Structure, shape and dynamics of biological membranes.

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accompanying the PhD thesis

Structure, shape and dynamics of biological membranes

1. The rich phase diagram of a ternary lipid mixture, including the 'closed loop miscibility gap' (an immiscibility region in the ternary system where all underlying binary systems are fully mixed), can be described by adding a minimal but necessary ternary term to the binary Flory-Huggins model. Using this extension, one can compute binodals, spinodals, critical points and line tensions.

   this thesis, chapter 3

2. The shape of a fully phase separated membrane vesicle containing two domains can be calculated from the Canham-Helfrich energy functional, and, by fitting it to experimentally determined shapes, can be used to extract the line tension between the domains.

   this thesis, chapter 4

3. Membrane inclusions, such as domains which have a lipid composition, and hence elastic parameters, that differ from those of the rest of the membrane, can communicate via deformations of the membrane itself. This process leads to a repulsive membrane mediated interaction, which depends on the size of the inclusion. As a consequence, inclusions can spontaneously sort by size.

   this thesis, chapters 5 and 6

4. Like their processive counterparts, nonprocessive microtubule-walking molecular motors which are attached to a flexible membrane can bind to a microtubule and start exerting forces on the membrane, resulting in the formation of a membrane tube. The combination of collective membrane tube pulling by nonprocessive motors and the tension in the tube results in a dynamic system with a stable attractor.

   this thesis, chapter 7

5. A microtubule-walking molecular motor which is attached to both a membrane and a microtubule facilitates the binding of other membrane attached motors to neighboring sites on the same microtubule. Thus clusters of molecular motors emerge, which can move in concert or exert forces on the membrane.

   Shaklee et al. (2009)

6. The reaction-diffusion dynamics of the building blocks of adherens junctions between epithelial cells (E-cadherin and α- and β-catenin proteins) play a pivotal role in the switch from the growth phase to the mature, stationary state of such a cell. A perturbation of any of the three components of this system usually results in tumorigenesis because it prevents this switch.

Basan et al. (2009)

7. Ternary lipid mixtures close to a demixing point in their phase diagram can be induced to sort into domains of different lipid composition by creating regions of different curvature in the system.

Tian and Baumgart, Biophys. J. **96***, 2676 (2009)*
Sorre et al., Proc. Natl. Acad. Sci. USA **106***, 5622 (2009)*

8. To be able to describe the motion of crawling cells, a solid understanding of the flow of the viscoelastic fluids both inside and outside the cell, as well as the coupling of those fluids to the cell's plasma membrane is crucial.

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