AKB 27 Cell Mechanics II

Time: Friday 11:30–13:00 Room: ZEU 260

AKB 27.1 Fri 11:30 ZEU 260

Investigating phagocytosis by optical tweezers-based microscopy — •Holger Kress[1], Ernst H.K. Stelzer[1], Gareth Griffiths[1], and Alexander Rohrbach[2] — [1]European Molecular Biology Laboratory (EMBL), Meyerhofstr. 1, 69117 Heidelberg, Germany — [2]Institute of Microsystem Technology (IMTEK), University of Freiburg, Georges-Köhler-Allee 102, 79110 Freiburg, Germany

Phagocytosis is a central cellular mechanism in the innate mammalian immune system. When an invading bacterium binds to the membrane of a macrophage cell, the cell membrane starts to wrap around the invader and internalizes the bacterium. Thereby, the bacterium is enclosed into an intracellular membrane-organelle, the phagosome.

Coated latex beads are used as bacterial model systems to investigate phagocytosis by optical tweezers-based photonic force microscopy. The motion of an optically trapped bead is tracked interferometrically in 3D with nanometer precision at a microsecond timescale. Measuring the thermal fluctuations of a trapped bead during the binding to the cell membrane provides information about the dynamics of the binding process. Once the bead is bound to the cell, the motion of the bound bead reveals the mechanical cellular response to the binding event. Here the optical trap serves as a mechanical force transducer and also as an indicator of the cellular forces. After the bead is taken up by the cell, the phagosome is tracked in 3D during its intracellular transport. We found stepwise intracellular transport with a step size of about 36 nm indicating single molecular motor activity.

AKB 27.2 Fri 11:45 ZEU 260

Viscoelastic Properties of Glial Cells and Neurons — •Yun Bi Lu[1,2], Kristian Franze[2], Josef Käs[2], and Andreas Reichenbach[1] — [1]Paul-Flechsig-Institut für Hirnforschung, Universität Leipzig, Jahnallee 59, 04109 Leipzig, Deutschland — [2]Abteilung Physik Weicher Materie, Universität Leipzig, Linnéstr.5, 04103 Leipzig, Deutschland

To achieve a better understanding of the physical support function of glia (meaning 'glue'), we investigate the mechanical properties of glial cells and neurons by using atomic force microscope. Müller cells, the principal glial cells of the retina, are the only cells spanning its entire thickness. We investigated the viscoelastic properties of different parts along Müller cells (endfoot, inner process, soma and outer process) and of bipolar cell (i.e., neuronal) somata. The results showed that Müller cell somata are more elastic (i.e., stiffer) than their processes and endfeet. If compared to bipolar cell somata, Müller cell somata were shown to be less elastic (i.e., softer). For both cell types, the ratio of elastic part to viscous part of the response was above 1, which means that their biomechanics are dominated by elastic rather than viscous properties. We performed similar measurements on astrocytes (glial cells) and pyramidal cells (neurons) isolated from brain hippocampus. The astrocytes were found to be less elastic than the pyramidal cells, and both cell types displayed dominant elastic properties. In conclusion, we suggest that glial cells are softer than neurons, and both cell types are elastic rather than viscous. This means that glial cells are neither 'glue' nor 'support cells'; most likely, they constitute very soft 'springs' generating an optimal substrate for neuronal cell process growth and plasticity.

AKB 27.3 Fri 12:00 ZEU 260

Investigating the Minimuscle — •Dan Strehle, Brian Gentry, Michael Gögler, David Smith, Katja Taute, and Josef Käs — Soft Matter Physics, Universität Leipzig, Linnéstraße 5, 04103 Leipzig

Skeletal muscle cells are made up of sarcomeres which align to form myofibrils. Myofibrils are the essential component of the muscular contraction mechanism. Its operation is determined by the interaction of actin filaments and myosin mini-filaments. Single myosin proteins have been extensively studied with optical tweezers. We are investigating the properties of the entire contraction structure. Thin actin bundles attached to polystyrene beads are exposed to myosin mini-filaments in ATP-depleted conditions. Upon addition of ATP myosin starts operating and the movement of the beads held in optical tweezers is observed.

AKB 27.4 Fri 12:15 ZEU 260

Cell spreading as a viability test for cells deformed in the Microfluidic Optical Stretcher — •Franziska Wetzel, Brian Lincoln, Jochen Guck, and Josef Käs — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Abteilung Physik der weichen Materie, Linnestrasse 5, 04103 Leipzig

A Microfluidic Optical Stretcher (MOS) is a two-beam laser trap where individual suspended cells are deformed by optical forces on the cell surface. The MOS can be used to distinguish and sort cells. To enable subsequent analysis it is essential that the cells are not damaged during this process. Therefore we investigated the impact of optical stretching using cell spreading which, being an active actin- and myosin-dependent process accomplished only by vital cells, is an ideal indicator for viability. Powers and duration times in a range typical for stretch experiments were applied on NIH/3T3 cells (mouse embryonic fibroblast cell line). Ambient temperature was set to 37°C to keep cells as close to culture conditions as possible. In the talk we will show that cells can spread after the application of optomechanical stress. Conclusively, cells remain viable in the MOS and, in consequence, the MOS can be used to sort cells (e.g. stem cells) for further analysis or culture.

AKB 27.5 Fri 12:30 ZEU 260

Diagnosing oral epithelial carcinomas by elasticity-based flow cytometry — •Falk Wottawah, Julia Dietrich, Stefan Schinkinger, Bryan Lincoln, Franziska Lautenschlaeger, Susanne Ebert, and Jochen Guck — Fakultaet fuer Physik und Geowissenschaften, Universitaet Leipzig

Despite recent advances in identifying the genetic and proteomic patterns characteristically altered in cancers and related to different stages of cancer, it is difficult, if not impossible, to use this information as biomarker for distinguishing individual cells. Polymer physics offers a much more general and unifying approach based on known molecular changes in the cytoskeleton, and its importance for the mechanical properties of the cell, during the progression of cancer. By measuring cellular deformability as a characteristic, cumulative marker of the various molecular changes using a microfluidic optical stretcher, it is possible to monitor the progression of diseases that affect the cytoskeleton, such as cancer. We establish the applicability of this innovative approach by using small sample sizes for diagnosing oral epithelial carcinomas in a clinical setting.

AKB 27.6 Fri 12:45 ZEU 260

Viscoelasticity and motility of murine fibroblasts transfected with additional filamin and actin measured with AFM-based microrheology technique — •Karla Mueller, Claudia Brunner, Bernd Kohlstrunk, Jens Gerdelmann, and Josef A. Kaes — Institut für Experimentelle Physik I, Physik der weichen Materie, Universität Leipzig, Linnestr 5, 04103 Leipzig

Malignantly transformed SVT-2 fibroblasts exhibit enhanced motility of the lamellipodium and decreased viscoelastic strength compared to normal fibroblasts. These properties are the result of an altered cytoskeleton. SVT-2 serve as a model cell line for cancer cells with a high metastatic potential. We present our efforts to reduce malignant cell motility by the insertion of additional cytoskeletal components with the goal to find a way to stop cancer metastasis. We transfected SVT-2 with actin to increase the number of filaments and filamin to increase the crosslinker density and probed the cell lines for their viscoelastic behaviour using the AFM microrheology technique as well as for the speed of lamellipodial extension.