Jan 9, 2015 10:40 AM Room 2207 EB3	**Dr. Albert Keung** Boston University

Synthetic Chromatin Biology

As we confront challenges in biology, medicine, and biotechnology there are exciting opportunities to develop synthetic approaches in eukaryotic organisms including yeast, plants, and mammals. A central feature distinguishing eukaryotes from prokaryotes is the packaging of eukaryotic DNA into chromatin, a polymeric scaffold comprised of a constellation of proteins, DNA, and RNA. Chromatin's rich structure gives rise to unique gene regulatory behaviors and underlies its relevance in diverse cellular processes from stem cell differentiation to viral latency. New technologies to control chromatin would advance our understanding of chromatin biology and our ability to treat many disease states. Yet, so far there have been few ways to synthetically read, write, and manipulate chromatin. Addressing this, I will describe a comprehensive, large-scale library of synthetic proteins that site-specifically controls chromatin states in the yeast, *S. cerevisiae*. Recruitment of these synthetic chromatin regulators to custom genetic reporters reveals diverse regulatory behaviors including: 1) two-input logic; 2) long-range regulation; 3) asymmetric spatial regulation; and 4) gene expression memory. Just as synthetic biology built a conceptual and experimental framework around the manipulation of DNA sequences, new systems to control and harness chromatin will deepen our understanding of eukaryotic cells and provide a powerful layer of regulation for biomedical and biotechnology applications.

Jan 12, 2015 10:40 AM Room 1011 EB1	**Dr. Dongxia Liu** University of Maryland, College Park

Design, Synthesis and Mechanistic Understanding of Hierarchical Lamellar Zeolites for Energy Conversion Applications

Energy is clearly a global grand challenge problem for the 21st century. In our research group, we combine our expertise in materials science, catalysis, and separation, aiming to create innovative catalyst and membrane technologies that enable active and selective chemical conversions with particular focus on the catalytic conversion of C_1 feedstocks. In this seminar, I will present our recent work on developing innovative lamellar zeolite catalysts and mechanistic understanding of their properties in catalytic reactions. Hierarchical meso-/microporous zeolites couple the catalytic features of micropores and the improved access and transport consequence of mesopores in a single material, possessing the capacity of processing large molecules. The synthesis and catalytic behavior investigation of meso-/microporous zeolites has become the subject of intense research. We have developed a simple one-step dual template synthesis method to tailor the textural properties of lamellar zeolite materials. Implications of the tunable meso-/microporosity on the spatial distribution and catalytic performance of active sites in lamellar zeolite catalysts have been studied using organic chemical titration, x-ray photoelectron spectroscopy and direct methane aromatization reactions. Volcano-type dependence between the hierarchy factor, distribution of active sites, and product formation rate with the dual template ratios in the hydrothermal synthesis suggest that the textural and composition properties and thus the catalytic performance of the catalysts can be optimized by the designed zeolite synthesis. The capability of forming hierarchical lamellar zeolites with tunable meso-/microporosity is important to keep their potential applications as broad as possible for a specific zeolite structure in catalytic reactions.

Jan 16, 2015 10:40 AM Room 2207 EB3	**Dr. Adriana San-Miguel** Georgia Institute of Technology

Automated imaging platforms and high-content data reveal hidden biological information in subtle C. elegans mutants

Elucidating the mechanisms governing biological processes relies heavily on our ability to characterize the physical features and traits of organisms. Today, a significant amount of biological readouts are based on fluorescent reporters. Studies that make use of these markers typically depend on changes perceivable by human observers. In the multicellular organism *Caenorhabditis elegans*, fluorescent markers can be visualized in intact animals with subcellular resolution. However, obtaining high-content data from high-resolution images of live animals is challenging due to the manual labor required for sample preparation, as well as the non-quantitative and biased nature of human vision. Coupling microfluidics with external hardware and custom automation software, we are able to acquire images in a high-throughput, fully automated manner. In addition, we develop algorithms to extract complex information from images of fluorescently labeled synaptic patterns in *C. elegans.* Using our integrated approach, we are able to isolate mutants that exhibit extremely subtle phenotypes, hidden to human vision. These mutants, nonetheless, reproducibly show measurable phenotypic differences. Making use of mathematical algorithms and visualization tools, we identify the characteristic traits of these mutants and predict altered genetic pathways. The novel alleles should aid in finding the missing players in synaptic establishment and maintenance, and thus propose candidate genes important for neurotransmission disorders.

