WINTER 2004
F21C/Food Science & Engineering Unit
SEMINAR SERIES

PRESENTER: DR. KAI-TAK WAN, MECHANICAL ENGINEERING, UNIVERSITY OF MISSOURI-ROLLA, ROLLA, MO Dr. Kai-tak Wan graduated in Chemical Physics from University of Maryland in 1993. After a 2-year post-doctoral research at University of Sydney and Hong Kong University of Science and Technology, he joined Nanyang Technological University in Singapore as Associate Professor of Mechanical Engineering. He was a visiting professor at Virginia Tech from 2001 to 2002, before joining the mechanical engineering department at University of Missouri-Rolla.

TITLE, ABSTRACT: MULTISCALE MECHANICAL MODELING FROM A SINGLE BIOLOGICAL CELL TO A MULTI-CELL AGGREGATE / TISSUE We measured in-situ the elastic modulus and piercing strength of the Zona Pallucida (cell membrane) of a mouse egg before and after in-vitro-fertilization (IVF) using a bio-MEMs device and an atomic force microscope (AFM), and reported the first time in literature the drastic change of mechanical behavior as a result of embryonic activities. A new solid mechanics model was constructed to include both bending and stretching of the ultra-thin membrane and residual stresses based on classical linear elasticity and viscoelastic rubber elasticity. The theory superceded the existing models of pure film bending and pure membrane stretching in the literature.

The new cellular biomechanics model was further extended to include cell-cell and cell-substrate adhesion. A series of experiments were conducted using liposomes of various phospholipid bilayers and treated glass surfaces as model cells and substrates respectively. Using our newly developed HR-RICM method (high resolution reflection interference contrast microscopy), the interfacial adhesion was measured to increase drastically by 2 orders of magnitude at a transition temperature of 37oC. The new adhesion model is currently used to investigate cell aggregation and thus the formation of 2-dimensional tissues / 3-D organs, aiming to establish the transition of the hierarchical mechanical behavior from micro- to macro scale and their inter-relationships. A new axisymmetric punch method and the related force sensing equipment were recently built to measure simultaneously the mechanical and adhesion parameters of an ultra-thin bio-membrane. The related mechanical model was constructed and experimentally verified. The new methods and theories will enhance the understanding of embryonic activities, morphogenesis, specific and non-specific adhesion of cells, stem cell condensation, and cancer research. There are also significant implications in the mechanical and adhesion behaviors of nano-structures (e.g. bucky balls and graphene sheets).

Tuesday, March 16, 2004, **4:00pm,** AG ENGR Bldg. 105

Refreshments Will Be Served