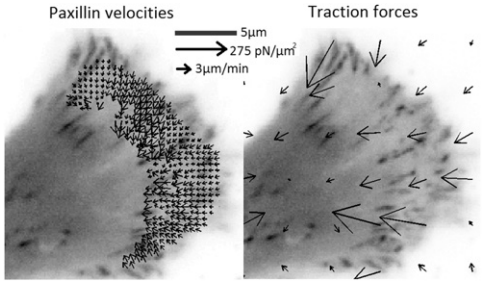
to study cell migration. Spatio-Temporal Image Correlation Spectroscopy (STICS) can create vector maps of protein velocities inside a living cell while Traction Force Microscopy (TFM) allows us to measure the forces applied by a cell on a substrate, which play a crucial role in cell migration. Using these techniques together allows us to simultaneously compare adhesion protein velocities inside the cells and the underlying traction forces exerted by the cell, to provide greater insight into cell migration. We show that traction forces and retrograde paxillin flow exhibit directional correlation but an inverse magnitude relationship in motile U2OS cells, indicating slippage at the molecular clutch level. By coating polyacrylamide gels with different ligands, we observe differences in the strength of those integin-ligand binding pairs. Finally, a new correlation analysis is introduced that can differentiate between potential adhesion movement models.



1110-Plat
Estimation of Cellular Forces during Migration through Non-Linear and Non-Affine Collagen Networks
Julian Steinwachs[1], Claus Metzner[1], Nadine Lang[1], Stefan Münster[2], Ben Fabry[1].
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Reconstituted collagen gels are a widely used environment to study cell migration in three dimensions. Collagen gels show strain stiffening and a strong lateral contraction during extension (Poisson ratio > 0.5). This behavior is not explained by linear elastic theory. To make quantitative estimates about the cellular forces and local mechanical properties of the matrix that the migrating cell encounters, a constitutive model of the gel is needed. On a microscopic scale, collagen gels consist of a network of mechanically coupled collagen fibrils that show buckling under compression and tautening and alignment under extension. These effects give rise to non-affine behavior of the network, which is virtually impossible to model or simulate numerically on a larger scale. Instead, we take advantage of the fact that the effects of a non-affine deformation is well captured by an affine network with non-linear elements. We extract the nonlinear force-length relationship of the network elements from two types of rheological measurements. First, we stretch and compress a collagen gel in the horizontal direction and measure its vertical contraction and dilation. From this we extract the asymmetry of the force-length relationship between extension and compression. Second, we shear a collagen gel in a cone plate rheometer. From this we extract the force-length relationship under extension. Finally, with a finite element analysis we compute the deformation field of a collagen gel around a contracting ellipsoid. We find that our model recapitulates the complex gel deformations typically measured around invasive tumor cells, such as a very large contraction of the gel surface above the cell.

1111-Plat
Role of Actin Cytoskeletal Structure for Cell Migration on Micro-Structured Surfaces
Hiromi Miyoshi[1], Jungmyoung Ju[1], Sang Min Lee[2], Dong Jin Cho[2], Jong Soo Ko[2], Taiji Adachi[3], Yutaka Yamagata[1].
[1]RIKEN, Saitama, Japan, [2]Pusan National University, Busan, Korea, Republic of, [3]Kyoto University, Kyoto, Japan.
Cell migratory behavior is known to be remarkably affected by the interaction with the surface topography at multiple scales, ranging from nanometers to tens of micrometers. Here, our aim is to clarify the interaction between cells and micrometer scale topography based on the role of actin cytoskeletal structure. We fabricated silicon microstructured surfaces with microgrooves of various sizes, and characterized the behavior of cells moving from the flat surface to the grooved surface. The intersecting grooves with a size that allow a cell to experience multiple grooves absorbed cells with a higher angle of approach, and repelled cells with a lower angle of approach. Similarly, the single line groove showed a tendency to repel cells with a lower angle of approach and absorb cells with a higher angle of approach. However, the tendency with the single line groove was less clear than that with the intersecting grooves. The result indicates that the intersecting grooves had a better discrimination performance of the angle of approach of the cells than a single line groove. The mechanism of this motility-based filtering is supposed to be primarily explained based on the lamellar dragging effect by the preferential lamellar protrusion into the grooves due to the mechanical restriction provided by the actin cytoskeleton. If the lamellar dragging effect is sufficiently high, the cells are absorbed by the grooved surface. In contrast, if the dragging effect is not enough to draw the cell body into the grooves, the cells are repelled by the grooved surface. This study provides a framework to tailor the microgrooved surface control of cell migration by using microgrooves.

