Modeling Lipid Droplets on membrane tubules

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Abstract

Membrane tubules of few tens of nanometer cross-sectional diameters and micron-scale lengths represent a basic structural component of intra-cellular organelles, such as endoplasmic reticulum and Golgi Complex, and emerge from plasma membranes in the course of cell crawling on extra-cellular matrices and substrates. Besides barrier functions, the tubular membranes serve as platforms for formation of peculiar cell organelles, Lipid Droplets and Migrasomes, whose properties are to be understood in terms of simple physics.

Lipid Droplets can be regarded as lenses of hydrophobic substance (triacylglycerol, sterol esters) growing up between the two membrane leaflets into micron-large buds, which, possibly, detach from the membrane to form emulsion-like droplets. We address the micromechanics of these organelles to gain understanding of physics behind their formation and evolution.

We analyze the shape and energy of a membrane tubule containing a lipid droplet in dependence of the droplet size and the elastic properties of the tubular membrane and the lipid monolayers covering the droplet surface. We determine the conditions of the droplet detachment from the tubule.