# IMPRS on Multiscale Biosystems

**Title**: Hybridization of cells and vesicles: a pathway to synthetic biology

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**Project description**: The emerging field of synthetic biology is considered to have great potential in future biotechnologies. Synthesizing man-made systems and bio-inspired materials allows much better external control on their functionality and performance. In this project, we will aim at establishing a system where a living cell is provided with membrane material and substances in a strictly controlled way. The particular cell type that we will investigate is the social amoeba *Dictyostelium discoideum*, a widely used model organism for the study of actin-driven cell motility and chemotaxis, see Fig.1 A. Supplying the cell with membrane material of specific mechanical and functional properties will allow investigating several basic questions, such as the role of membrane tension and composition on pseudopod formation or the concentration dependence of dynamical processes in the actin cortex. As model membranes, we will employ giant unilamellar vesicles, which represent cell-size membrane capsules (see Fig. 1B), prepared from specific lipids and loaded with substances of interest. The cell-vesicle hybridization will be established by means of electrofusion. The reverse process, i.e. vesicle shedding by the cells (blebbing), will also be investigated, whereby blebs will be harvested and their electrofusion with model membranes investigated. As a first step, the conditions for membrane electroporation (necessary to establish fusion) will be identified on model vesicles and blebs. The explored systems will be studied with high-end microscopy techniques including confocal and super-resolution microscopy.

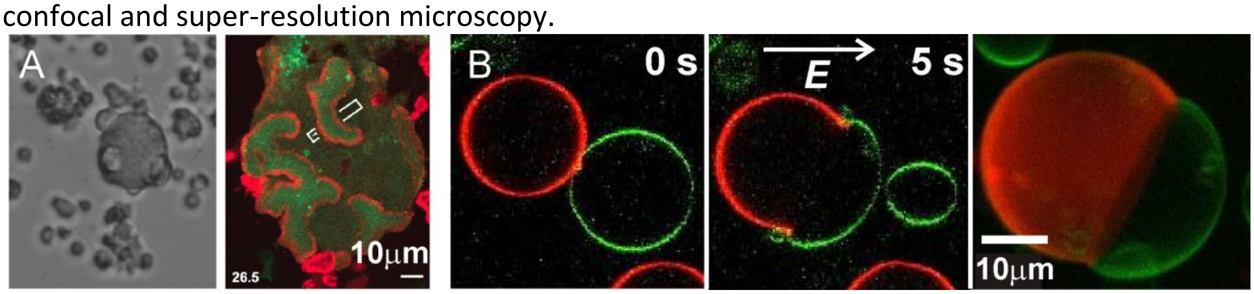


Figure: (A) Giant *Dictyostelium* cells (~70μm in diameter) created by cell fusion (left). Inside such cells, self-organized traveling waves can be observed (right, link to article), composed of $PIP_3$-rich membrane domains (green) surrounded by dense F-actin structures (red). (B) Creating a hybrid giant vesicle. Two vesicles of different compositions (red and green) undergo electrofusion (link to article). The field direction is indicated on the second snapshot. The last image shows a 3D reconstruction of the resulting hybrid vesicle.

**Required background**: MSc in biophysics or physics, interest in physics of biological systems, interest in interdisciplinary work; basic knowledge of membranes and microscopy experience will be advantageous.

**Papers to read before the interview**: https://doi.org/10.1146/annurev-biophys-052118-115342, http://www.pnas.org/content/103/43/15841, http://www.pnas.org/content/110/10/3853

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