Atomic Force Microscopy for Nanoscale Biophysical Studies and Nanomedicine

Ratneshwar Lal, Ph. D.

Professor of Mechanical/Aerospace and Bioengineering University of California, San Diego Jacobs School of Engineering

Date: Friday, April 1st, 2011
Time: 11:00 am-12:30 pm
Location: ENB 109

Note : After the talk Dr. Lal will briefly discuss NIH related funding evaluation and reviews

Nanomedicine is intricately linked to nanoscience and technology and spans all areas of human health management. The scope of nanomedicine include learning about the physicochemical properties of biomacromolecules, cells and sub-cellular structures, investigating molecular machines and their interactions with other machines and its environment, and creating tissues/organs from understanding biological systems at the most basic molecular scale. The aim of my presentation will be to discuss the contribution of scanning probe techniques, especially atomic force microscopy in Nanomedicine and its three components: nanodiagnositics, nanotherapeutics, and bio-nanodevices. Specific areas that I will discuss include:

- Development of Integrated multimodal "SMART AFM" and its application that has provided new paradigms for our understanding of protein misfolding diseases, and to diseases arising from environmental and life choices. The integrated multimodal AFM that we have developed over a years of collaborative research combines AFM, Optical Tweezers, double chamber electrical recording, chip-based TIRF and FRET and microfluidics and provides versatile nanotools for multiscale (nano-to-system), multimodal (structural, physicochemical properties and functional) and multidimensional study of living biological systems.
- Development of integrated cantilevered microarrays, TIRF, microfluidics and nanoelectronics-based parallel sensors. This allows high throughput and rapid diagnosis of pathogens, allergens and many biomarkers for cancer, asthma and other diseases as well as for therapeutics design
- Development and characterization of nanocarrier-based drug delivery, including nano liposomes and nanoparticles. This allows high efficiency *in vivo* or topical administration of small dosage of therapeutics with low side effects. Multimodal AFM plays a significant role in their characterization.

Professor Lal received his MS and Masters of Philosophy in Physics and Biophysics from JNU in New Delhi and his Ph.D. in Neurobiology from the University of Alabama. After postdoctoral training at Caltech, he was a faculty member at the University of Chicago and the University of California at Santa Barbara. Before assuming his current position at UCSD, he was a Professor and the Director of the newly established Center of Nanomedicine at the University of Chicago

Professor Lal is an authority on biomedical applications of atomic force microscopy (AFM) and nanoscale imaging of complex biological systems. Research in his lab involves the development of nanotechnologies for and multi-scale biophysical and system biology studies of channels and receptors. His lab also designs nanosensors and devices for biomedical diagnostics and therapeutics. Current projects include i) structure-function study of hemichannels in heart, breast and liver, ii) structure-function study of amyloid ion channels in degenerative diseases, iii)) nanomechanical properties, cytoskeletal organization and sustenance of normal and abnormal cells, iv) designing multimodal "Smart AFM" integrating AFM, Optical Tweezers, electrical recording, and single molecule microscopy, and v) designing nanodevices and BioMEMs for array-based screening of therapeutics and their delivery and tissue engineering. He has presented many international keynote lectures and his work has featured in many popular magazines and news media, including Time, Smithsonian and UPI. Professor Lal was the UTS Invited Professor in Sydney for their BioNanotechnology initiative and a New Zealand Government International Science Scholar. Professor Lal is on advisory board of several entrepreneurial companies, including RC Nano LLC and Be Green Packaging LLC. Professor Lal is an Associate Editor of the journal *Nanomedicine: Nanotechnology, Biology and Medicine* and serves on the NIH Nano study section. In addition to seminal research publications in the field of nanomedicine, Dr Lal holds several patents based upon AFM cantilever arrays, microfluidics, optoelectronics and nanotubes for medical diagnostics and medical nanodevices, nanoscale fluid behavior and new TIRF, FRET and related optical microscopy.

Jointly Sponsored by: Nanotechnology Research & Education Center & USF Nanomedicine Research Center