AKB 13 Cell Adhesion II

Time: Tuesday 14:30–15:45 Room: ZEU 260

AKB 13.1 Tue 14:30 ZEU 260

Redistributing intracellular stress with biofunctionalized PDMS pillars to investigate the force induced growth of Focal Adhesions — •Patrick Heil[1,2], Achim Besser[1,2], and Joachim Spatz[1,2] — [1]Max-Planck-Institute for Metals Research, Heisenbergstr. 3, 70569 Stuttgart, Germany — [2]Dept. Biophysical Chemistry, University of Heidelberg, INF 253, 69120 Heidelberg, Germany

Focal contacts (FCs) are important adhesion sites between eukaryotic cells and the extracellular matrix. The development of FCs is substrate dependent: they grow more favorably on stiffer substrates than on soft ones. A deeper insight into this observed cellular mechanosensitivity is crucial to understand the role of FCs in cell adhesion and motility. To quantitatively study this mechanosensitivity and the stimulation of FC growth, microfabricated arrays of elastic polymer pillars are used to manipulate the FC assembly of rat fibroblasts: We use cell-attached micropillars to apply lateral force to the Focal Adhesion sites.

The micropillars are specifically biofunctionalized with ligands such as fibronectin that are known to stimulate cell adhesion. Furthermore, they can be used as force sensors to monitor the applied lateral force in real time. The cells, fibroblasts transfected to express YFP-labeled Paxilin, are maintained in favorable conditions, allowing live imaging of FCs over extended periods of time. Thus, the resultant growth rate of FCs versus applied force can be systematically measured.

We also present a theoretical model to explain force dependent growth of FCs. This model is based on the interplay between an elastic equation for the plaque of FC proteins and the dynamics of protein adsorption.

AKB 13.2 Tue 14:45 ZEU 260

The Electrical Noise of Cell-Substrate-Junctions: A New Method to Probe Cell Adhesion — •Moritz Voelker and Peter Fromherz — Max-Planck-Institut für Biochemie, Martinsried

The junction between cultured cell and substrates is filled with electrolyte. The aqueous cleft between membrane and solid has a width of typically 50 nm and a sheet resistance in the order of several Mohm-square. As every electrical resistance, the junction resistance must exhibit Johnson noise in the form of fluctuations of the local voltage with respect to the bulk electrolyte. We report on a measurement of these voltage fluctuations for rat hippocampus neurons on silicon dioxide, using electrolyte-oxide-silicon field-effect-transistors with a particularly low intrinsic noise. We evaluate the spectral power density of the junction noise by subtracting the noise of open transistors from the total noise of covered transistors. In a first approximation, the resulting net power spectrum is fitted with a Lorentz spectrum for an RC equivalent circuit of the cell-chip junction. The novel technique is non-invasive, does not rely on molecular probes and does not require any intra or extracellular stimulation. It allows to detect variations of cell adhesion in real time as induced by external chemical stimuli.

AKB 13.3 Tue 15:00 ZEU 260

Adhesion of microcapsules — •Peter Graf and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57/III, D-70550 Stuttgart

We describe the adhesion and deformation of an initially spherical capsule on a flat surface due to an attractive contact potential. The model includes the Helfrich bending energy, the energy of the elastic deformations, and the energy of the contact potential. Given the elastic constants of the capsule's material and the strength of the contact potential we calculate the axially symmetric shape of the adhered capsule. Above a critical adhesion strength a contact area forms. For the radius of this contact area we find a power law. Its prefactor depends on the elastic constants and can be expressed in scaling form. We discuss this elastic case in relation to adhesion of fluid vesicles and compare our model with recent experimental results (N. Elsner, F. Dubreuil, and A. Fery, Phys. Rev. E 69, 031802 (2004)) with good agreement.

AKB 13.4 Tue 15:15 ZEU 260

Cell Adhesion by Atomic Force Measurements — •Julia Schmitz[1], Martin Benoit[1], Jenia Manevich[2], Ronen Alon[2], and Kay-Eberhard Gottschalk[1] — [1]LMU Munich — [2]Weizmann Institute

Integrins are involved in many fundamental cellular processes. They act in concert with other receptors and are the starting point of intracellular signalling networks. Since integrins are force transducing proteins, atomic force spectroscopy is an ideal tool to investigate these receptors in their native environment. The here examined VLA-4 integrin of white blood cells plays an important role in the immune response. Its natural ligand is the vascular cell adhesion molecule, VCAM. First, we are testing VLA-4 mediated interactions of the resting cell with immobilized VCAM. By doing force measurements under different immobilized VCAM densities, we obtain insight into on- and off-rates of two non-soluble proteins, one being immobilized on a surface and and the other being in the outer membrane of a living cell. Additionally, the mechanical properties of the anchoring cell membrane are probed. These measurements will serve as a baseline for the characterization of the cell behaviour under a variety of conditions. We are now characterizing the influence of divalent cations as well as of chemokines. Initial results demonstrate that the information we are obtaining by means of AFM is extremely detailed and complementary to flow-chamber and other measurements, so that a combination of different tools will be very valuable for a better characterization of cell adhesion properties.

AKB 13.5 Tue 15:30 ZEU 260

How Mechanical Forces Controll Cell Adhesion — •Matthias F. Schneider[1], Stefan W. Schneider[2], and Achim Wixforth[1] — [1]Biophysics Group, Universität Augsburg, Universitätsstr. 1, D-86135 Augsburg, ermany — [2]Deptartment of Dermatology, University of Muenster, Von-Esmarch-Str. 58, D-48149 Muenster, Germany

Proteins and cells are exposed to a variety of flow conditions when traveling through our vascular system. Shear rates range between 1 to 10000 1/s. The impact of such high shear forces on the protein's function and its controll of adhesion is being investigated in the present study. Therefore we designed a novel acoustically driven microfluidic device (few microliters) to mimick blood flow szenarios on a chip. We found that von willebrand factor (VWF) - the key protein in the first steps of platelet adhesion- is a shear flow and hence mechanically activated protein. At a critical shear rate the protein undergoes a discontinous conformation from a compact coil to an elongated fiber. Only when elongated the protein binds to the surface and is able to mediate blood platelet adhesion.

This is an excellent example how mechanicall forces controll cellular functions. As an example it is discussed how the described effect is able to explain the onset of arteriosclerosis in narrow arteries.