Microfluidic Platform to Study Membrane Properties

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Abstract

Supported planar lipid bilayers generated by the classical Montal-Mueller (MM) method have been used for decades as model system to study the functional properties of ion channels and pores. This classical method suffers from several drawbacks since the supported Montal-Mueller planar bilayers are delicate and metastable structures with a short life time in an artificial geometry. Recently, a new method was proposed by H. Bayley et al.[1] which allows producing very stable planar lipid bilayer by contacting two water droplets in a surrounding oil phase (droplet interface bilayer). This approach provides an improved platform to measure ionic transport properties of membrane proteins in a more realistic non-supported environment.

Based on the concept of droplet interface bilayer we present a droplet based microfluidic approach to generate free standing lipid membranes at a predefined location and to study their behavior. Due to the intrinsic advective transport of lipid molecules in droplet based microfluidics the membrane formation is three to six orders of magnitude faster compared to conventional static bulk settings [2]. Thus the microfluidic approach easily allows for automatized and high-throughput formation of droplet interface bilayers of desired composition.

As example, we generate symmetric and asymmetric (phospho-) lipid membranes of controlled composition and probe their properties [2,3]. We demonstrate the formation of planar lipid bilayer in our microfluidic setting and their equivalence to reported results using conventional approaches by measuring their specific capacity and by observing membrane domains as report in the literature. This microfluidic approach shall be well suitable to study e.g. transport properties across membranes or SNARE protein mediated fusion processes.

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