**Curvature induced phase separation in lipid bilayers: A structural and compositional perspective**

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The cellular membranes posses a range of different type of curvatures, with many biological processes occurring under curvature as high as 1/R = 1/20 nm-1. There is experimental evidence that curvature should induce phase separation in lipids mixtures including those with melting points above and below the experimental conditions [1–3], and for lipid mixtures containing low and high intrinsic curvature lipid types [4]. Such knowledge is based on fluorescence microscopy or molecular simulation data and little does it reflect the actual lipid composition or the structure of such membranes. The correlation between nanoscale membrane curvature and phase separation is a crucial point for understanding of membrane functionality. That is pivotal across a spectrum of applications, encompassing drug delivery and beyond.

In the present study, the curvature-induced phase separation for lipid mixtures containing low (phosphatidylcholine) and high intrinsic curvature (cardiolipin) lipid types was investigated by neutron reflectometry. The distinctive aspect of neutron reflectometry lies in its capability to reveal coexisting planar and curved model membranes, whereas small-angle neutron scattering allows us to study membranes with single curvature.

Here the “diffracting scaffolds” formed by SiO2 nanoparticles (NPs) ranging from 200 to 50 nm in diameter [5] were used to deposit a continuous, supported lipid bilayer (SLB) on both the SiO2 NPs and the flat regions in between these NPs [6]. In the given work, a clear compositional difference was shown between planar and curved regions of the nanoSLB prepared by solvent depletion as well as vesicle fusion methods. Moreover, selective lipid deuteration provided direct evidence of a curvature degree effect on lipid phase separation, which is critical for membrane functionality, as well as a very first characterization of the structure of the coexisting flat and curved bilayers. These models and protocols are now available to study a range of systems that will enable mapping the relationship between biological function and membrane structure under curvatures that are relevant in membrane biophysics.

References

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