Jan 23, 2015 10:40 AM Room 2207 EB3	**Dr. Reeja Jayan** **MIT**

Engineering Thin Film Materials and Interfaces for Flexible, Miniaturized Energy Devices

Ceramic and polymeric thin film materials and the interfaces they form with diverse substrates are critical components in energy harnessing and storage devices like solar cells and batteries. This talk will introduce two novel approaches to engineer such materials.

First, I will introduce a solution-based process that crystallizes ceramic (TiO2) thin films at low temperatures (~ 150 oC) using microwave radiation assisted selective heating. These materials require temperatures over 400 oC to crystallize using conventional synthesis techniques. High temperature processing creates incompatibility with microfabrication processes and limits the choice of substrate materials on which these films can be grown, as flexible plastic or polymeric substrates typically decompose at temperatures > 200 oC. The low temperature microwave process thus enables the integration of ceramic thin films directly onto temperature-sensitive substrates like plastic for use in flexible thin film solar cells, batteries, and micro/nano devices.

Next, I will demonstrate how initiated chemical vapor deposition (iCVD) polymerization can be used to synthesize nanoscale (~ 20 nm), conformal polysiloxane thin films which serve as nanoscale electrolytes for the emerging field of three-dimensional (3D) batteries. An important consideration for miniaturizing on-board electrochemical energy storage for many applications including sensing, actuation, communications, and medical implants is the footprint area of the power source. 3D battery designs use electrodes with non -planar geometries, effectively enabling power sources to possess high energy density and high power density within a small footprint area (1 mm^2 - 1 cm^2). Electrolyte films in 3D batteries must cover these complex electrode geometries while retaining the underlying morphology of the electrodes, i.e. conformal coverage. Such uniform and thin polymer films are difficult to achieve by solution processing due to de-wetting and surface tension effects. In contrast, the conformal nature of the iCVD polymerization process realizes complete coverage of nanostructured electrodes like nanowires by a uniform, continuous, and pinhole free thin film. This is the first time nanoscale films with siloxane ring moieties, which are excellent electrical insulators, have been demonstrated as room temperature ionic conductors. These nanoscale films also exhibit good mechanical and chemical stability, and are easily scalable over large areas.

Jan 30, 2015 10:40 AM Room 2207 EB3	**Dr. Markita Landry** MIT

Optical Sensing of Biological Activity, One Molecule at a Time

Nanomaterials have distinct optical, chemical, and mechanical properties that make them useful for biomedical applications including the development of highly sensitive and specific sensors of biological activity. In particular, semiconducting single-wall carbon nanotubes (SWNT) are unique near-infrared emitters, making them well-suited for use as fluorescence-based optical sensors: SWNT exhibit an extraordinary quantum yield, have essentially infinite lifetimes, and emit in an optical window where tissues, cells, blood, and other biological samples are maximally transparent. We present several brief examples in which SWNT have been instrumental in advancing technologies at the interface of nanomaterial and molecular biosciences.

