The Effect of Cholesterol on Biological Membranes

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Mammalian cell membranes, unique films forming the borders of cells and organelles, are composed of lipid bilayers, proteins and other molecules such as for instance cholesterol. In my work, I have focused on bilayers composed of various types of lipids commonly present in the cell membranes – phosphatidylglycerols (DOPC, DPPC, DPPE) and sphingolipids (Ceramide2, Sphingomyelin) and their mixtures with cholesterol. Overall 55 membranes varying in the lipid type and the amount of cholesterol were studied using molecular dynamics simulations. Behaviour of the system was studied within a time span of 200 ns using Gromacs software simulation package. Subsequently, specific analysis of the systems has been carried out in order to evaluate structure-property relationships. All the membranes were more organised and less fluid after addition of cholesterol. The membranes built of phosphatidylcholines (DOPC, DPPC) tend to be more influenced; their thickness increased and the added cholesterol moved towards the lipid polar heads. Well-organized sphingolipid membranes were affected by the added cholesterol to a lesser extent. The performed research has shown that cholesterol is able to significantly change the properties of the membranes and therefore may affect also the membrane function and drug transport. The role of lipid composition and the amount of cholesterol in biomembranes is crucial and its lack of or excess can cause severe health problems. Various tissues differ in their lipid membrane composition which should be taken into account especially when considering membrane behaviour at different conditions and designing new drugs.

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