Synopsis of Original Research Paper

Fuctional Role of Archaeal Ethereal Phospholipids

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Archaeal membrane lipids are structurally unique and are consisted of isoprenoid chains linked to glycerol with ether bond in contrast to the ester linkage of eubacterial and eukaryotic membrane lipids. The most striking feature of archaeal membrane lipids is the presence of macrocyclic structures as large as 36-membered rings of methanogens.

An objective of this research is to develop synthetic methodology of these extreme macrocycles and the unique archaeal ether lipid, which are useful for studies on physico-chemical properties as membrane lipid and to develop new materials with intriguing properties. For this purpose, we have succesfully synthesized archaeal 36-membered macrocyclic membrane lipids ans its acyclic congener. Described in this report is the biophysical significance of the archaeal 36-membered macrocyclic diether phospholipid 36MPC as a function of temperature, which was studied by measuring of membrane fluidity, liposomal proton permeability, and liposomal thermostability in comparison with its acyclic counterpart, DPhyPC, egg yolk lecithin eggPC, and a mixed lipid of DMPC-cholesterol (2:1). Fluorescence anisotropy measurements indicated that the macrocyclic structure led to a decrease in the fluidity in the inter-membrane hydrophobic part more than in the membrane surface by limiting the motional freedom of the alkyl chains. The proton permeability was also significantly reduced by introducing a macrocyclic structure. Liposomal thermostability measurements using 6-carboxyfluorescein (CF) suggested that 36MPC formed liposomes with greater thermal stability than these of DPhyPC. The presence of glycolipids to the corresponding phospholipids greatly reduced the CF leakage from liposomes. Most importantly, DMPC-cholesterol liposome showed less leakage than 36MPC at 40˚C. However, by raising the temperature, this situation was completely reversed. This suggested that the cyclic structure contributed to the formation of stable liposomes, especially at higher temperatures. These findings clearly demonstrate that the 36-membered macrocyclic lipid membrane plays an important role for the thermophilic archaea to adapt to extreme environments.