



Department of Mechanical Engineering

Presents

MechanoBiology Models: From Silk Materials to Cellular Mechanotransduction

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4:00 -- 5:00 p.m.

3110 Etcheverry Hall*

Coffee & Cookies will be served.

*ABSTRACT *

**The ongoing fusion of mechanical engineering with biomedical applications has enabled the probing of complex biological systems from an engineering perspective and has cast a detailed light on the underlying biological mechanisms. In this talk we will examine the symbiotic relationship between numerical and biological models in order to better understand biomedical processes. Specifically, we will focus on three examples: spider silk fiber spinning, electrogelation of an aqueous silk-protein solution, and mechanotransduction of compressive forces in the asthmatic airway. In the first example, water removal inside the spider's spinning canal is central to creating the intricate internal structure of silk fibers - resulting in their unsurpassed mechanical properties. During the process of electrogelation, the formation of a silk-protein hydrogel out of an aqueous solution in the presence of an electrical current is controlled by local pH changes. Lastly, the transduction of mechanical loads by airway epithelial cells, important in a disease such as asthma, involves changes in the concentration of extracellular proteins being transmitted into intracellular biochemical signals that influence cell behavior. In each of these cases, a finite-element transport model has been developed: water diffusion through spider silk, electro-diffusion of ions through an aqueous silk solution, and protein diffusion-convection in the extracellular space. The transport models were directly coupled to experimental observations and provided an important missing link in elucidating the governing mechanisms. The presented biocomputational models, existing at the interface of engineering and biology, serve as

initial steps towards a deeper understanding of an area with significant potential to yield important scientific and medical advancements.

BIOGRAPHY

Nikola Kojic received an MD from Harvard Medical School in 2009 and a PhD in Biomedical Engineering from the Harvard-MIT Division of Health Sciences and Technology in 2007. In 2003 he obtained an MS in Mechanical Engineering from MIT and in 2000 received a BS in Mechanical Engineering from the University of California, Berkeley. He was also awarded the Asher Shapiro Fellowship in Fluid Mechanics from MIT's Mechanical Engineering. His doctoral research was conducted in the Harvard Airway Mechanobiology Lab and focused on cellular mechanotransduction pertaining to asthma. Currently, Dr. Kojic is a Postdoctoral Research Associate in the Biomedical Engineering Department at Tufts University where he is numerically and experimentally exploring bioengineering applications of silk-based biomaterials. Dr. Kojic's publications include co-authorship of the textbook Computer Modeling in Bioengineering: Theoretical Background, Examples and Software, a book chapter in CellularMechanotransduction: **Diverse Perspectives from Molecules to Tissues, and 10 peer-reviewed journal articles.

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