

## Multicomponent Lipid Model Membranes: Phase Screening with SAXS

### Overview

Biomembranes consist of layers composed of different lipids in which proteins and other compounds are embedded. The main lipids in mammalian plasma membranes are glycerol-based phospholipids, sphingomyelins and cholesterol with varying concentration. Chemical structures of these lipids are given in figure 1.

In this experiment the structures of MLV's from different mixtures of *sphingomyelin* (SM), *POPC* and *cholesterol* in excess water (10% mol/mol lipid/water) with various concentrations were screened at different temperatures with SAXS.

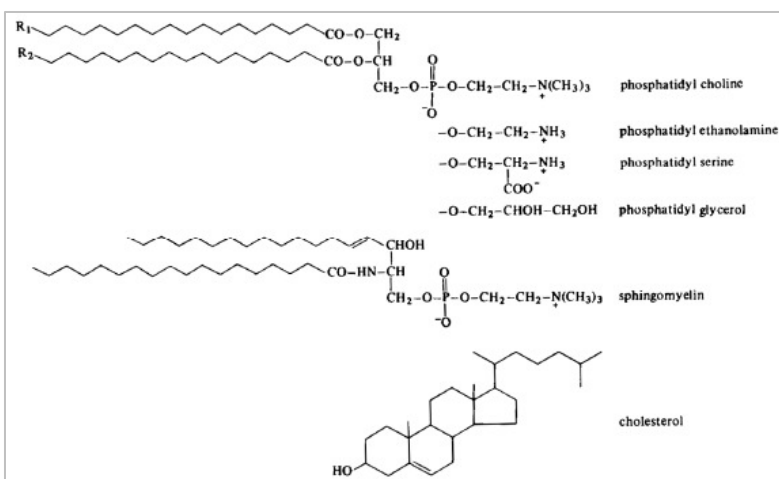


Figure 1: Chemical structures of the lipids used in the model membrane.

### Experimental

Small-angle X-ray scattering (SAXS) experiments were carried out with a HECUS SWAX-camera attached to a 2-kW generator (sealed-tube with Cutarget, wavelength  $\lambda = 0.154$  nm). Scattering curves were monitored in a  $q$ -range from 0.14 to 4.0 nm<sup>-1</sup>. The 128 samples were sampled by an autosampler (Metrohm 750) in

combination with the flow-through sample-cell and a temperature-scan between 10-60 °C was performed by using a temperature-controller (KPR) with the MTC-program (HECUS). The scattering curves were analysed by using the HECUS 3D-View program.

### Results

A maximum in  $d$ -spacing of the multibilayers was found for the lipid mixture POPC:SM = 1:2 mol/mol with 2 % cholesterol (figure 2) at 23 °C. In general, the column POPC:SM 1:2 has always the highest  $d$ -value in each row. The values in this column first increase with increasing cholesterol ratio until 2% are reached and decrease afterwards. This

behaviour is with increasing amount of cholesterol also shown by pure SM, whereas the  $d$ -spacing of pure POPC increase to minor extent until 20 % cholesterol has been reached. The mixtures POPC:SM 2:1 and 1:1 show a decreasing of the  $d$ -spacing with cholesterol.

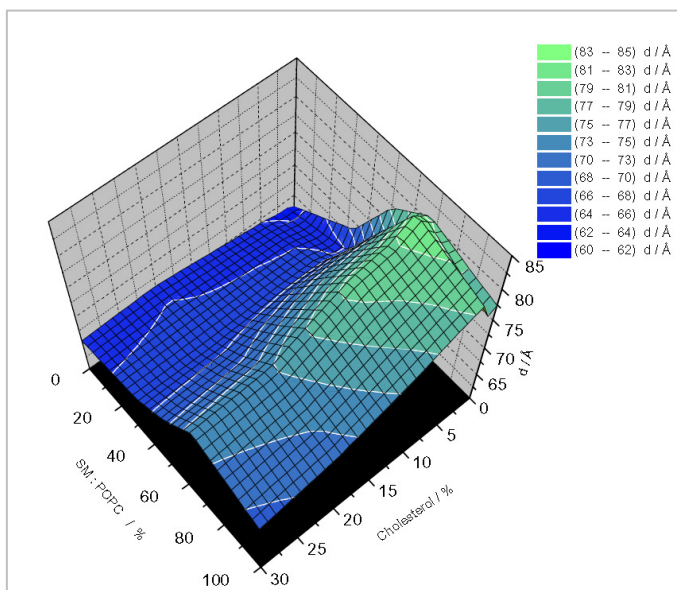


Figure 2: 3D-plot of the d-values over the concentration-matrix at 23 °C.

Temperature scanning of the lipidmixture of the maximum (POPC/SM = 1 / 2 and 2% cholesterol) show that the d-spacing is slightly increasing between 10 °C and 23 °C. After this, the phase transition from the L<sup>R</sup>-phase to the L<sup><</sup>-phase starts. This behaviour was only observed for this sample composition (figure 3).

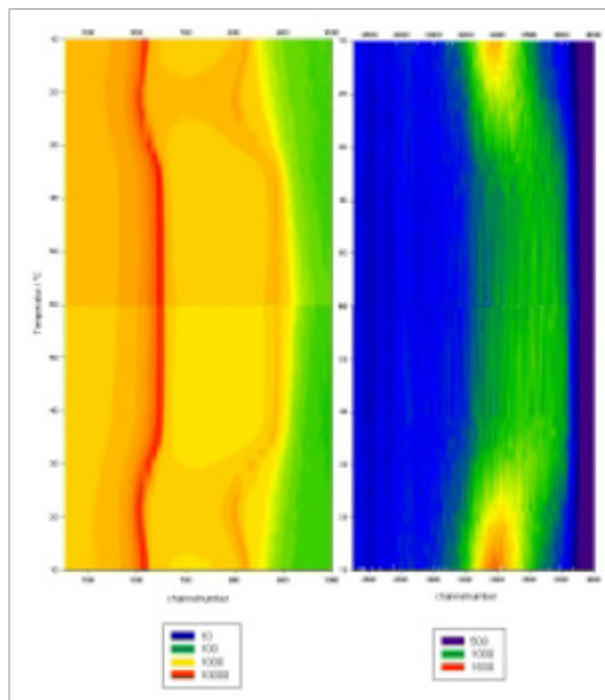


Figure 3: Intensity contour plot of the temperature scan with the lipid mixture POPC/SM = 1 / 2 and 2% cholesterol.

## Conclusion

The results indicate that POPC, SM and Cholesterol mix in both the gel and the liquid crystalline phases for all studied compositions. The lipids form a lipid bilayer with a repeat distance depending on the single composition. No explicit phase separation was found but a reorganisation by cycling through the phase transition, which leads to slightly different shapes and intensities in the SAXS-pattern but

with the same repeat distances. An outstanding point of the concentration matrix of the three lipids in the gel phase is the mixture POPC:SM = 1:2 w/w with 2% cholesterol with a markedly thicker layer between 20 °C and 25°C and a slightly higher transition temperature than the surrounding.