BP 30: Cell mechanics III

Time: Thursday 16:15–17:00 Location: H4

BP 30.1 Thu 16:15 H4

Passive and active response of bacteria under mechanical compression — •Renata Garces[1], Samantha Miller[2], and C.F. Schmidt[1,3] — [1]DPI, University of Goettingen — [2]The Institute of Medical Sciences, University of Aberdeen — [3]Department of Physics, Duke University

The ability to maintain a positive turgor pressure, by means of higher osmolarity of the cell interior than the exterior, is a requirement for proper metabolism in walled microbial cells. Turgor pressure is sensitive to changes in external osmotic conditions, and is drastically increased upon osmotic downshock, together with cell volume. Bacteria prevent lysis caused by excessive osmotic pressure through mechanosensitive (MS) channels: membrane proteins that release solutes (ions) in response to mechanical stress. The exact mechanism of channel gating in the natural setting, however, has been elusive due to the lack of experimental methods appropriate for the small dimensions of prokaryotes. We here present experimental data on the gating of MS channels of E. coli subjected to compressive force under iso-osmotic conditions. We indent living cells with micron-sized beads attached to the cantilever of an atomic force microscope (AFM) and characterize the mechanical response. We show that turgor pressure can be monitored through the measured response and quantify its value and fluctuations for individual single cells before and after MS channel gating.

BP 30.2 Thu 16:30 H4

Moving chromosomes in intact cell nuclei — Matthäus Mittasch[1], Anatol Fritsch[1], Michael Nestler[2], Juan Iglesias[1], Archit Bhatnagar[1], Kaushikaram Subramanian[1], Axel Voigt[2], and •Moritz Kreysing[1] — [1]MPI of Cell Biology, Dresden — [2]Department of Mathematics, TU Dresden

Recently we have described that we can move the cytoplasm of cells and developing embryos in a non-invasive manner (1). Here we demonstrate that we can optically generate hydrodynamic flows also in the nucleoplasm of developing C. elegance embryos during mitosis. Induced flows cause the instantaneous motion of chromosomes, indicating the absence of inertia and elastic creep relaxation in the nucleoplasm. Furthermore, chromosomes may be moved in time-reversal manner, which characterizes the mitotic nucleus as Stokes fluid type suspension of colloidal particles. We explicitly show that prophase chromosomes are free to exchange neighbors. Using the Stokes Einstein relation we estimate flow induced forces to be on the order of 10-100fN only, emphasizing the non-invasive character of induced flows. Biologically interesting, we find that altering chromsome position does not impact developmental success. This largely rules out a functional relevance of trans-mitotic inheritance of chromosome positioning.

Reference: Mittasch et al., " Non-invasive perturbations of intracellular flow reveal physical principles of cell organization", Nature Cell Biology 1 (2018)

BP 30.3 Thu 16:45 H4

Microtissues as an In-vitro platform for Investigating Muscle Mechanics — •Delf Kah, Ingo Thievessen, Marina Spörrer, Wolfgang Goldmann, and Ben Fabry — Department of Physics, Biophysics Group, Friedrich-Alexander-University Erlangen-Nuremberg, D-91052, Erlangen, Germany

In-vitro engineered muscle tissue grafts are of growing interest for different applications including regenerative therapy, replacement of infarcted cardiac sites, or as a drug testing platform. Critical for the successful development of suitable models for engineered muscle grafts is the maturation into an in-vivo-like, highly aligned, and contractile tissue. To achieve this, we established a stretchable and electrically paceable system consisting of an array of 4x2x2 mm microwells with two elastic pillars that serve as force sensors. Our system provides a universal platform for a variety of cell-mechanical investigations of different types of muscle tissue. Cardiomyocytes mixed with collagen, for example, form aligned tissues that show distinct mechanical response depending on the stiffness of the PDMS pillars. This indicates a force feedback in response to the mechanical regime similar to the classic Frank-Starling mechanism. Tissues from skeletal muscle cells, on the other hand, show increased static contractility when exposed to mechanical stress during early tissue development.