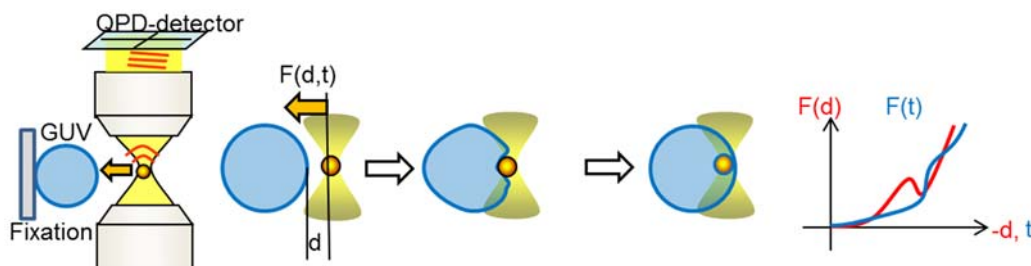


Energetic investigation of induced particle uptake into functionalized giant unilamellar vesicles.

Background: A manifold of cells in our body is continuously deciding whether small particles in the micrometer size range are uptaken into the cell interior or not. In particular, macrophages, as part of our immune system, take up bacteria and other particles, which is only possible by the interplay of different biophysical forces. For a better analysis of the relevant forces and to better assess the role of known factors during phagocytosis, a possible approach is to use biomimetic systems, which show a significantly reduced complexity relative to a cell. The simplest biomimetic variant of the cell is a giant unilamellar vesicle (GUV), where the chemical and mechanical properties of the spherical lipid bilayer can be manipulated in many different ways. The membrane of the GUV has to be deformed significantly to engulf and uptake a particle. The question arises whether and how far the adhesion energy released during particle binding can compensate the energy costs for membrane deformation.

The project: The goal of this proposal is to better understand the physical mechanisms of phagocytosis – in particular the role of the membrane deformation. In this context, we want to establish a method allowing to measure the energetics during particle uptake into an artificial cell (GUV). By using a photonic force microscope, an optically trapped particle will be approached in a controlled manner to the membrane, while the particle displacements are measured interferometrically to determine the changes in force and energy. In a bottom-up approach we will add stepwise more complexity to the biomimetic system, such that the uptake probability into the GUV, or the measured force profiles, respectively, will change according to different system parameters that need to be tested in this proposal. Such parameters are the composition of the GUV membrane, the properties of the particle and, at a level of advanced complexity, the influence of cytoskeletal components inside the GUV. Mathematical modelling will help to improve the mechanistic understanding during particle uptake and to better interpret the experimental data.



Binding of an optically trapped $1\mu\text{m}$ polystyrene particle to a fixed GUV. The required deformation forces and energies are measured through advanced 3D back focal plane interferometry as a function of distance and time. The particle uptake forces, energies and position fluctuations depend on various biophysical parameters.

The candidate: We seek a motivated candidate working as a PhD student or postdoc in our lab. As a postdoc (100% E13 position), the candidate should have a solid background in biophysics and optical trapping / tracking. A PhD student (65% E13 position) should have experiences in at least one of the two fields of research. The project is in collaboration with another research group in Freiburg. Experiences in programming and fluctuation data analysis are of advantage.