BP 23: Focus Biological Cells in Microfluidics II

Time: Tuesday 14:00–16:00 Location: BPc

BP 23.1 Tue 14:00 BPc

ROS induces intracellular acidosis associated with increased cell stiffening — •Yesaswini Komaragiri[1,3], Huy T Dau[1], Doreen Biedenweg[2], Ricardo H Pires[1,3], and Oliver Otto[1,3] — [1]Biomechanics, ZIK-HIKE, Universität Greifswald, Greifswald, Germany — [2]Universitätsmedizin Greifswald, Greifswald, Germany — [3]Deutsches Zentrum für Herz-Kreislauf-Forschung e.V., Standort Greifswald, Universitätsmedizin Greifswald, Greifswald, Germany

Reactive oxygen species (ROS) are associated with important alterations in cell physiology. The impact that superoxides and other ROS have on the cytoskeleton has been extensively documented; however, the mechanism by which they may affect cell mechanics remain to be understood. By varying concentrations of hydrogen peroxide, we exposed the human myeloid precursor cell line (HL60) to different levels of ROS. Using real-time fluorescence and deformability cytometry, we coupled the mechanical characterization of cells with a simultaneous fluorometric assessment of intracellular superoxide levels. Our work reveals a direct correlation between the elastic modulus of cells and levels of superoxide. We did not detect global changes in the F-actin and microtubule network but demonstrate that cell stiffening at elevated ROS levels is driven by intracellular acidosis.

BP 23.2 Tue 14:20 BPc

Lingering dynamics of microvascular blood flow — •Alexander Kihm[1], Stephan Quint[1], Matthias Laschke[2], Michael Menger[2], Lars Kaestner[1], Thomas John[1], and Christian Wagner[1] — [1]Department of Experimental Physics, Saarland University, Saarbruecken, Germany — [2]Institute for Clinical and Experimental Surgery, Saarland University, Homburg, Germany

The microvascular networks in the body of vertebrates consist of the smallest vessels, such as arterioles, venules, and capillaries. The flow of red blood cells (RBCs) through these networks ensures the gas exchange in, as well as the transport of nutrients towards the tissues. Any alterations in this blood flow may have severe implications on the health state. Since the vessels in these networks obey dimensions similar to the diameter of RBCs, dynamic effects on the cellular scale play a key role. The steady progression in numerical modeling of RBCs even in complex networks has led to novel findings in the field of hemodynamics, especially concerning the impact and the dynamics of lingering events. However, these results are yet unmatched by a detailed analysis of the lingering in experiments in vivo. To quantify this lingering effect in in vivo experiments, we analyze branching vessels in the microvasculature of Syrian hamsters via intravital microscopy and the use of an implanted dorsal skinfold chamber. We present a detailed analysis of these lingering effects of cells at the apex of bifurcating vessels, affecting the temporal distribution of cell-free areas in the branches and even causing a partial blockage in severe cases.

BP 23.3 Tue 14:40 BPc

Phenotyping photokinetic and excitable behaviours of single microswimmers in confinement — Samuel Bentley, Vasileios Anagnostidis, Hannah Laeverenz-Schlogelhofer, Fabrice Gielen, and •Kirsty Y. Wan — Living Systems Institute, Exeter, United Kingdom, EX4 4QD

All living organisms are environmentally intelligent. This is the fundamental distinction between life, and other forms of matter. Even unicellular organisms are capable of complex behaviours. Here, we study the detailed motor actions of flagellated algal microswimmers, using motility as a dynamic read-out of whole-organism behaviour. Previous studies have focussed on locomotor transients over short timescales ranging from seconds to minutes. Here we present a novel microfluidic platform which can allow us to monitor single cells over unprecedented timescales. Two representative species of microswimmers were trapped and confined inside circular arenas: a biflagellate which exhibits a form of run-and-tumble, and an octoflagellate which exhibits a distinctive, tripartite behavioural repertoire termed run-stop-shock. Stochastic transitions in swimming gait are projected onto a low-dimensional behavioural state space. Single-cell motility signatures were analysed to reveal species-specific photokinetic and excitable behaviours. Finally, we conduct on-demand pharmacological perturbations within these microenvironments, to shed new light on the physiological basis of excitable flagellar dynamics.

Invited Talk BP 23.4 Tue 15:00 BPc

Synthetic cells: De novo assembly with microfluidics and DNA nanotechnology — •Kerstin Göpfrich — Max Planck Institute for Medical Research, Jahnstr. 29, 69120 Heidelberg, Germany

The future of manufacturing entails the construction of biological systems and synthetic cells from the bottom up. Instead of relying exclusively on biological building blocks, the integration of new tools and new materials may be a shortcut towards the assembly of active and eventually fully functional synthetic cells [Göpfrich *et al., Trends Biotechnol.*, 2018]. This is especially apparent when considering recent advances in DNA nanotechnology and microfluidics. Exemplifying this approach, we use microfluidics for the assembly of synthetic cellular compartments that we equip with natural or synthetic cytoskeletons. Light serves as a non-invasive stimulus to trigger their symmetry-breaking contraction [Jahnke *et al., Adv. Biosys.*, 2020; *Adv. Funct. Mater.*, 2019]. We further demonstrate the division of giant unilamellar lipid vesicles (GUVs) as synthetic cell models based on phase separation and osmosis rather than the biological building blocks of a cell's division machinery. We derive a parameter-free analytical model which makes quantitative predictions that we verify experimentally [Dreher *et al., Angew. Chem.*, 2020]. Remarkably, we show that caged compounds provide full spatio-temporal control to increase the osmolarity locally in an illuminated area, such that a target-GUV undergoes division whereas the surrounding GUVs remain unaffected. All in all, we believe that precision technologies, like microfluidics, can help to accelerate synthetic biology research.

30 min. Meet the Speaker