NU Mechanical and Industrial Engineering Colloquium Series – Spring 06

FRIDAY Jan 26, Egan Research Center 306

PROGRAM

10:45 - 11:00 a.m. Tea, Coffee and Treats
11:00 - 11:45 p.m. Lecture (typical)
11:45 - 12:00 p.m. Q&A and Discussion

ABSTRACT

It is a common misunderstanding that theoretical solid-mechanics and empirically-driven life-sciences are mutually exclusive disciplines. The communities of engineering and biomedical sciences can in fact complement one another and bridge the chasm. Incorporating exact engineering principles such as thermo-visco-elasticity and thermodynamics into biological sciences nurtures cross-pollination and even facilitates exploration into uncharted regimes. The trans-disciplinary investigations also open new grounds for mechanical engineers. This seminar will exemplify *Life-Science based Solid-Mechanics* and *Nano-Bio-Mechanics* by (i) embryology and artificial insemination, (ii) stem cell chondrogenesis and tissue engineering, and (iii) ophthalmology and ocular lenses. A new bio-MEMS is constructed for Intra-Cytoplasmic Sperm Injection (ICSI), a method of artificial insemination for mouse eggs (oocyte). A rigorous solid-mechanics model is constructed to extract the materials properties of the glycoprotein shell before and after fertilization. We published the first time in literature the quantitative measurement of elastic modulus and piercing force of mouse oocyte wall, and their drastic increase as a consequence of fertilization. The new technique is capable of further delving into the mechanical aspects of embryology, developmental biology morphogenesis, and their relation to biochemistry. Adhesion of a single cell onto a biological substrate or a neighboring cell is the basics of tissue engineering. New mechanics model is constructed to elucidate intercellular adhesion, multi-cell aggregation, and formation of 2-D and 3-D tissues. Some aspects of the theory are in fact empirically verifiable and bear medical significance. The theoretical framework is further extended to drug delivery microcapsules of liposome. The viscoelastic behaviors of human ocular lenses as a function of ageing are important engineering parameters to understand the natural accommodation mechanics in vision and patho-physiology such as presbyopia and cataract. Static and cyclic loading of porcine and human lenses are carried out in our laboratories. Opto-mechanical models are constructed to account for the concerted deformation of the uniformly distributed nano-scale lens fibers and the encapsulating lens capsule during accommodation. Besides natural lenses, the new techniques enhance the chemical development of hydrogels and new implant technology for cataract lenses.

SEMINAR TITLE

"The Challenge of Solid-Mechanics of Soft Biological Tissues"

SEMINAR SPEAKER

Professor Kai-tak Wan,

Mechanical Engineering,

Chemical and Biological Engineering

University of Missouri, Rolla

BIOGRAPHIC PROFILE

Dr. Kai-tak Wan earned his B.Sc. (1st Hon) in Physics from University of New South Wales (Australia) in 1988, and Ph.D. in Chemical Physics from University of Maryland at College Park. Since 2002, he has been working at University of Missouri-Rolla. Dr. Wan worked at NIST, University of Sydney (Australia), Hong Kong University of Science and Technology, Nanyang Technology University (Singapore), and Virginia Tech. He has published over 50 peer-reviewed journal papers on topics such as thin film mechanics, phospholipids vesicle mechanics and adhesion, and membrane biomechanics.

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