Feb 1, 2010 10:40 AM 1011 EB1	**Dr. Nancy Allbritton** Department of Biomedical Engineering - NC State/UNC-CH

Analysis and Separation of Cells using Microfabricated Devices

The separation of single or small groups of cells from within a heterogeneous population is a fundamental need in almost all areas of biomedical research. This effort is required in order to obtain unique cells possessing a desired characteristic for genetic studies, cloning, or other applications.

Despite recent technological advances, selection and isolation of individual or small groups of live cells from a population remains a signicant challenge. Most live-cell separation methods require that cells be dispersed into a single-cell suspension, but removal of adherent cells from their growth surface may at times be undesirable.

A microfabricated cell array platform composed of releasable elements in combination with an integrated laser microscope system has been developed for analyzing, sorting and collecting viable cells from a mixed population while the cells remain adherent to their growth surface. The individual polymeric elements containing single cells or colonies can be released and collected with minimal perturbation.

Studies have shown that adherent cells cultured on the array can be analyzed and selected using standard imaging methods. Furthermore, target cells can then be collected with high viability and efficiently cloned. Benefits of this new approach include improved cell viability, smaller sample size requirements, and broader alternatives for cell selection.

Mating of the technique with image cytometry can be expected to provide a high-throughput tool for selection and isolation of adherent cells for biomedical and pharmaceutical applications.

Feb 3, 2010 10:40 AM 1011 EB1	**Dr. Ashley Smart** California Institute of Technology

Linking Form and Function in Complex Systems: From Granular to Metabolic Networks

In many systems complexity arises from an interdependence between form and function. On one hand, components of a complex system organize in some nontrivial way as a result of interaction rules, with these rules ultimately determining the system's shape and topology. On the other hand, the system's shape and topology affect its ability to carry out prescribed tasks.

The result is that even if the individual components can be completely characterized (a rarity in itself), it is still difficult to predict behaviors of the bulk. The emerging field of complex networks is helping to unravel some of the mystery underlying the behavior of these systems, for example, social networks, automobile and air transit networks, and economies.

Here we discuss form-function relationships in a pair of examples relevant to engineering, one from physical sciences, the second from biology. In the first example we consider conduction in granular media, a problem characterized by highly heterogeneous but correlated stress distributions that occur naturally in granular packings and play a key role in transport.

In the second example, we consider effects of network topology on robustness of cell metabolism. Using simple flux balance constraints, we describe metabolic failure as a percolation process that depends significantly on network structure and can be modeled, to some extent, analytically.

In both cases we uncover compelling, quantitative evidence of the impact of form on system functionality by drawing from tools of complex networks analysis.

Feb 8, 2010 **10:40 AM** **1011 EB1**	**Dr. Chekesha Liddell** Cornell University

Anisotropic Soft Materials Structures for Photonics

Controlling light-matter interactions with materials structured at micron and submicron length scales has been predicted as the basis for enhancements in the performance of a range of technologies, including photovoltaics, sensors and solid state lighting devices. However, the types of thermodynamically stable structures from building blocks such as colloidal spheres with simple interactions are limited.

This talk will highlight our investigations of how particle shape programs the self-organization of colloidal structures from 'mushroom cap'-shaped particles. We find the mushroom caps to adopt a series of high density packings commensurate with the confinement height in a multilayer sequence structure.

The ideal density of each phase at the minimum geometrically allowed height was calculated and used to rationalize the stability range of each structure observed. The mushroom cap particle geometry has associated projection profiles of anisotropic and isotropic systems simultaneously.

Thus, features of both systems are apparent in their phase behavior and they provide an expanded range of phases over spheres or the rod-like dimer cases. Optical property simulations for unconventional structures with nonspherical particle bases will also be discussed.

Feb 15, 2010 **10:40 AM** **1011 EB1**	**Dr. Lingchong You** Department of Biomedical Engineering - Duke University

Engineering bacterial population dynamics

Synthetic biology, or de novo engineering of synthetic gene circuits, may impact broad areas including energy, medicine, and computation. It may also provide insights into fundamental biological "design" principles.

In this talk, I will describe ongoing efforts in my lab to program cell populations using engineered cell-cell communication, as a way to learn basic biology and to lay the foundation for practical applications.

Feb 22, 2010 **10:40 AM** **1011 EB1**	**Dr. Victor Agreda** Eastman Chemical Company

Process Intensification (PI) at Eastman Chemical Company

An overview of industrially relevant aspects of the chemical engineering field of Process Intensification (PI) is given. PI is defined, basic PI methods and tools discussed, and three examples of PI at Eastman are reviewed.

