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Membrane domain alteration under the action of biologically active substances: an EPR study

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Plasma membrane is an active barrier with heterogeneous distribution of lipids and proteins arranged in several coexisting domains with different fluidity characteristics. Fluidity of the whole plasma membrane reflects the ordering and dynamics of phospholipid acyl chains in specific membrane domains, as well as the fraction of each domain in the membrane. Different biologically active substances can strongly influence the fluidity characteristics, in this way they affect processes in the membrane such as transport, enzyme activities and expression of the receptors and consequently cell growth, differentiation and transformation. In this paper the electron paramagnetic resonance method (EPR) is described by which it is possible to characterise the domain structure in the membranes of biological samples. The method is based on the computer simulation of the EPR spectra line-shapes of the membrane dissolved spin probes. In the model we take into account that the membrane is heterogeneous with several coexisting domains. The parameters, which describe ordering, dynamics and polarity of the spin probe environment in each domain as well as the proportion of individual domain in the membrane can be determined by the evolutionary optimisation of the simulated spectra to the experimental spectrum. This procedure allows the extraction of small changes in the membrane caused by different influences from the environment. The contribution of the relative portion of each domain can be distinguished from the contribution of fluidity alterations in the domain. Two examples are discussed: (i) The influence of cholesterol on the membrane fluidity alterations in alkyl-phospholipid liposomes; (ii) the difference in the domain structure of neutrophil membranes from blood (dormant neutrophils) and bronchoalveolar fluid in asthmatic horses (active neutrophils).