INFLUENCE OF TEMPERATURE AND MACROMOLECULES ON PHASE TRANSITIONS IN TWO-DIMENSIONAL LIPID FILMS

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Interactions between macromolecules and lipids influence on the processes occurring on the surface of living cells and the functional properties of cell membranes. For investigations of these interactions, a lipid monolayer on the surface of a liquid is used usually as a model system instead of a lipid bilayer of the cell membrane.
In this work, the interactions of polyelectrolytes and proteins (beta-lactoglobulin (BLG) and lysozyme) with a lipid monolayer were investigated by the methods of surface rheology, microscopy and spectroscopy under conditions close to physiological. In this case monolayer contains a mixture of zwitterionic and anionic lipids, which is the basis of cell membranes. The presence of polyelectrolyte with positively charged functional groups under the lipid monolayer leads to a change in the phase state of molecules in the surface layer due to electrostatic interactions. Both an increase in temperature and the presence of an oppositely charged polyelectrolyte in the sublayer leads to a disorder in the structure of the lipid monolayer and prevents the transition of the monolayer from a liquid-expanded to a liquid-condensed state. The effect of macromolecules on the surface layer increases with increasing concentration of negatively charged lipid in the monolayer. It was previously shown that positively charged BLG macromolecules at pH 2 have a significant effect on the properties of a negatively charged lipid monolayer due to both electrostatic and hydrophobic interactions [1]. At a pH of 7.4, BLG has a negative charge, and lysozyme has a positive charge, which significantly increases effect of lysozyme on the structure of the negatively charged lipid monolayer. Lysozyme strongly reduced the dynamic surface elasticity of the lipid monolayer, while BLG had practically no effect. Probably, the presence of both electrostatic and hydrophobic interactions between lysozyme macromolecules and the lipid monolayer contributes to the bactericidal activity of this protein against gram-negative bacteria.

1. Bykov, A. G., Tsyganov E. A., Tulin D. V., Akentiev A.V., Milyaeva O.Yu., Loglio G., Miller R., Panda A.K., Wan Z., Noskov B.A. Dynamic Properties of Mixed Layers of a Lipid With a Protein or Its Fibrils. // Langmuir. 2025. 41: 18126–18133. https://doi.org/10.1021/acs.langm uir.5c02103

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