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Differently Charged Nanodisc-Stabilizing Copolymers Influence the Formation of Lipid Triple Layers at the Air-Water Interface

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In order to investigate the interactions of proteins with biological membranes, lipid monolayers at the air-water interface are a suitable and simplified membrane model system. Although this is a well-established model to observe interactions between various biopolymers and lipid membranes, membrane spanning proteins could not yet be studied by this system and its corresponding methods, e.g., film balance measurements, fluorescence microscopy or infrared reflection-absorption spectroscopy (IRRAS).

A new membrane model system – a well-defined lipid triple layer at the air-water interface – is our approach to solve this problem. By assembling lipid bilayers underneath a lipid monolayer, it will be possible to investigate transmembrane proteins in a fully hydrated and oriented bilayer with the aforementioned methods. To design this model system, we inject lipid bilayers, e.g., vesicles or nanodiscs, into the aqueous subphase underneath the preassembled monolayer. One promising approach to promote the triple layer assembly is electrostatic adsorption of polymer-stabilized lipid nanodiscs containing negatively charged lipids to a positively charged monolayer. The advantage of using copolymers to prepare lipid nanodiscs is to prevent possible interference with the integral membrane proteins to be analyzed. Thus, the right choice of this polymer is essential for designing a suitable triple layer model. The charges of the commonly used copolymers for nanodiscs formation, SMA and DIBMA, may interfere with the electrostatic interaction between the lipids. Furthermore, free polymers in solution may interact with the anchoring monolayer altering its desired properties.
Therefore, in this study we investigated the influence of differently charged copolymers derived from SMA on the triple layer formation. From film balance and IRRAS experiments, we conclude that although their charge has no significant influence on their interaction with the monolayer, the amount of adsorbed nanodiscs clearly depends in the charge of the used polymer.