1112-Plat
Flow Mechanotransduction Regulates Traction Forces, Intercellular Forces, and Adherens Junctions
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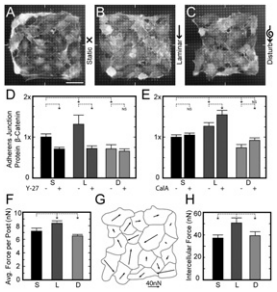
University of Washington, Seattle, WA, USA.
Endothelial cells react to shear stresses with mechanotransduction responses that modify the cytoskeleton and cell-cell contacts. Cultures of endothelial cells were patterned as monolayers on micropost arrays and different shear flow profiles were applied to investigate the interplay between traction forces, intercellular forces, and adherens junctions (A–C). Cells exposed to laminar flow had elevated traction forces compared to static conditions while cells experiencing unsteady or disturbed flow exhibited lower traction forces (F). Similarly, the size of cell adherens junctions increased after laminar flow and decreased after disturbed flow. Decreasing cytoskeletal tension with Y-27632 decreased the size of adherens junctions (D), while increasing tension through Calyculin-A increased their size (E). A novel approach to measure intercellular forces between cells in the monolayers was developed (G) and these forces were found to be significantly higher for laminar flow than for static or disturbed conditions (H) with adherens junction size reflecting these tension changes. These results indicate that laminar flow can increase cytoskeletal tension while disturbed flow decreases cytoskeletal tension. The corresponding change in cytoskeletal tension under shear can produce intercellular forces that can potentially affect the assembly of adherens junction.



1113-Plat
Stress Clamp Experiments on Multicellular Tumor Spheroids
Fabien Montel[1], Morgan Delarue[1], Jens Elgeti[1], Danijela Vignjevic[1], Giovanni Cappello[1], Jacques Prost[2], Jean-Francois Joanny[1].
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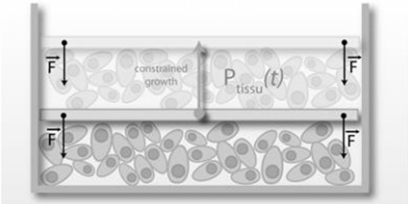
Cancer progress is a multistep process. In contrast with the genetic aberrations, the precise role of the micro-environment and its interplay with the tumor is still poorly understood.
In this work, we present two different approaches to measure the effect of mechanical stress on tissue growth and death. The first setup use osmotic pressure to deform a dialysis bag and exert a known pressure on a multicellular tumor spheroid. Our results indicate the ability to modulate tumor growth depending on the applied pressure. Moreover, we demonstrate quantitatively that cells have a different response to stress whether they are located in the core or in the periphery of the spheroid. The second setup is a microfluidic based integrated system which enables to feed and visualize spheroids in the same time that we apply a known pressure. We compare the results to numerical and analytic models developed to describe the role of mechanics in cancer progression.
Fabien Montel, Morgan Delarue, Jens Elgeti, Laurent Malaquin, Markus Basan, Thomas Risler, Bernard Cabane, Danijela Vignjevic, Jacques Prost, Giovanni Cappello and Jean-François Joanny. *Stress clamp experiments on multicellular tumor spheroids.* ***Physical Review Letters. In press.***



Platform: Membrane Physical Chemistry I

1114-Plat
Peptide Perturbations in Model Membranes
Robin L. Samuel, Susan D. Gillmor.
George Washington University, Washington, DC, USA.
We investigate peptide interactions with model membranes and how they affect phase dynamics and mobility. Previously, we have studied lipid phase