

ABSTRACT

In order to study lipid membrane properties, fluorescence solvent relaxation method, which enables us to determine the degree of hydration of the membrane and the mobility of the hydrated lipid molecules, was used. Applying three different naphthalene derivatives as fluorescent dyes (Patman, Laurdan and Prodan) allowed probing different parts of the headgroup region of the bilayer. First, wavelength-dependent parallax quenching measurements resulted in the determination of precise locations of Laurdan and Patman within the DOPC bilayer. Exploring the issue of the probes locations within the lipid bilayer, acrylamide quenching experiments were performed. They have shown Patman relocalization in cationic, DOTAP-containing systems. Bilayers formed from phosphatidylcholines with different alkyl chains (DOPC, POPC, OPPC and PCΔ6) but the same polar head were also studied. The results have shown differences in the both hydration and mobility of the membranes depending on the type of fatty acid chains of bilayer lipids. Finally, liposomes formed from cationic lipids, commonly used to deliver genes into cells *in vitro* and *in vivo*, were investigated. Measurements of the structure and dynamics of fully hydrated liquid crystalline lipid bilayers composed of the mixtures of cationic DOTAP and neutral DOPC with the use of fluorescence solvent relaxation technique were performed. The nonmonotonic dependence of dipolar relaxation kinetics (occurring exclusively on the nanosecond timescale) on DOTAP content in the membrane was found to exhibit a maximum integral mean solvent relaxation time at 30 mol % of DOTAP. Up to 30 mol %, the addition of DOTAP does not influence the amount of bound water at the level of the sn₁ carbonyls, but leads to an increased packing of phospholipid headgroup. Above this concentration, elevated lipid bilayer water penetration was observed. Additionally, to study the influence of hydrocarbon chain length and its saturation on membrane hydration and mobility, measurements similar as for DOTAP/DOPC were performed for the DMTAP/DMPC system.