Mechanical Engineering SEMINAR

Solid-mechanics in Biological Sciences

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Solid-mechanics can make significant contributions to the by and large empirically driven life-sciences and biomedical sciences, though it is conventionally thought to be mutually exclusive discipline. Incorporation of engineering principles into biology promotes cross-pollination and even facilitates exploration into uncharted regimes. This seminar focuses on several 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 bio-MEMS is constructed for Intra-Cytoplasmic Sperm Injection (ICSI) in a mouse egg (oocyte). A solid-mechanics model is built to extract the materials properties of the glycoprotein shell before and after fertilization. We published the first time in literature the quantitative measurement of the elastic modulus and piercing force of oocyte wall, and their drastic changes as a consequence of fertilization. The technique leads to new understanding of the mechanical aspects of embryology and developmental biology.

Adhesion of a single cell onto a biological substrate or an apposing cell is the basics of tissue engineering. Mechanics models are constructed to elucidate intercellular adhesion, multi-cell aggregation, formation of 2-D and 3-D tissues, coagulation of biomimetic microcapsules and bacteria. It is interesting to note that part of the theoretical models is applicable to nano-structures and membranes (e.g. graphene).

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 nano-scale lens fibers and the encapsulating lens capsule during accommodation. The new characterization techniques enhance the development of prosthetic hydrogels and implant technology for cataract lenses.

Dr. Kai-tak Wan received his BSc (1st Hon) in Applied Physics from the University of New South Wales (Australia) and PhD in Chemical Physics from the University of Maryland at College Park. He worked at National Institute of Standards and Technology (NIST), Virginia Tech, and University of Sydney (Australia). He published over 55 peer-reviewed journal papers. Dr. Wan received NSF-Career Award from the Nano- & Bio-Mechanics Program in 2006.

Thursday, March 5, 2009
11:00-12pm Seminar in 233 Mudd
Lunch served at 12pm in MECE lobby