Non-bilayer structures: Their block architecture

Peter Fromherz

Max-Planck-Institut für biophysikalische Chemie
3400 Göttingen und Universität Ulm, Abteilung für Biophysik,
Oberer Eselsberg, 7900 Ulm (Donau)

Defects in the lipid bilayer are known to be present in the process of intra-membrane and inter-membrane lipid exchange, in lysis and in particular during membrane fusion. The molecular configuration of those non-bilayer structures is unknown.

It is proposed that the molecular architecture of surfactant micelles is a paradigm of non-bilayer assembly i.e. for the architecture of narrowwest convex and concave structures made from lipid-like material.

For the micelles themselves a novel block-assembly has been designed on a critical inspection of experimental data and their comparison with conventional micelle packing. The crucial conclusion is, that the micelles- and other related narrow curvatures - are not attained by arbitrary radial coiling of the hydrocarbon chains or by extensive water penetration but by the preferentially orthogonal assembly of molecular blocks with parallel correlated chains, such that the width of correlation equals the length of the hydrocarbon.

The elementary block-defect in a bilayer consists of a rotated block of four hydrocarbon chains, i.e. of one cardiolipin, two lecithin or four lysolecithin molecules. The energy of this defect is high as compared to kT. It is stabilized by radial aggregation in the plane of the membrane, by material exposing hydrocarbon as proteins, plastics and in particular another membrane with rotated block defects. It is stabilized also by detergent-like membrane solutes as lysolecithin. The correlation derived from the models between the conditions of stabilization and the physical processes as isotropic P-31 spectra, flip-flop, lipid particles in freeze-etching, intermembrane lipid exchange and various stages of membrane fusion are in good agreement with the experimental data.

1. P. Fromherz, Chem. Phys. Lett. 77 (1981) 460
2. P. Fromherz, Nachr. Chem. Techn. Lab. in press
3. P. Fromherz, Bunsenber. Phys. Chem. in press
4. P. Fromherz, FEBS-Letters submitted