2014 PROGRAM

8 AM REGISTRATION & CONTINENTAL BREAKFAST
Gallery, W.T. Young Library

8:45 AM WELCOME
Dr. Eli Capilouto, University of Kentucky President
Auditorium, W.T. Young Library

9 AM DR. HAO YAN
Arizona State University
Designer Architectures for Programmable Self-assembly

The central task of nanotechnology is to control motions and organize matter with nanometer precision. To achieve this, scientists have investigated a large variety of materials including inorganic materials, organic molecules, and biological polymers as well as different methods that can be sorted into so-called "bottom-up" and "top-down" approaches. Among all of the remarkable achievements made, the success of DNA self-assembly in building programmable nanopatterns has attracted broad attention. In this talk I will present our efforts in using DNA as an information-coding polymer to program and construct DNA nano-architectures with complex geometrical features. Use of designer DNA architectures as molecular sensor, actuator and scaffolds will also be discussed.

10 AM BREAK & REFRESHMENTS

10:30 AM DR. DONALD E. INGBER
Harvard University
From Cellular Mechanotransduction to Biologically Inspired Engineering

In this lecture, I will describe the fundamental role that mechanical forces play in control of cell and tissue development, as well as how this knowledge is being leveraged to engineer new bioinspired materials and devices. Living cells form and function as dynamic hierarchical assemblies of nanometer scale components, yet they exhibit great robustness, mechanical strength and biochemical efficiency. This is possible because they use 'tensegrity' architecture to mechanically stabilize their internal molecular scaffolds, which also orient most of the cell's biochemical processing machinery. This structural perspective has led to new insights into the molecular basis of cellular mechanotransduction – the process by which living cells sense mechanical forces and convert them into changes in intracellular biochemistry. It also has led to the creation of human "organ-on-a-chip" microdevices that recapitulate the complex structures and functions of living organs, which represent powerful new in vitro tools for modeling human physiology and disease.

11:30 AM LUNCH

1:30 PM POSTER SESSION
Ballroom, King Alumni House

2:30 PM DR. TODD YEATES
University of California Los Angeles
Giant Protein Cages and Assemblies in Nature and by Design

Nature has evolved myriad sophisticated structures based on the assembly of protein subunits. Many types of natural protein assemblies (such as virus capsids) have been studied extensively, while a number of equally sophisticated natural protein assemblies are only beginning to be appreciated. Among the latter group is a broad class of giant, capsid-like assemblies referred to as bacterial microcompartments. They serve as primitive metabolic organelles in many bacteria by encapsulating sequentially acting enzymes within a selectively permeable protein shell. Our laboratory has elucidated key mechanisms of these protein-based bacterial organelles through structural studies. On the engineering side, sophisticated natural protein assemblies like these have for many years represented an ultimate goal in protein design. By exploiting principles of symmetry that are shared by nearly all natural self-assembling structures, we have developed methods for engineering novel proteins that assemble to form a variety of complex, symmetric architectures. Recent successful designs include hollow protein cages composed of 12 or 24 identical subunits in cubic arrangements. Symmetric materials that extend by growth in two or three dimensions are also possible. Natural and engineered protein assemblies will be discussed, along with their future prospects for synthetic biology and biomedical applications.

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40TH ANNUAL SYMPOSIUM ON CHEMISTRY & MOLECULAR BIOLOGY

ESTABLISHED BY M. BENTON NAFF
IN MEMORY OF ANNA S. NAFF

COMPLEXITY AND SELF ASSEMBLY

FRIDAY, APRIL 25, 2014

SPEAKERS:
DR. HAO YAN
DR. DONALD INGBER
DR. TODD YEATES

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF KENTUCKY
LEXINGTON, KY 40506-0055

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PRESENTS

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COMPLEXITY AND SELF-ASSEMBLY

