

Polymorphic structural transitions in DNA + DPPC + divalent metal cations aggregates

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The structure and temperature behaviour of the DNA+dipalmitoylphosphatidylcholine (DPPC) bilayer as a function of concentration of divalent metal cations (Ca(II) and Zn(II)) were examined using small-angle X-ray diffraction (SAXD), small-angle neutron scattering (SANS) and differential scanning calorimetry (DSC). From physical point of view, the aggregates form smectic lyotropic mesophases. Aggregates were prepared at millimolar concentrations of divalent cations that are physiologically relevant. Potentially, the aggregates with calcium are gene delivery vehicles. With increasing concentration of ions, the temperature of the gel-to-liquid crystalline phase transition of DPPC increases. SAXD shows a structural heterogeneity as a function of the cation concentration and temperature: At low cation concentration (~1 mM), aggregates show two DPPC phases, one with a lateral segregation of DNA and cation, while higher cation concentration improves the DNA packing and the condensed lamellar phase is observed in DNA+DPPC+20 mM ion aggregates. In the liquid-crystalline state, aggregates with calcium are temperature stable up to 80 °C. However, concentrations above 20 mM ZnCl₂ promote the dissolution of the condensed lamellar phase into DPPC+Zn(II) unilamellar vesicles and DNA is neutralized by Zn(II) ions. The screening of Zn(II) charge and the formation of a diffuse double layer due to increasing ionic strength of solution are responsible for the observed changes.

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