IMPRS on Multiscale Biosystems

Project Title: Controlling transmembrane transport by light

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Project description: Light is a versatile tool increasingly employed in biotechnology for controlling biological processes. Examples are provided by optogenetics, which relies on light to control cellular functions modulated by genetically expressed light-sensitive ion channels, and photopharmacology, where biological activity is controlled with synthetic photoswitches attached to the protein of interest. In this project, we will aim at establishing optical control on the activity of mechanosensitive channels, proteins which open and close in response to changes in the tension of the membrane. The bilayer stress will be manipulated by lipid molecules which alter their conformation in a light-responsive manner (see Langmuir 33:4083, 2017 and Adv. Sci. 5:1800432, 2018). Giant unilamellar vesicles (cell-sized closed membranes) with reconstituted proteins will be used as a model membrane system. Membrane tension will be controlled osmotically or with a homebuilt manipulation setup using micropipettes (see Figure). As a model protein, we will employ the bacterial MscL, which can let ions, small molecules and even peptides pass through the impermeable membrane. The work will involve biophysical in vitro work in the Dimova lab at the MPI and biochemical and spectroscopic work in the Heberle group at FU Berlin.

Required background: MSc in biophysics, (bio)chemistry, physics or physical chemistry. Strong interest in physics of biological systems, interest in interdisciplinary work is required. Basic knowledge of membranes and microscopy experience will be advantageous.

Papers to read before the interview:
https://pubs.acs.org/doi/abs/10.1021/la0358724
https://doi.org/10.1016/B978-0-12-396534-9.00001-5

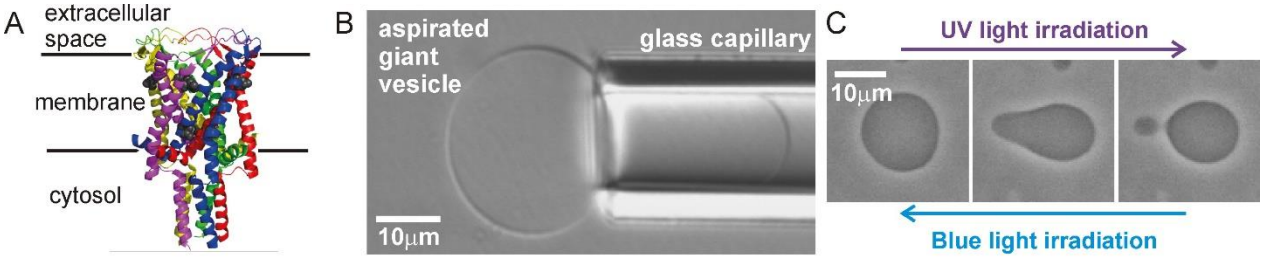

Figure: (A) Crystal structure of MscL with four subunits (red, blue, purple, yellow and green). The major tension sensor is shown as grey spheres. (B) A giant lipid vesicle aspirated in a micropipette connected to a hydrostatic pressure system used to control the membrane tension (see J. Phys. Condens. Matter 18:S1151, 2006). (C) Light-induced changes in a giant vesicle containing light-switches (see Adv. Sci. 5:1800432, 2018). The area of the vesicle increases under UV light and it buds out. Blue light reverses the process.

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