Membrane Mechanics in the Context of Living Cells

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Abstract:

Madin Darby canine kidney cells (MDCK II) grown to confluent monolayers respond to changes in membrane tension by adjusting their plasma membrane area. We show that a feedback machinery between plasma membrane tension and cellular area exists implying that epithelial cells detect and respond to deviations from a given membrane tension by creating or removing excess membrane area. Changes in membrane tension are evoked by external stimuli directed to the actin cytoskeleton (cytochalasin D), the contractile actomyosin cortex (blebbistatin), the plasma membrane lipid composition (methyl–β–cyclodextrin, MBCD), and the coupling of the actin filaments to the plasma membrane by building complexes of cellular PIP2 with microinjected neomycin. By means of site– specific AFM (atomic force microscopy)–indentation experiments in conjunction with membrane–tether pulling at the identical position, we were able to monitor changes in membrane tension and area compressibility in response to these stimuli reinforcing the idea that membrane tension is used as set-point to regulate cell morphology. The results are compared with site-specific indentation experiments of pore–spanning apical membranes showing that membrane mechanics governs the elastic response of living untreated MDCK II cells.

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