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What do we really measure when we track the diffusive dynamics in biomembranes?

There are numerous techniques able to gauge diffusion in biomembranes. For instance, quasi-elastic neutron scattering measures diffusion in a non-perturbative manner over nanosecond time scales, yet sampling in space is here done over large distances. Meanwhile, single-particle tracking allows one to track the dynamics of individual molecules in almost nanometer resolution, but these measurements are based on the use of markers that may interfere with the system under examination, either very little or unexpectedly much. Here we discuss recent nanoscale computer simulation studies that were designed to explore the diffusion mechanisms of lipids and membrane proteins, and the effects of streptavidin-functionalized Au nanoparticles on the lateral diffusion of lipids in biomembranes. The results show that lipids diffuse in a concerted fashion as clusters of lipids whose motion is highly correlated, and membrane proteins move as dynamical complexes with tens of lipids dynamically bound to the protein. Meanwhile, lipids linked to a streptavidin-nanoparticle complex also move in a concerted manner but as a complex with the linker protein and numerous non-labeled unlabeled lipids, and it turns out that this can slow down the motion of the probe by about almost an order of magnitude. Altogether, the results highlight the view that prior to using any technique and/or probe, it makes sense to understand the physical basis of the diffusion process that one aims to measure. Otherwise, interpretation of experimental data can be a surprisingly difficult task.

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