Coupling of membrane nanodomain formation and enhanced electroporation near phase transition

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Biomembranes pass through phase transitions with a change in the environmental temperature. It was experimentally demonstrated that a transition not only involves membrane structural changes, but also a change in ion permeability [1,2]. At the main phase transition temperature T_m, the permeability displays a peak and current fluctuations of quantized amplitude can be measured.

Here, the temperature-dependent structural features of a one-component dipalmitoylphosphatidylcholine bilayer and its stability against an applied electric field was investigated at and close to T_m by means of atomistic molecular dynamics simulations [3]. The simulations demonstrate the dynamic appearance and disappearance of thin, interdigitating and thick, ordered lipid domains in fluid-like bilayers close to T_m, which vanished at higher temperatures. The structures were spatially related and likely represent precursors of the ripple phase forming below T_m. Similarly, a metastable two-phase bilayer consisting of a gel and a fluid domain adopted a thickness minimum at the phase interface formed by interdigitating and splaying lipids. Close to T_m, electroporation was enhanced with pores preferentially forming in the thin nanodomains. Together, these findings provide a link between the increased permeability and structural heterogeneity close to phase transition.

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