Understanding Surface Tension of Vesicles using Micropipette Aspiration Analysis

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Hybrid lipid vesicles are vesicles that integrate block copolymers into one or both leaflets of the vesicle's bilayer. By controlling the lipid:polymer ratio in each leaflet, asymmetric hybrid vesicles can be synthesized. Historically, asymmetric hybrid polymer lipid vesicles have been difficult to synthesize using self-assembly methods which limit the degree of asymmetry and stability of the hybrid vesicles. Asymmetry within the vesicle membrane is desirable because it affects the mechanical stability and permeability of the membrane. This feature is important to improving the utility of vesicles for encapsulation. We show that by using a microfluidics approach, we can tune the lipid:copolymer ratios in the different leaflets leading to stable asymmetric hybrid vesicles with an adjustable level of asymmetry at a high throughput. We demonstrate the ability of our vesicles to encapsulate a model cancer drug thereby marking them as a promising drug delivery system. Controlled heterogeneous or homogeneous domain formation at different lipid:polymer ratios were successfully produced. Via image analysis, mechanical properties were measured and may be used as models for lipid rafts which are present on cells. In this project, MATLAB was used to better understand the mechanical properties and behaviors of the vesicle walls.