Methyl Acetate via Reactive Distillation is the main example and is covered in detail. High level results of PI work on Polyethylene Terephthalate and Syngas Production from Solid Fuels are also reviewed.

Mar 8, 2010 10:40 AM 1011 EB1	**Dr. William Reichert** Department of Biomedical Engineering - Duke University

Endothelial and neural progenitor cells as tools

In two separate research activities progenitor cells have emerged as playing central reparative roles. We have recently isolated late out growth endothelial progenitor cells from the peripheral blood of adults with coronary artery disease.
With the intent of employing EPCs as an autologous endothelialization source, we have shown that these cells express all of the characteristic markers of healthy human aortic endothelial cells. Currently, we are sodding EPCs into the luminal surface of small diameter ePTFE vascular grafts for animal implantation.
In a separate study of an in vitro reactive gliosis model, we found that three factors were necessary to obtain a robust cellular response to neuroelectrode materials: serum, bFGF and media conditions that promote neural progenitor cell growth. This suggests that NPCs that differentiate to reactive astrocytes may be more important in initiating gliosis than are resident astrocytes that activate and migrate to the site of injury.

Mar 22, 2010 10:40 AM 1011 EB1	**Dr. Elaine Cohen-Hubal** Environmental Protection Agency

Exposure Science for Chemical Risk Management

Globally there is a need to characterize potential risk to human health and the environment that arises from the manufacture and use of tens of thousands of chemicals. A new generation of scientific tools has emerged to rapidly measure signals from cells, tissues, and organisms following exposure to chemicals.
High visibility efforts to apply these tools for efficient toxicity testing raise important research questions and opportunities in the field of exposure science. Exposure information is required to link information on potential toxicity of environmental contaminants to real-world health outcomes.
As we move forward to implement this new vision for toxicity testing, a transformational change in exposure science is also required. Application of novel techniques to capture critical determinants at biologically-motivated resolution for translation from controlled in vitro systems to the open, multifactorial system of real-world human-environment interaction will be critical.
Development of an exposure ontology and knowledgebase will facilitate extension of network analysis to the individual and population for translating toxicity information and assessing health risk. Such a sea change in exposure science is required to incorporate consideration of lifestage, genetic susceptibility, and interaction of non-chemical stressors for holistic assessment of risk factors associated with complex environmental disease.

Mar 29, 2010 10:40 AM 1011 EB1	**Dr. Edward Samulski** Department of Chemistry UNC-CH

Photonic Crystal Geometry for Organic Solar Cells

We report organic solar cells with a photonic crystal nanostructure embossed in the photoactive bulk heterojunction layer, a topography that exhibits a 3-fold enhancement of the absorption in specific regions of the solar spectrum in part through multiple excitation resonances.

The photonic crystal geometry is fabricated using a materials-agnostic process called PRINT wherein highly ordered arrays of nanoscale features are readily made in a single processing step over wide areas (4 cm2) that is scalable. We show efficiency improvements of ~ 70% that result not only from greater absorption, but also from electrical enhancements.

The methodology is generally applicable to organic solar cells and the experimental findings corroborate theoretical expectations.

Apr 9, 2010 2:00 PM 3018 EB1	**Dr. Clifford L. Henderson** Georgia Institute of Technology

Manufacturing Organic Nanostructures & Their Unusual Properties

The ability to form high resolution two dimensional and three dimensional structures in various organic materials is a critical and enabling technology in a wide variety of modern applications. There are numerous challenges moving forward in the development of materials and methods for forming such nanoscale organic structures at smaller dimensions. The first part of this talk will review our recent work to elucidate the magnitude, scaling, and underlying causes of such physicochemical property changes in polymeric materials. In particular, the diffusion behavior and mechanical property behavior of polymer ultra-thin films and nanostructures will be discussed, and the implications of such property changes on current nanomanufacturing techniques such as high resolution optical lithography will be discussed.

The second half of the talk will highlight some of our recent breakthroughs in this area and show how such structure-property models can be used to rapidly perform de novo design and screening of organic molecular resists, thus greatly enhancing the material discovery process.

In order to overcome many of the challenges associated with lithographic nanomanufacturing using polymers, our group has also recently been pioneering the use of positive and negative tone organic molecular resists. To aid in that material design and processing effort, we have developed a number of structure-property relationship models based on common chemistry and chemical engineering principles.