Innovative functionalization of SWNT with polymers can provide SWNT with novel functions for a variety of applications. For instance, our work has shown that we can impart sensing capabilities to SWNT such that the SWNT-polymer conjugate produces a signature optical signal in the presence of a specific analyte molecule such as vitamin B2. Further development of these optical sensors is promising for areas in need of sensors with high spatial and temporal resolution, such as label-free detection of proteins within a cell, point-of-care diagnostic tools, and nanoscale therapeutics. The immediate utility of our optical sensors is demonstrated by monitoring vitamin uptake into a living cell for over an hour. We also successfully utilize this platform to produce optical sensors for neurotransmitter detection and visualize this process of molecular recognition on the single-molecule scale. We further show the utility of SWNT-polymer conjugates in the scope of plant nanobionics: the detection of molecular pollutants inside living plants with a dual-wavelength ratiometric signal. Future work will focus on the real-time detection of protein expression, microbial infections, deep tissue imaging, and kinetics of protein misfolding.

Feb 2, 2015 10:40 AM Room 1011 EB1	**Dr. Minkyu Kim** MIT

Next-Generation Polymeric Materials Engineered from Multi-Functional Protein Building Blocks

Natural materials can serve as great inspirational sources to develop next-generation polymeric materials for human health care, attributed to their exceptional physical and chemical properties including biocompatibility, biodegradability and potential nontoxicity. Typically, the unique properties of natural materials are related to their biopolymer elements, particularly multi-functional proteins, and the structural organization of biopolymers in materials. To mimic the properties of natural materials, well-characterized functional protein building blocks can be engineered into artificial protein polymers, which can then be hierarchically assembled into nanostructured materials, in contrast to constructing the entire complex natural system. Based on this bioinspired approach, I will discuss the mechanical protein building blocks responsible for muscle toughness and red blood cell deformability as well as a proper crosslinking strategy to potentially construct mechanically responsive materials for biomedical applications. I will also discuss the first artificially engineered protein polymer hydrogels recently developed that mimic the enhanced selective transport function of the nuclear pore complex for advanced separation technology.

Feb 9, 2015 10:40 AM Room 1011 EB1	**Dr. Kevin Solomon** University of California, Santa Barbara

Teaching an Old Dog New Tricks: (Re)engineering Microbes as Chemical Factories and Beyond

Microbial systems are powerful, adaptable platforms that can operate at diverse length and time scales to address grand challenges in energy, health, and sustainability. Typical applications range from highly selective microbial chemical factories to environmental biosensors, with recent innovations in synthetic biology paving the way for their use in personalized medicine and computing. Catalyzing these developments are enabling technologies that extend the capabilities of microbes and increased systems-level understanding. In this talk, I demonstrate these approaches to design microbial systems as more efficient chemical factories.

First, I describe the development of metabolite valves, dynamic gene circuits, for the creation of non-natural biosynthetic pathways. Analogous to the control valve ubiquitous in chemical plants, glucose valves redirect the flux of glucose within microbial cells to reprogram metabolism. They control the yield and selectivity of these engineered chemistries and reduce the demand for pH control in existing processes.

Next, I discuss how reverse engineering natural systems can inform the design of more efficient bioprocesses. Motivated by the challenge of efficient lignocellulose hydrolysis, I employ powerful next generation sequencing on primitive non-model microbes to identify novel enzymes for biotechnology, and examine how they are coordinated for optimal performance on diverse substrates. This integrated approach of reverse engineering and reprogramming natural systems greatly expands our ability to develop sustainable solutions with synthetic biology, and will be critical to the development of robust next-generation biological systems.

Feb 16, 2015 10:40 AM Room 1011 EB1	**Dr. Martien Cohen Stuart** Wageningen University (WU), The Netherlands

Code for a Coat: A Viral Coat Protein from Scratch

Viruses are among the simplest biological systems. From a chemical point of view, though, they are highly sophisticated self-assembled particles designed to transport and deliver nucleic acids to host cells, with the aim to hijack the host cell's synthetic machinery for virus replication. It is the design of the coat (or capsid) protein(s) which is crucial for this process to be successful, and one may therefore consider designing a functional viral capsid as a challenge in synthetic biology.

