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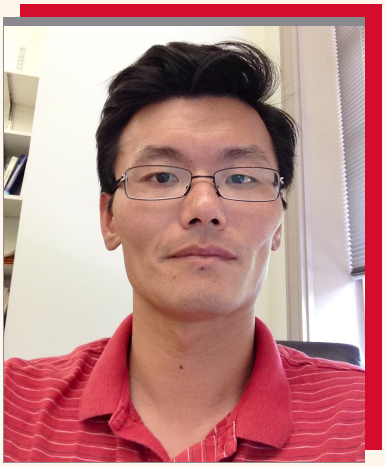
The Role of Water in Cell Mechanics and Cancer Metastasis



SEAN X. SUN

Associate Professor
Department of Mechanical Engineering
John Hopkins University
Baltimore, MD

ABSTRACT:

The lipid bilayer membrane of eukaryotic cells is directly permeable to water. Membrane proteins such as aquaporins can also rapidly passage water across the cell surface. Recent careful volume measurements during osmotic shock experiments show that cells can actively adjust its volume by adapting to external osmotic shocks. We mathematically analyze a mechanochemical system that controls cell pressure and volume in response to external perturbations. This system includes cytoskeletal dynamics, myosin contraction and active regulation of cellular osmotic content. We show that water permeation across the cell membrane is a major contributor to the slow phase of cellular mechanical response. Cell shape changes during division and morphogenesis, and cellular tension homeostasis also have significant contributions from water dynamics. A generalization of this system also explains electromechanical properties of cells. Lastly, we demonstrate that water permeation alone can drive cell motility in confined environments. This finding is significant for cancer cell motility in confined environments.

BIOGRAPHY:

Sean Sun received his PhD in theoretical chemistry from UC Berkeley. After a postdoctoral fellowship in the Lab of George Oster, he joined Johns Hopkins University in 2003, where he is currently an Associate Professor. Dr. Sun is interested in quantitative modeling in cell biology and mechanics of cells and tissues. He is especially interested in mechanochemical processes in biology. Dr. Sun is a recipient of the NSF CAREER award and Alexander von Humboldt Award for Experienced Researchers.