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The Structural Variety of DNA-DPPC-Divalent Metal Cation Aggregates: SAXD and SANS Study

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ABSTRACT

Neutral phospholipid bilayers in presence of divalent metal cations spontaneously form vesicles with a positive surface charge. Due to their interaction with DNA polyanion, colloidal aggregates with an internal organized structure are formed. Aggregates are potential DNA delivery vectors [1].

We investigate the structure of DNA – saturated dipalmitoylphosphatidylcholine (DPPC) - divalent metal cations (Ca^{2+} and Zn^{2+}) aggregates. Synchrotron small-angle X-ray diffraction (SAXD) reveals the structural variety of aggregates as a function of cations concentration: either a) a superposition of lamellar L^x phase with the DNA strands (of unknown organization) intercalated into water layers between adjacent lipid bilayers and L_{DPPC} phase of DPPC bilayers without any DNA strands, or b) a condensed gel lamellar phase L_g^c with the lipid bilayer periodicity d ~ 8.0 nm, and the DNA – DNA interhelical distance d_{DNA} ~ 5.1 nm.

The increase of temperature induces the decrease of the intensity and the increase of the width of the diffraction peak related to DNA. In the fluid state, the condensed lamellar phase L_α^c gradually converts into L^x phase. The DNA – DPPC – Zn^{2+} aggregates prepared with the DNA of short length fragments have lost their long-range organization in the fluid state. Small-angle neutron scattering (SANS) curves show the "dissolution" of the aggregates into a partially disordered lamellar phase and unilamellar vesicles. SANS curves are analyzed by a strip-function model [2] to obtain structural parameters of the DPPC bilayer.

The structure of the aggregates is also of interest as a model for contact sites between DNA and bio-membranes and can help to clarify the role of DNA – lipid interactions in formation of cellular structures [3].

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