We have engineered and tested a set of artificial proteins by studying their assembly with DNA, and find that by carefully balancing protein-DNA binding strength and lateral protein-protein attraction we can obtain particles that in terms of their physical behaviour are very similar to those of Tobacco Mosaic Virus, a rod-like plant virus.

The road is now open to design proteins that can assist DNA to be replicated within a host cell, such as a bacterium.

Feb 23, 2015 10:40 AM Room 1011 EB1	**Dr. Carissa Young** Massachusetts Institute of Technology

Systems Analyses Advance Therapeutic Development & Drug Discovery in Complex Diseases

Current challenges in therapeutic development, biopharmaceutical production, and limitations of human disease models motivate our pursuit to understand how cellular processes and molecular interactions perform under systemic perturbations. Systems biology approaches with their integration of computational, experimental, and observational inquiries guide the rigorous assessment of regulation at multiple scales. We employ a systems-level understanding to characterize biological networks underlying complex cell behavior including (i) cell stress response

pathways of a single-cell organism such as yeast, and (ii) communication networks within 3-D tissues that recapitulate human physiology and disease progression.

As arguably the most well-characterized cellular response promoting homeostasis, the Unfolded Protein Response (UPR) is defined by a coordinated program of transcription that up-regulates genes within the early secretory pathway. In contrast to this classical description, our investigations in *S. cerevisiae* further indicate that an extensive program of global repression exists, highly enriched in protein synthesis and metabolic functions. DNA recombination strategies combined with high-resolution imaging techniques determined that protein redistribution, resultant spatial effects, and organelle modifications are diverse consequences of UPR activation. The elucidation of these pathways has become of growing importance in therapeutic development, as the UPR has been intimately linked to Alzheimer′s disease, Parkinson′s disease, diabetes, cancer, and inflammation.

Clearly, the complexity of human physiology must be assessed in a more complex environment that accounts for interacting cell types coexisting in a hierarchical 3-D structure. The emergence of organ-on-a-chip microfabricated devices facilitates the study of human physiology *in vitro*, enabling the development and validation of predictive models in drug discovery. The integration of tissue engineering, primary cell sources, emerging biomaterial strategies, and computational models promoted novel experiments to investigate breast cancer metastasis. As a result, we have identified plausible signatures of human-specific cross-talk between the tumor and hepatic tissues. Ultimately, these results will directly impact clinical prognosis of early metastatic disease while improving drug efficacy and toxicity models of chemotherapies.

Mar 2, 2015 10:40 AM Room 1011 EB1	**Dr. David Ollis NCSU**

The Outbound CHE PhD: Ready ? Or Not ?

Outbound juniors and seniors in Chemical and Biomolecular Engineering are required to take a professional development seminar (one unit) which covers communication skills including mock interviews, resume preparation, and researching prospective employers; additional topics include professional ethics and etiquette, and technology and society issues. No similar formal activity exists at our PhD level, but the following comments from graduate students over the last five years indicate the need:

- The department and advisor(s) give me adequate preparation for job seeking: Grads: only 5/17 agree (2011 survey)
- I think the department could assist advisors in helping students search for jobs; career students such as ourselves probably have little experience in interviewing and resume writing. (nine identical responses ! (2011 survey)
- In general, I feel that the department could offer a lot more in terms of professional development. I attend many events at Duke, UNC, and RTP regarding professional development, but all of these workshops were things I sought out. The department has a long way to go in terms of offering career guidance.(2015 comment)

This seminar surveys professional development needs for outbound PhDs seeking industry R & D, postdoctoral, and/or teaching positions. While individual advisors typically offer informal and individual advice in these areas, the need for a parallel, formal offering is evident from the repeating themes in grad student comments and surveys noted above.

We propose installation of a one unit professional development seminar series with topics including resume development, mock interviews, company, postdoc, or university summaries, as well as comparisons of professional expectations in industry vs academia. The seminar will also cover presentations on managing yourself, academic research groups, and industrial R & D teams, as well as grantsmanship, career stories, and women in research. Additional topics will include skills such as preparing research and demonstration videos, presenting research via YouTube, and participating in Q & A industry/university panels.

