Reversible Adhesion of Particles on Lipid Bilayers through Electrostatics or Depletion

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Abstract

Biological membranes partition living organisms and eukaryotic cells into different compartments, each of which having its own function and integrity. Moreover, some organelles, such as the endoplasmic reticulum, are characterized by very complex membrane shapes, which seem to confer to them, at least partly, their function. The regulation of biological membrane geometries is therefore crucial.

In vivo, proteins are one of the main actors of membrane deformation, as they are able to sense curvature and bend membranes. While many different curvature stabilizing proteins have been identified, the physical mechanisms underlying their function are not well understood. On the other hand, 3D membrane geometries have been observed in protein-free systems as the result of the adsorption of particles on membranes [1,2]. Thus, the adsorption and self-assembly of simple colloidal particles could serve as a useful model system to reveal the essential physics of membrane deformation by bound proteins.

Several theoretical and numerical studies have predicted how particles behave when adsorbed to membranes [3,4,5]. However, relevant experimental data is lacking, mainly due to the fact that these studies typically use irreversible binding of particles to membranes [6,7].

In this work, we present two approaches for reversible binding of particles to membranes: depletion and electrostatic interactions. In the case of depletion we add 1 μm Polystyrene-particles to lipid membranes in the presence of Polyethylene glycol (PEG). Strength and range of the depletion interactions can be finely controlled by the amount and molecular weight of the depletant polymer chains. In the case of electrostatics we add polystyrene-particles coated with PEG-poly-L-lysine (PEG-PLL) to negatively charged lipid bilayers. PLL is positively charged and allows the particle to adsorb on the membrane while PEG adds a steric hindrance preventing it from adhering too strongly.

References:

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