Apr 12, 2010 10:40 AM 1011 EB1	**Dr. James McClain** Micell Technologies

Design, Fabrication and Pre-clinical Evaluation of a Novel Drug-eluting Stent

Drug-eluting stents (DES) have become a standard of care for the treatment of coronary artery disease. While generally effective, future generations of DES should offer greater safety by optimizing the stent's drug-delivery coating to provide the most effective structure for long-term healing.

Micell Technologies (www.micell.com), founded in 1996 based on supercritical fluid (SCF) technologies discovered at UNC-Chapel Hill, NC State and Pacific Northwest National Laboratory, is focused on developing a novel DES that may be safer to patients without compromising the clinical efficacy of today's best devices.

The entrepreneurial efforts of developing a novel DES based on SCF technologies will be presented. The coating process and product specification have been optimized to provide a multi-laminate rapidly absorbing DES coating formulation.

Specific performance-enabling features include: (1) delivery of sirolimus to coronary artery tissue at the site of implant (2) in a manner wherein drug distribution is less dependent on strut support (3) for a sustained period, controlled by crystalline sirolimus formulation, and (4) with concurrent polymer absorption and drug-delivery that protects the artery from inherently inflammatory polymer absorption products.

The MiStent DES has been tested with in vitro and pre-clinical animal models demonstrating high local tissue concentrations of sirolimus, sustained drug delivery and favorable tissue response.

Apr 19, 2010 10:40 AM 1011 EB1	**Dr. Stephen Craig** Department of Chemistry - Duke University

Mechanically Adaptive Polymers

The structural materials of biology often adjust their composition and properties in response to their mechanical environment. This talk will present recent work that is driven by the desire to install new mechanically-triggered adaptive properties in synthetic polymers and composites.

Two strategies are being pursued, and they are united by the incorporation of molecules that "sacrifice" themselves either reversibly or irreversibly under a critical load. These studies have led to polymer properties that are often counterintuitive, including: (1) polymers that develop structural integrity under forces that break covalent bonds; (2) molecules that get shorter when they are pulled; and, (3) polymer gels that get stronger when strong bonds are replaced with weak bonds.

Apr 26, 2010 10:40 AM 1011 EB1	**Dr. Jay Lewis** Research Triangle Institute

Organic and Flexible Electronics

Organic and flexible electronics promise a new generation of electronic and optoelectronic devices that offer lower weight, higher performance, improved ruggedness, and lower cost. It has become clear that the most promising applications for organic and flexible electronics are those where devices do not compete directly with traditional alternatives, but rather provide new functionality that leverages the benefits of this technology.

RTI has been involved in organic and flexible electronics research for nearly a decade, and this seminar reviews some of these activities. We discuss the benefits to oxide-metal multilayer structures in providing more robust transparent conductors, and some of the concerns with mechanical testing. We discuss the use of infrared-absorbing quantum dots for photodetector applications, and will describe the development of an all-printed sensor structure including micron-scale electrode gaps formed by inkjet printing.

Finally, we will describe the integration of flexible, ultra-thin silicon with polymeric substrates to provide high performance, CMOS functionality in a flexible form factor.

May 3, 2010 10:40 AM 1011 EB1	**Dr. Michael Shuler** Cornell University

Using Biochemical Engineering Ideas For In Vitro Drug Evaluation

We seek to understand the response of the human body to various pharmaceuticals. Our platform technology is an in vitro system that combines microfabrication and cell cultures and is guided by a computer model of the body. We called this in vitro system a micro cell culture analog (microCCA) or a “Body-on-a-Chip”.

A microCCA device contains mammalian cells cultured in interconnected micro-bioreactors to represent key body organs linked through the circulatory system and is a physical representation of a physiologically based pharmacokinetic model. MicroCCAs can reveal toxic effects that result from interactions between organs as well as provide realistic, inexpensive, accurate, rapid throughput toxicological studies that do not require animals.

Multidrug resistant (MDR) cancer often occurs after initial success with a chemotherapeutic drug. Here we test a possible combination cancer treatment using a chemotherapeutic drug, doxorubicin, and two MDR suppressors (cyclosporine and nicardipine).

The microCCA shows an unexpected synergistic response to certain drug combinations not observable in traditional assay systems. The toxic response is selective to the MDR resistant cancer cells; the MDR suppressors do not alter toxicity in the “bone marrow” compartment.

We have also used a microCCA to test potential combination therapies for colon cancer. Simple microwell plates cannot probe this system, but the microCCA predicts the types of responses observed experimentally. We have coupled these body modules with a micro model of the GI tract to examine the response to oral exposure of drugs, chemicals, or nanoparticles.