Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Membrane stress relaxation by transbilayer cholesterol exchange

MARK L. HENLE, L. MAHADEVAN, Harvard University — Fusion and fission events in the cell membrane play a crucial role in many biological processes, yet the mechanism for inducing the membrane bending deformations required for such events remains poorly understood. In particular, standard membrane elastic models predict a problematically high energy barrier for the strongly curved "neck" region formed during fusion and fission. These models assume that the exchange of lipids between membrane leaflets is negligible. While this is valid for phospholipids, other amphiphilic molecules such as cholesterol undergo rapid flip-flop between leaflets. Such exchange can relax bending stresses in the membrane: By flipping from the compressed to the expanded leaflet, cholesterol can reduce the energy required to bend the membrane. In this talk, we present a coarse-grained energetic model (derived from a simple microscopic description of the membrane) for a two-component lipid bilayer that contains a lipid species that can undergo rapid transbilayer exchange. Using this model, we show that lipid flip-flop dramatically reduces the energetic barriers encountered during membrane fusion and fission events and also plays an important role in determining the deformations induced by external forces such as osmotic pressure.

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Date submitted: 06 Dec 2010 Electronic form version 1.4