Foraging Strategies for Starving and Feeding Amoeba
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Do individual cells have a search strategy when their target is outside their range of detection? Does this strategy change when a high density of targets is encountered?
To answer these questions, we observed single, well-isolated cells of the social amoeba Dictyostelium as they forage for bacteria on a flat surface. Time-lapse movies of this predator-prey system were recorded and analyzed. By varying the concentration of the food source over several orders of magnitude the dynamics of the amoebae as they responded to their environment could be studied.
At low bacterial density the amoebae scooped up the bacteria as they passed over them without any detectable change in motion. At higher bacterial density the amoebae slowed down, picking up essentially all bacteria encountered, and were found to change their long-timescale behavior from an unbiased random walk to a self-avoiding random walk. This way the amoebae avoids searching for food in already depleted regions. A single amoeba typically ingested 250 bacteria before pausing for 15 min to divide.

1902-Pos
Cell Elastic Modulus Cytometry using Diode-Bar Optical Stretchers
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The mechanical deformation of biological cells using optical forces is an efficient experimental method to study cellular mechanical properties that may identify cell types and detect disease states. However, the low throughput has significantly limited its utility and application due to the need to sequentially isolate and probe individual cells. We have implemented a pseudo steady-state high-throughput optical stretcher in which anisotropic forces from an inexpensive laser diode stretch osmotically swollen bovine erythrocytes in a continuous microfluidic flow at a rate of ~ 1 cell/second. This measurement rate is a factor of 10-100 higher than previous demonstrations of optical stretching. We also simulate the deformation of elastic capsules induced by single diode-bar optical stretcher with and without flow. Finally, we demonstrate how theory can be applied to determine the elastic modulus of individual cells from experimental measurements of the equilibrium deformation. Analysis of the deformed cells results in a shear modulus in the range of reported values from $2.5x10^{-3}$ dyne/cm to $1.3x10^{-2}$ dyne/cm for swollen human erythrocytes. This new optical approach has the potential to be readily integrated with other cytometric technologies, and with the capability of measuring cell populations, thus enabling true mechanical-property based cytometry.

1903-Pos
Isoform-Specific Contributions of Alpha-Actinin to Glioma Cell Mechanobiology
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Glioblastoma Multiforme (GBM) is a malignant astrocytic tumor associated with low survival rates because of aggressive infiltration of tumor cells into the brain parenchyma. Expression of the actin binding protein alpha-actinin has been strongly correlated with the invasive phenotype of GBM in vivo. To probe the cellular basis of this correlation, we have suppressed expression of the nonmuscle isoforms alpha-actinin-1 and alpha-actinin-4 and examined the contribution of each isoform to the structure, mechanics, and motility of human glioma tumor cells in culture. While subcellular localization of each isoform is distinct, suppression of either isoform yields a phenotype that includes dramatically reduced motility, compensatory upregulation and redistribution of vinculin, reduced cortical elasticity, and reduced ability to adapt to changes in the elasticity of the extracellular matrix (ECM). Mechanistic studies reveal a reciprocal relationship between alpha-actinin and non-muscle myosin II in which depletion of either alpha-actinin isoform reduces myosin expression and maximal cell-ECM tractional forces, and inhibition of myosin-mediated contractility alters subcellular distribution of both isoforms of alpha-actinin. Our results demonstrate that both alpha-actinin-1 and alpha-actinin-4 make critical and distinct contributions to cytoskeletal organization, rigidity-sensing, and motility of glioma cells, thereby yielding mechanistic insight into the observed correlation between alpha-actinin expression and GBM invasiveness in vivo.

1904-Pos
The Optical Mouse Trap: in Vivo Probing of Capillary Viscoelasticity
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Optical traps have proven to be a versatile quantitative non-contact manipulation tool. We here demonstrate an optical trap in vivo. We used it to perform microrheology and measure viscoelasticity inside capillaries of a living mouse. We also studied particle interactions with the vascular endothelial boundary layer. It has been reported that the lumen of capillaries is covered with a very sensitive at least 0.5 μm thick polymer layer, the endothelial glycocalyx (EG) which is extruded by and attached to the endothelial cells that line the inside of blood vessels. The EG is crucial for the chemical and physical protection of the vessel wall and also serves as a mechanosensor for shear flow. We found no indication of elastic response, suggesting the EG is a primarily viscous polymer layer. We also observed the adhesive interaction of blood platelets with the vessel wall after introducing photo-chemical damage by fluorescence excitation of injected dye.

1905-Pos
Mapping Elasticity Down to the Molecular Scale: a Novel High-Resolution Approach to Study Cell Mechanics
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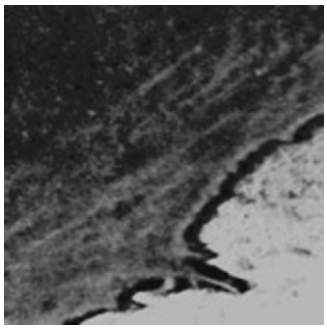
The mechanical properties of cells govern a variety of processes critical for the control of their behavior, and they are strongly determined by the cytoskeleton. These observations have inspired numerous studies on cells and reconstituted cytoskeletal networks. However, it remains a challenging task to relate structural and mechanical properties on the molecular scale within living materials.
To analyze cell mechanical properties on the molecular scale, we used recently developed torsional harmonic cantilevers to obtain high-speed force-distance curves in parallel to high-resolution AFM tapping mode images in fluid. By applying this technique, we were able to acquire stiffness maps of