Influence of Cholesterol on Head Group Order and Mobility in Lecithin Bilayers as Determined by Dielectric Relaxation Measurements

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The complex permittivity $\varepsilon(\nu)=\varepsilon'(\nu)- i\varepsilon''(\nu)$ of aqueous solutions of dimyristoyl- and dipalmitoylphosphatidylcholine/cholesterol-mixtures has been measured in the frequency range ν = 100 kHz to 50 MHz by means of time domain reflectometry. Measurements have been performed in dependence of cholesterol concentration and temperature.

The dielectric relaxation, which was found in this frequency range can be partly attributed to the restricted motion of the phosphatidylcholine group in the bilayer surface. The relaxation strength and the relaxation time decrease distinctly with increasing cholesterol concentration. The analysis of the data by means of a solution model, which takes into account the shape of the lecithin vesicles, yields the head group orientation correlation factor g_I, the relaxation time τ_I of the head group rotational motion and the vesicle radius $\tilde{r}$.

The surface of pure lecithin bilayers is found to be arranged in domains with 10 to 100 neighbouring head groups with parallel orientation. g_I also increases if temperature exceeds the phase transition temperature of the bilayer. Incorporation of small amounts of cholesterol into the membrane disrupts the surface order. This is accompanied with an increase of the head group mobility.