Mar 23, 2015 10:40 AM Room 1011 EB1	**Dr. Darren Lipomi** University of California, San Diego

Molecularly Stretchable Materials and New Approaches to Nanomanufacturing for Thin-Film Optics and Electronics

The term ″plastic electronics″ masks the wide range of mechanical behavior possessed by films of π-conjugated (semiconducting) small molecules and polymers. There is also an apparent trade-off between electronic performance and mechanical compliance in films of some of the best-performing conjugated polymers and polymer-fullerene blends, which fracture at tensile strains not significantly greater than those at which conventional inorganic semiconductors fail. The design of materials that can be deformed significantly would facilitate roll-to-roll production, mechanical robustness for potable applications, conformal bonding to curved surfaces (i.e., for implantable biomedical devices). This seminar describes my group′s efforts to understand and control the structural parameters that influence the mechanical properties of modern conjugated polymers. Our conclusions include the strong effect of the side chain in determining the elasticity, ductility, and adhesion of polymers and their blends with fullerenes, and how this effect can be predicted by theory. Mechanical, electronic, and spectroscopic evidence suggest that compliance and electronic performance need not be in competition, and could inform the engineering of the next generation of semiconducting polymers for mechanically tough, ultra-flexible, and stretchable applications. This seminar will also describe our work on methods of producing graphene with low waste in ways that are compatible with roll-to-roll printing. These large-area graphene films could be used simultaneously as both the transparent electrodes and barrier films for stretchable and ultra-flexible organic optoelectronic devices. We will also describe the scalable fabrication and physical self-assembly of new types of plasmonic nanostructures templated by graphene.

Mar 30, 2015 10:40 AM Room 1011 EB1	**Dr. Ehsan Jabbarzadeh** **University of South Carolina**

Towards Programming Mammalian Cell Behaviors for Engineering Tissues

The field of tissue engineering has evolved to develop functional substitutes for damaged tissues using combinations of cells, scaffolding materials and signaling molecules. Despite great promise, there exist important challenges to creating off-the-shelf engineered tissues. One important hurdle is our insufficient understanding of the molecular mechanisms associated with cell-extracellular matrix interactions. Another challenge lies in the development of biomaterials that not only mimic the structure of natural tissues but also allow for the formation and infiltration of blood vessels. To address these challenges, we have taken an integrated approach with three components.

The first component of our work included the control of host macrophage phenotype through natural and physiological interventions to switch pro-inflammatory behavior to a pro-angiogenic phenotype.

The second component of our research dealt with understanding the underlying mechanisms by which stem cells sense and respond to external microenvironmental cues. In this context, we engineered platforms capable of parsing the combinatorial effects of matrix elasticity, cell shape, and cell size on lineage specification of stem cells.

The third component of our work focused on development of no-viral gene delivery carriers based on the use of carbon nanotubes with tunable chemistry and gene release profile to control cellular fate at the intercellular level.

I will discuss how our findings advance the current understanding of the complex mechanisms behind tissue formation in biomaterials and cell-material interactions and provide potential design strategies for regenerative medicine.

Apr 6, 2015 10:40 AM Room 1011 EB1	**Dr. Takanari Inoue** Johns Hopkins University

Toward Total Synthesis of Cell Functions: Deconstructing and Constructing Chemotaxis and Phagocytosis

In multicellular organisms, cells undergo proliferation and differentiation into specialized cell types which are then able to exhibit complex specialized behaviors such as phagocytosis and chemotaxis. All of these processes are tightly regulated by complex webs of signaling that have proved difficult to disentangle. Recently, we put forth new concepts and tools to both break down and reconstitute these complex cellular behaviors. In the seminar, I will discuss with our recent findings of minimal signaling events to make normally inert cells chemotax and phagocytose using chemical and synthetic biology techniques combined with fluorescence imaging and microfluidics device. Our synthetic cell biology approach could make major contributions to future studies of these issues, including potential clinical applications.

