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Role of lipids in nanoscale membrane remodeling: from poration to nanoelasticity.

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The last century nobel-winning technique, patch-clamp, was designed and have been used for decades to resolve and characterize ionic current through individual protein channels. In its original form, the method utilizes a glass pipette with a submicron tip to localize a small patch of cellular membrane inside the tip and measure its electrical characteristics in real time. We use this highly localized and sensitive approach to characterize membrane remodeling at nanoscale. In line with its original purpose, we apply patch-clamp to resolve and quantify individual pores forming in biomimetic membranes during local rearrangements of lipid matrix. We characterize pore formation by the specific lipid mixtures containing lyso-lipids and cholesterol, and, recently, by lipid-coated carbon nanotubes. We also pioneered using nano-positioned patch-clamp pipettes for localized manipulations of membrane geometry, specifically, for production of short membrane nanotubes mimicking structural intermediates of membrane fusion and fission. We found that these nanotubes behave as "soft-wall" ionic channels whose conductance can be used to characterize nanoscale membrane mechanics as well as to quantify membrane remodeling by proteins. In this talk, I'll review the basic principles of the technique and our recent findings on the membrane permeation by carbon nanotubes and on the mechanisms of membrane remodeling by dynamin 1, the protein orchestrating membrane scission in endocytosis.

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