Structure Determination of Membrane Curvature Sensitive Molecules Using Spherical (Nanoparticle) Supported Lipid Bilayers and Solid-State MAS NMR

R. Fu (NHMFL); Gill, R. L. (Pennsylvania State U., College of Medicine); Tian, F. (Pennsylvania State U., Biochemistry and Molecular Biology, Medical School)

Introduction

We are exploiting and developing spherical nanoparticle supported lipid bilayers (SSLBs) to model various degrees of biological membrane curvature for the structural study of geometry-sensitive molecules. SSLBs, first introduced in 1990 [1], preserve many characteristics of cell membranes such as lateral fluidity, impermeability to ionic species, and flexibility along the fatty acyl chain. Unlike the commonly used liposomes, SSLBs can be homogeneously prepared with well-defined curvatures (defined by the size of solid supports), providing a membrane model system for the study of geometry-sensitive molecules such as SpoVM [2]. We have demonstrated that SSLBs are not only suitable for biochemical and biophysical measurements and fluorescence spectroscopy, but also provide a model membrane for solid-state NMR structural studies of curvature sensitive molecules.

Experimental

NMR data were collected on the 600 and 800 MHz spectrometers to determine structures of SpoVM and a functionally impaired mutant, SpoVM^{P9A} in SSLBs.

Results and Discussion

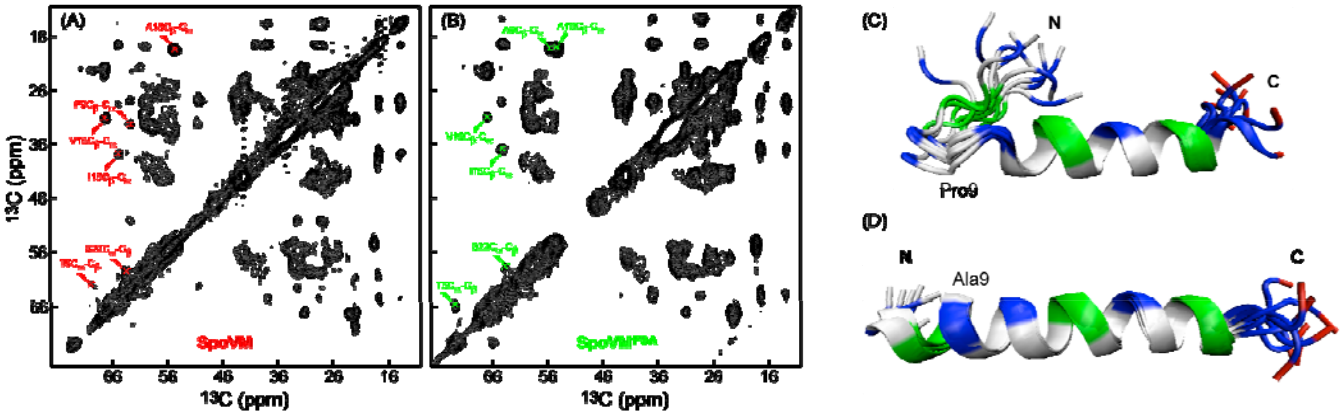

Fig. 1: ^{13}C-^{13}C PARIS spectra of SpoVM (A) and SpoVM^{P9A} (B) in DMPC-coated 50 nm SSLBs. NMR structures of SpoVM (C) and SpoVM^{P9A} (D) determined in isotropic bicelles.

Several resonances were readily assigned in the ^{13}C-^{13}C PARIS spectra of SpoVM and SpoVM^{P9A} in DMPC-coated 50 nm SSLBs (Fig. 1). The C_α and C_β secondary chemical shifts for those assigned residues were consistent with the structures of SpoVM and SpoVM^{P9A} determined in isotropic bicelles using solution NMR.

Conclusions

SpoVM and SpoVMP^{9A} adopt a different helical structure in a bilayer-like membrane environment.

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References

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[2] Ramamurthi, K.S., *et. al.,* Science, **323,** 1354-1357 (2009).