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Lateral diffusion in sphingomyelin bilayers

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Abstract

Sphingomyelin (SM) is an important lipid of eukaryotic cellular membranes and neuronal tissues. We studied lateral diffusion in macroscopically oriented bilayers of synthetic palmitoylsphingomyelin (PSM) and natural sphingomyelins of egg yolk (eSM), bovine brain (bSM) and bovine milk (mSM) by pulsed field gradient NMR (PFG NMR) in the temperature range 45-60 °C. We found that the mean values of lateral diffusion coefficients (LDCs) of SMs are 1.9-fold lower compared with those of dipalmitoylphosphatidylcholine (DPPC), which is similar in molecular structure. This discrepancy could be explained by the characteristics of intermolecular SM interactions. The LDCs of different SMs differ: egg SM is most similar to PSM; both of them have a 10% higher LDC value compared with the other two natural SMs. Besides, all natural SMs show a complicated form of the spin-echo diffusion decay (DD), which is an indicator of a distribution of LDC values in bilayers. This peculiarity is explained by the broad distributions of hydrocarbon chain lengths of the natural SMs studied here, especially mSM and bSM. We confirmed the relationship between chain length and LDC in the bilayers by computer analysis of a set of 1H NMR spectra obtained by scanning the value of the pulsed field gradient. There is a correlation between lower LDC values and SM molecules with longer acyl chains. The most probable mechanisms by which long-chain SM molecules decrease their lateral diffusion relative to the average value are protrusion into the other side of the bilayer or lateral separation into areas that diverge with their LDCs. © 2010 John Wiley & Sons, Ltd.

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Keywords

biomembrane, interdigitation, self-diffusion, translational mobility