Apr 13, 2015 10:40 AM Room 1011 EB1	**Dr. Michael Roland** Naval Research Lab

Liquids and the Formation of Glass:The Difficult Problem Albert Einstein Avoided

Glass-formation on earth may be as old as the planet itself, with naturally-occurring glasses used by man since the beginning of recorded history. Modern glass-making is a highly developed technology, used to produce not only inorganic glasses but also certain metals and many plastics. Moreover, the glass transition phenomenon is exploited in various applications, including skid-resistant automobile tires, military armor, and maintaining blood flow around arterial plaque.

Despite the long history, the factors governing the transition of a liquid to a glass remain the subject of much scientific inquiry and debate. Near the point of vitrification, small changes in temperature or pressure can alter the time scale for molecular motions from nanoseconds to a duration exceeding the human lifespan. Yet these spectacular changes occur without any obvious change in the arrangement or interactions of the constituent molecules. In this talk I will describe the basic differences between a liquid and its glassy state, focusing on what causes the slowing down of molecular motions that leads to glass-formation.

Apr 20, 2015 10:40 AM Room 1011 EB1	**Dr. Ann L. Lee** Sr VP Genentech

Technology and Product Innovations in Biotechnology

At Roche and Genentech, personalized healthcare (PHC) is at the core of the company′s strategy for developing new medicines against serious diseases. PHC is a key enabler increasing the efficacy and success rate in drug development that results in novel medicines with tremendous promise to patients.

Modern diagnostics and biomarkers help to identify patient sub-groups most likely to benefit from specialized treatments. Using PHC strategies, targeted medicines are developed based on deep understanding of molecular pathways and evidence-based clinical practice. The first portion of the presentation highlights the innovations that have contributed to the development of several breakthrough novel medicines in oncology, and it also shares insights from the perspective of what it takes to make these drugs.

For monoclonal antibody therapeutics, improvements in process technologies have continued to build upon the recombinant DNA techniques that Genentech first pioneered nearly three decades ago. Additional manufacturing innovations have been developed to produce novel therapeutic modalities such as antibody drug conjugates. Innovations in formulation technology resulted in increased stability and bioavailability for a targeted small molecule therapeutic. The second portion of this talk provides an overview of key process and analytical developments, scale-up, and manufacturing innovations which contributed to the development of this and other targeted oncology drugs.

May 11, 2015 1:00 PM EBIII 2213	**Amit Singer** **Princeton University**

"Beyond Scalar Affinities for Network Analysis"

Abstract:
The popular representation of datasets and networks as undirected weighted graphs is instrumental for many purposes such as clustering, dimensionality reduction, semi-supervised learning, and more. In this talk we will explore several instances in which endowing the edges with vectors or transformations is beneficial for certain applications in computer vision, structural biology, and manifold learning.

Bio:
Amit Singer is a Professor of Mathematics and a member of the Executive Committee of the Program in Applied and Computational Mathematics (PACM) at Princeton University. He joined Princeton as an Assistant Professor in 2008. From 2005 to 2008 he was a Gibbs Assistant Professor in Applied Mathematics at the Department of Mathematics, Yale University. Singer received the BS degree in Physics and Mathematics and the PhD degree in Applied Mathematics from Tel Aviv University (Israel), in 1997 and 2005, respectively. He was awarded the Moore Investigator in Data-Driven Discovery (2014), the Simons Investigator Award (2012), the Presidential Early Career Award for Scientists and Engineers (2010), the Alfred P. Sloan Research Fellowship (2010) and the Haim Nessyahu Prize for Best PhD in Mathematics in Israel (2007). His current research in applied mathematics focuses on theoretical and computational aspects of data science, and on developing computational methods for structural biology.