Mechanical signaling at the cell membrane

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Abstract:

Membrane tension affects cell migration, vesicle fusion and recycling, the cell cycle, cell signaling, and mechanosensation. The fluid-mosaic model posits a liquid-like plasma membrane, which can flow in response to tension gradients. It is widely assumed that membrane flow transmits local changes in membrane tension across the cell in milliseconds. This conjectured signaling mechanism has been invoked to explain how cells coordinate changes in shape, motility, and vesicle fusion, but the underlying propagation has never been observed.

In this talk, I will begin with showing how membrane tension controls membrane shape transition in a synthetic membrane system. Then, I will show that in biological membranes, propagation of membrane tension occurs quickly in cell-attached blebs but is largely suppressed in intact cells. The failure of tension to propagate in cells is explained by a fluid dynamical model that incorporates the flow resistance from cytoskeleton-bound transmembrane proteins. Perturbations to tension propagate diffusively, with a diffusion coefficient ~0.024 $\mu m^2/s$. Local increases in membrane tension lead only to local activation of mechanosensitive ion channels and to local vesicle fusion. Thus, membrane tension is not a mediator of long-range intracellular signaling, but local variations in tension mediate distinct processes in sub-cellular domains.