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Mechanical mysteries of bio-membranes

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The membranes that form the boundaries of every cell and every organelle inside every cell are remarkable materials – flexible, two-dimensional, self-assembled fluids. Exploring the ways in which these physical characteristics guide the biological functions of membranes has yielded many fascinating insights in recent years. I'll describe two projects from my lab in the area of membrane biophysics. One relates to the trafficking of cargo in cells, which involves dramatic changes in membrane shape and topography. By tugging on membranes with optical tweezers to measure their mechanical rigidity, we've found that a key trafficking protein has the ability to lower membrane rigidity by up to 100% as a function of its concentration, thereby lowering the energetic cost of membrane deformation. The other relates to the fluidity of membranes. By carefully examining the Brownian motion of membrane-anchored nanoparticles, we have found that membranes are not simple "Newtonian" fluids, but rather are viscoelastic – a two-dimensional analogue of the entertaining grade-school staple of corn-starch and water. I'll stress in my talk the fascinating issues that invite exploration at the intersection of physics and biology, and some of the challenges involved in exploring them.