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Stochastic model and the dynamic behavior of raft-like domains in biological membranes

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In recent years, new features in the behavior and structure of biological cell membranes have been discovered. It turned out that an important role in the functioning of membranes and cells is played by so-called rafts, dynamic domains in membranes through which various signals enter the cell. Biological membranes are in a nonequilibrium state. Therefore, the apparatus of a mathematical stochastic storage model and distribution that involve the lifetime of the system as a thermodynamic parameter are involved in their study. These research tools are valid for nonequilibrium systems. A stochastic model of the kinetics of raft-like domains in biological membranes are constructed, the characteristics of nonstationary and stationary behavior of domains are determined, their lifetimes are determined. The phase transition in the system of raft-like domains of the noise-induced phase transition between the extinction and survival modes in the Verhulst model, intended for describing the growth of populations and generalized to many other phenomena, is revealed. The impact of external influences on the behavior of the raft-like domain system has been studied. The assumption that the point of phase transition serves as the stationary point in which the system of raft-like domains is located is proposed and justified. Following, we consider two coexisting populations. The first consists of many (small) clusters, and is described by the Smoluchowski equation. The second set is reduced to one large cluster, the size of which oscillates stochastically. It is shown that dynamic chaos can exist in such a system, as well as other features of dynamic behavior. This largely explains the dynamic behavior of raft-like domains in biological membranes.

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