Math 218 - Seminar on Mathematics for Complex Biological Systems

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Protein Organisation during Immune Cell Adhesion and Energy Barriers during Formation of Intraluminal Vesicles

Abstract:
I will present two examples of dynamic cell-membrane processes we have been working on, highly inspired by recent experimental results, and described by combining scaling, mathematical modelling and numerical simulations. i) Immunological synapse: The cellular basis for the adaptive immune response during antigen recognition relies on a specialized protein interface known as the immunological synapse. We propose a minimal mathematical model for the dynamics of the immunological synapse that encompass membrane mechanics, hydrodynamics and protein kinetics. Simple scaling laws describe the time and length scales of the self-organizing protein clusters as a function of membrane stiffness, rigidity of the adhesive proteins, and the fluid flow in the synaptic cleft. ii) Formation of Intraluminal Vesicles: The endosome is a membrane-bound compartment, which encapsulates cargo as it matures into a multi-vesicular body that regulate cell activity as well as enabling communication with surrounding cells. The cargo encapsulation process take place as Intraluminal Vesicles form at the endosome membrane, a process in part regulated by the Endosomal Sorting Complex Required for Transport (ESCRTs). We develop a membrane model including membrane elasticity, protein crowding (steric repulsions) and gaussian bending rigidity, which suggests that the vesicles form passively only needing to overcome a small energy barrier.

Hosts: Li-Tien Cheng, Bo Li, and Ruth Williams

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