Matthew Hess

Major: Mechanical Engineering
University: University of Kansas
Faculty Mentor: Dr. Gabor Forgacs
Mentor Department: Physics & Astronomy
Funded by: NSF-REU Biosystems Modeling

Membrane tether formation studied with magnetic tweezers

Matthew Hess, Basarab Hosu and Gabor Forgacs

Membrane tethers are ubiquitous nanometer-diameter cylindrical extensions of biological membranes. They form through either active or passive processes, by locally acting tensional forces. The physical properties of membrane tethers depend on the viscoelastic properties of the biological membrane and its immediate surroundings, such as the cortical cytoskeleton in the case of the cell membrane. Tether formation is integral to such physiological processes as extravasation from the circulatory system of leukocytes as part of the inflammatory response or malignant cells during metastasis, as well as cell-to-cell communication. Quantifying the viscoelasticity of the membrane with characteristic biophysical parameters provides insight into these physiological processes. Using magnetic tweezers, we applied constant tensional forces to the plasma membrane through non-specifically attached magnetic beads. The physical response of the resulting tethers was analyzed in terms of standard viscoelastic models. This provided the characteristic biophysical parameters of the tethers. In order to identify the contribution of the cytoskeleton to tether formation, tethers were pulled before and after disrupting the cytoskeleton with Latrunculin A, an actin depolymerizing agent. Measurements were performed using Chinese Hamster Ovary (CHO) and Human Brain Tumor (HB) cells. The membrane of HB cells was systematically found to be less rigid and viscous than that of CHO cells, possibly reflecting the invasive potential of the cancerous cells.