Hao Yan is the Milton D. Glick Distinguished Professor in Chemistry and Biochemistry and Director of the Center for Molecular Design and Biomimicry in the Biodesign Institute at Arizona State University. Hao Yan studied chemistry and earned his bachelor's degree at Shandong University, China. He obtained his Ph.D. in chemistry under Professor N. C. Seeman at New York University in 2001, working on design and construction of sequence dependent DNA nanomechanical devices. He then moved to the Computer Science Department at Duke University, where he continued to explore his interests in DNA based molecular computing and programming. He joined Arizona State University as assistant professor in the Department of Chemistry and Biochemistry in 2004. In 2008, he was promoted with early tenure directly to full professor. The focus of his research is to use nature's design rules as inspiration to advance biomedical, energy-related, and other technological innovations through the use of self-assembling molecules and materials. He aims to create intelligent materials with better component controls at the molecular level. He is leading an interdisciplinary team to design bio-inspired molecular building blocks and program their higher order assembly into systems that will perform complex functions. Dr. Yan has published more than 130 papers and has received honors including the Rozenberg Tulip Award in DNA Computing, Alfred P. Sloan Research Fellowship, NSF Career Award, AFOSR Young Investigator Award.

Donald Ingber is the Founding Director of the Wyss Institute for Biologically Inspired Engineering at Harvard University, the Judah Folkman Professor of Vascular Biology at Harvard Medical School and Boston Children's Hospital, and Professor of Bioengineering at the Harvard School of Engineering and Applied Sciences. He received his B.A., M.A., M.Phil., M.D. and Ph.D. from Yale University. Dr. Ingber is a founder of the emerging field of biologically inspired engineering, and at the Wyss Institute, he oversees a multifaceted effort to identify the mechanisms that living organisms use to self-assemble from molecules and cells, and to apply these design principles to develop advanced materials and devices for healthcare and to improve sustainability. He also leads the Biomimetic Microsystems platform in which microfabrication techniques from the computer industry are used to build functional circuits with living cells as components. His most recent innovation is a technology for building tiny, complex, three-dimensional models of living human organs, or "Organs on Chips," that mimic complicated human functions as a way to replace traditional animal-based methods for testing of drugs and establishment of human disease models. In addition, Dr. Ingber has made major contributions to mechanobiology, tissue engineering, tumor angiogenesis, systems biology, and nanobiotechnology. He was the first to recognize that tensegrity architecture is a fundamental principle that governs how living cells self-organize themselves to respond biochemically to mechanical forces, and to demonstrate that integrin receptors mediate cellular mechanotransduction. Dr. Ingber has authored more than 375 publications and 85 patents, and has received numerous honors. He also serves on the Board of Directors of the National Space Biomedical Research Institute, and is a member of both the American Institute for Medical and Biological Engineering, and the Institute of Medicine of the National Academies.

Todd Yeates is a Professor of Chemistry and Biochemistry at the University of California, Los Angeles. He earned his bachelor's degree at UCLA in 1983. He stayed on at UCLA and earned his Ph.D. in 1988. There he helped determine the crystal structure of the bacterial photosynthetic reaction center as part of a team racing to determine the first crystal structures of membrane proteins. He then moved to The Scripps Research Institute to do his postdoctoral research on the structure of poliovirus with Prof. James Hogle. Yeates returned to UCLA in 1990 to join the faculty in the Department of Chemistry and Biochemistry. His interdisciplinary research, combining molecular biology with computing and mathematics, has focused on macromolecular structure and computational genomics. His varied research findings include: an explanation for why proteins crystallize in certain favored arrangements; the development of new equations for detecting disorder in x-ray diffraction data from protein crystals; the discovery of thermophilic microbes rich in intracellular disulfide bonds; development of comparative genomics methods; development of designed protein cages or 'nanohedra'; the discovery of novel topological features such as links and slipknots that stabilize thermostable proteins; and elucidation of the structure of the carboxysome shell and the shells of other bacterial microcompartments, which serves as primitive metabolic organelles inside many bacterial cells. Yeates is a member of the Molecular Biology Institute, the California Nanosystems Institute, the UCLA-DOE Institute of Genomics and Proteomics, and a Fellow of the American Association for the Advancement of Science. He has published approximately 150 research papers.

For additional information, contact Professor Jason DeRouchey at derouchey@uky.edu.

2014 Committee: Professor Jason DeRouchey, Chair
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