

Ion penetration as an indicator of changes in the hydrophobicity of lipid bilayer membranes: spin-probe spin-label method

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The spin-probe spin-label method is based on the magnetic interaction between two different kinds of paramagnetic compounds introduced into an investigated system. In our experiments we have used stearic acid spin labels, with the free radical nitroxide moiety attached to various positions along the alkyl chain, and paramagnetic metal ions, $[\text{Fe}(\text{CN})_6]^{3-}$ and Ni^{2+} , to investigate ion penetration into the phosphatidylcholine bilayer membranes in the presence of different membrane modifiers, namely: cholesterol, polar carotenoids, gramicidin and spermine. The effects of these modifiers are as follows: (1) In the presence of cholesterol the level of ion penetration increases up to the 9th carbon of the alkyl chain and decreases in the center of the bilayer. (2) Polar carotenoids reduce the ion penetration in the membrane center and in the near polar headgroup region. (3) The ion penetration increases at all locations in the membrane when gramicidin is present. (4) Spermine strongly reduces ion penetration, especially near the polar headgroup region. The results of these experiments performed in the fluid phase correlate well with the hydrophobicity profiles obtained for frozen membranes.