Description of the subject

a) Effect of actin dynamics and myosin on the stability of membrane tubes
Membrane tubes are produced inside cells, and cut into small vesicles to insure intra-cellular trafficking. The mechanism of tube cutting may depend on the acto-myosin cytoskeletal system. This is what we want to address in vitro, using reconstituted membranes and purified proteins including actin, myosin, and actin-related proteins. The Sykes lab has worked in actin dynamics and force production for more than ten years and has the ability to tackle this new question with a novel optical set up developed in the lab. A membrane tube is pulled by a bead held in an optical tweezer, and bead position and applied force are recorded with unprecedented resolution by using a quadrant diode detection. Proteins can be flowed into the observation chamber and the stability of the tube is observed by microscopy while the force on the tube is recorded at the same time. The master student will be able to use our setup to address a very important question in biology of how membrane tubes can be destabilized by the active actin cytoskeleton.

b) Acto-myosin mechanics and cortical tension build-up studied with cell-sized liposomes mimicking cells
The cortex of cells is an acto-myosin shell, a few hundreds of nanometers thick, just underneath the cell membrane. It contributes to the cell’s mechanical properties, especially when cells round up before division. Therefore, the tension that the acto-myosin system is able to build up is crucial for correct cell division. How much tension is there? How does the action of actin and molecular motors in the cortex lead to cell rounding up? We will address these issues by reproducing this tension build-up using a stripped down system made of a liposome membrane at the surface of which we reconstitute an acto-myosin cortex. We will measure shape changes by microscopy, and measure cortical tension build-up by optical methods based on recording cortical fluctuations or by micropipette aspiration. The master student will design the experimental system by the choice of proteins and concentrations, and use existing experimental setups to quantify tension. The actin cortex will be reconstituted either outside the liposome by putting the formed liposomes inside a bath of proteins, or it will be reconstituted inside liposomes by using an encapsulation method based on an initial emulsion that is then transformed into liposomes. The Sykes lab masters both methods.

Tutor/supervisor
Same tutor for a) and b)
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Selected publications or patents of the Research Group offering the work programs a), b), c) etc:

a) Effect of actin dynamics and myosin on the stability of membrane tubes
b) Acto-myosin mechanics and cortical tension build up studied with cell-sized liposomes mimicking cells


Scientific or technical background required

a) Effect of actin dynamics and myosin on the stability of membrane tubes

This project is for either a biologist or an experimental physicist. The student should be interested in optics, but does not have to be an optician, since the home-made setup already exists in the lab and is working. The student should have some very basic knowledge of biochemistry and protein manipulation.

b) Acto-myosin mechanics and cortical tension build up studied with cell-sized liposomes mimicking cells

This project is for either a biologist or an experimental physicist. An interest in biochemistry is required, but we master the utilization of lipids and proteins in the lab. An interest in imaging is necessary. The student should be highly motivated by quantitative experiments and manipulations