Influence of Ceramide 3 and Ceramide 6 on the internal structure and hydration of DMPC bilayers studied by neutron and X-ray scattering

M.A. Kiselev[1], E.V. Zemlyanaya[1], N.Y. Ryabova[1], T. Hauss[2], L. Almasy[3], S.S. Funari[4], J. Zbytovska[5], D. Lombardo[6]

[1] *Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia*
[2] *Helmhotlz-Zentrum Berlin for Materials and Energy, Berlin, Germany*
[3] *Research Institute for Solid State Physic and Optics, Budapest, Hungary*
[4] *Max Planck Institute of Colloids and Interfaces, Golm, c/o HASYLAB, Hamburg, Germany*
[5] *Department of Pharmaceutical Technology, Charles University, Prague, Czech Republic*
[6] *CNR- Istituto per i Processi Chimico-Fisici, Messina, Italy - lombardo@me.cnr.it*

Abstract

Ceramides are bioactive lipids implicated in many special functions of biological membranes. As a structural component of the cell membrane it play a crucial role in apoptosis. Small angle neutron scattering (SANS), neutron diffraction and X-ray powder diffraction were used to investigate influence of Ceramide 3 and Ceramide 6 on the internal structure and hydration of DMPC membrane in fully and partly hydrated states at T=30°C. The findings of the obtained results support the idea that ceramide (CER3 and CER6) addition promotes significant changes in membrane organization of DMPC bilayers with the formation of phases with new structural properties. More specifically, while the membrane thickness remains unchanged under the influence of CER3 and CER6 a pronounced increase of the hydrophobic core region of the DMPC bilayer is detected at small concentrations of added Ceramide.

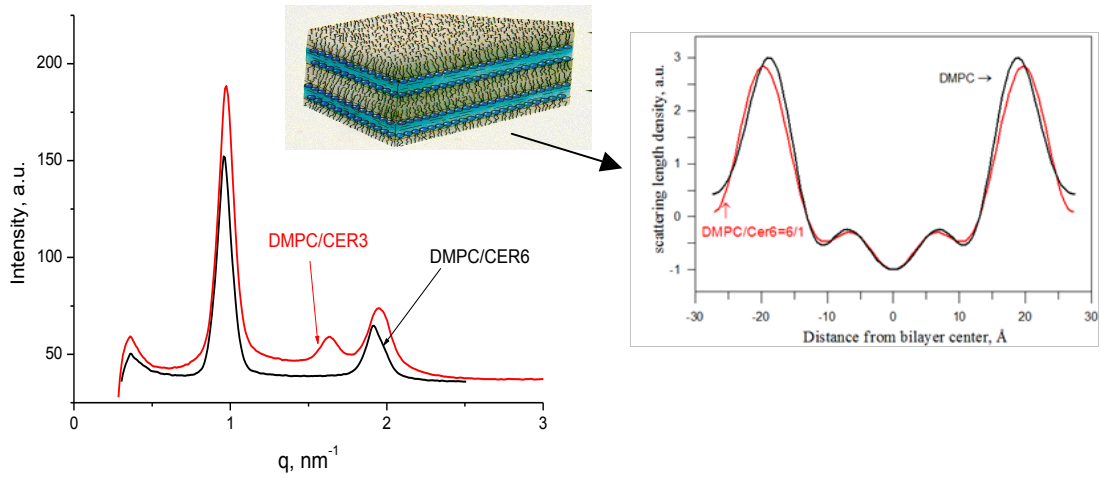

Fig. 1. X-ray powder diffraction for mixed DMPC/Cer3 and DMPC/Cer6 membranes with molar ratio 6/1 at T=30°C. The corresponding neutron scattering length density ρ(x) profile across the membrane calculated from the neutron diffraction experiment is presented in the inset.

Interestingly, the less hydrophilic character of CER3 causes formation of a new phase (V-shaped form) as evidenced by X-ray powder diffraction analysis. The use of appropriate hydrophobic-hydrophilic (HH) approximation for the analysis of the SANS data evidenced a decrease in the average radius and the polydispersity of the vesicles that has been ascribed to hydrogen bonds intermolecular interactions (due to the presence of ceramide hydroxyl groups) that segregate lateral domains into tight lipid packing with a more compact, rigid character.
Our investigations furnish new structural aspects of ceramide's formation in lipid bilayers and evidence some relevant parameters for the control of the microstructure and macroscopic phase transition in mixed bio-membrane systems.