Modeling Membrane Architecture with Spherical Nanoparticle Supported Lipid Bilayers

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Introduction

Many essential cellular processes require transient membrane remodeling with a large degree of spatial and temporal accuracy. Moreover, it was recently discovered that membrane curvature could regulate protein activity and serve as a geometric cue for protein subcellular localization. However, little is known about the molecular mechanisms responsible for the generation and regulation of membrane geometry. We are developing SSLBs to model various degrees of biological membrane curvature for the study of geometry-sensitive molecules.

Experimental

In SSLB [1], the bilayer is separated from the solid supports by a thin layer of water molecules (~20 Å, Fig. 1a), and thereby it preserves many characteristics of cell membranes such as lateral fluidity, impermeability to ionic species, and flexibility along the fatty acyl chain. We have demonstrated that these SSLBs were able to capture a membrane curvature sensitive peptide, SpoVM, in a concentration-dependent manner (Fig. 1b).

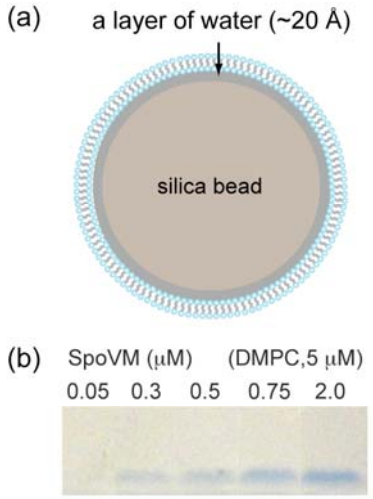

Fig. 1: (a) SSLB representation. (b) Capture of SpoVM using 1 μm DMPC-coated SSLBs

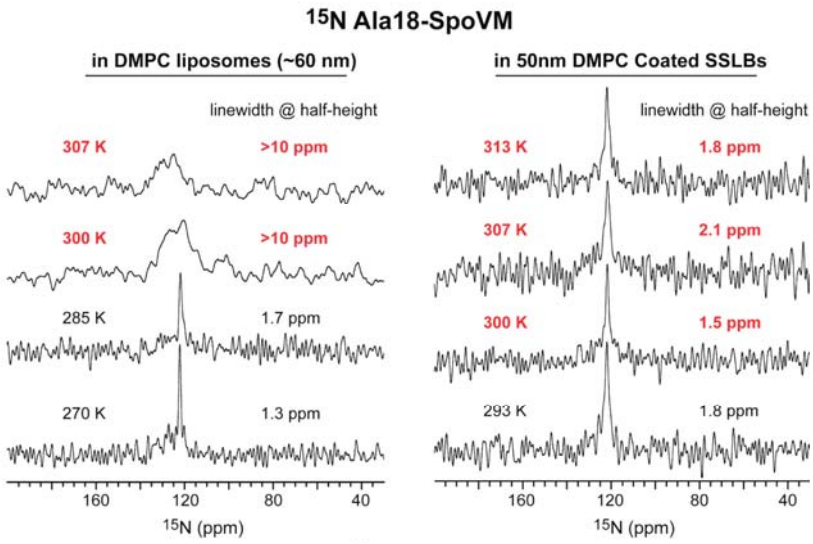

Fig. 2: Comparison of 1D ^{15}N MAS specra of SpoVM in 50 nm DMPC-coated SSLBs and liposomes.

Results and Discussion

Previously we have shown that the SpoVM spectra of the SSLB preparations were astonishingly similar to the reference spectra of liposome preparations, indicating that the peptide likely adapts similar structures in these two membrane models. Fig. 2 compares the spectral resolution of a ^{15}N-Ala$_{18}$ labeled SpoVM in SSLBs and in liposomes. The ^{15}N linewidth of SSLBs is comparable to some of the very best values reported in the literature for membrane proteins, indicating good homogeneity of SSLB preparations. Moreover, unlike in liposome preparations the spectral resolution of SSLB preparations is maintained in liquid crystalline phase.

Conclusions

Our results support the use of SSLBs as a model for the study of membrane curvature-sensitive molecules. Moreover, SSLBs may provide a unique system to improve spectral resolution of membrane proteins.

Acknowledgements

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References

[1] Bayerl, T.M., *et al.*, Biophys. J., **58**, 357-362 (1990).