SOCIETY OF POSTDOCTORAL SCHOLARS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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3RD ANNUAL POSTDOCTORAL RESEARCH SYMPOSIUM

JANUARY 25, 2013

Beckman Foyer near Auditorium and Room 1005: Registration

8:00 – 8:45 Registration and light breakfast
Posters up from 8:00 am to 6:30 pm

Auditorium: Opening remarks and Talks, Session 1 Chair: Qi Zhang

8:45 – 8:50 Welcome - Society of Postdoctoral Scholars, Evelina Tapia
8:50 – 8:55 Remarks - Postdoctoral Affairs Office, Alexis Thompson

9:00 – 9:15 Qi Zhang
Evolution of Lanthipeptide Synthetases (1.1)
9:15 – 9:30 Nihan Yonet-Tanyeri
Microfabricated Hydrogel Patch for Bimodal, Dual Protein Drug Delivery (1.2)
9:30 – 9:45 A. Cuneyt Tas
Synthesis of monodisperse micropills (1.3)
9:45 – 10:00 Sam Lohse
Environmental Fate and Transport of Gold Nanoparticles in Natural Water and Soil (1.4)
10:00 – 10:15 Steven Adie
Computed optical coherence tomography for image-guided surgery of breast cancer (1.5)

Beckman Foyer near Auditorium and Room 1005: Break

10:15 – 10:30 Break: Coffee, tea, water

Auditorium: Talks, Session 2 Chair: Alex Wong

10:30 – 10:45 Alex Wong
Measuring Workplace Outcomes Using the ICF Model in Adult Survivors of Childhood Cancer (2.1)
10:45 – 11:00 Camille Goudeseune
Mechanized GTD (2.2)
11:00 – 11:15 Erick Paul
Interaction between declarative and procedural memory systems (2.3)
11:15 – 11:30 Sanda Dolcos
Perspective Taking and Evaluative Judgments in First Encounters: An fMRI Investigation (2.4)
11:30 – 11:45 Aga Burzynska
Positive effects of physical exercise and aerobic capacity on white matter in old age (2.5)

Beckman Atrium and Room 1005: Poster session and lunch

11:45 – 12:45 Even number posters presented
12:45 – 1:45 Odd number posters presented

Auditorium: Talks, Session 3 Chair: Bai Cui

1:45 – 2:00 Bai Cui
New Insight into the Mechanism of Irradiation-Assisted Stress Corrosion Cracking (3.1)

2:00 – 2:15 Scott Slimmer
Electrically Small RF Antennas: Novel Design, Fabrication, and Feed Strategies (3.2)

2:15 – 2:30 Youbo Zhao
High-resolution imaging through scattering media by optical parametric amplification of ballistic photons (3.3)

2:30 – 2:45 Ashwin Dani
State Estimation for Stochastic Nonlinear Dynamical System using Contraction Analysis (3.4)

2:45 – 3:00 Daria Khvostichenko
A microfluidic chip for LCP crystallization and subsequent X-ray analysis of membrane proteins (3.5)

Beckman Foyer near Auditorium and Room 1005: Break

3:00 – 3:15 Break: Coffee, tea, water

Auditorium: Talks, Session 4 Chair: Kyle Mathewson

3:15 – 3:30 Kyle Mathewson
Human Optophysiology (4.1)

3:30 – 3:45 Shih-Fang Chen
Predictive Models and Uncertainty Analysis of Volatile and Nonvolatile Biomarkers Concentrations in Simulated Exhaled Breath Monitoring (4.2)

3:45 – 4:00 Julie Allen
Multiple radiations of Passerines in the Andes? A phylogenetic perspective on species distributions (4.3)

4:00 – 4:15 Clare Rittschof
Plasticity in honey bee aggression (4.4)

4:15 – 4:30 Benjamin Blehm
Two is Better than One: How Opposing Motors Cooperate to Transport Cargo in Living Cells (4.5)

Auditorium: Closing Remarks

4:30 – 5:30 Keynote: Daniel J. Simons
The trouble with Intuition: Why We Have No Idea How Our Mind Works and Why It Matters

5:30 Closing remarks, Taras Pogorelov

Beckman Atrium: Reception

5:40-6:30 Reception
Best Talk and Travel Awards
Posters are accessible

Organizers: Yekaterina Golubeva, Taras Pogorelov, Evelina Tapia

Sponsors: Office of the Chancellor, Beckman Institute, Institute for Genomic Biology, College of Engineering, and the Graduate College

Talk abstracts

1. 1 Evolution of Lanthipeptide Synthetases

Qi Zhang (zhangqiwzzw@gmail.com)
Department of Chemistry, UIUC
Yu Yi, Wilfred van der Donk

Research in the 20th century identified several major groups of natural products including terpenoids, alkaloids, polyketides, and non-ribosomal peptides. However, the genome sequencing efforts of the first decade of the 21st century have revealed that another major class is formed by ribosomally-synthesized and post-translationally modified peptides. These molecules are produced in all three domains of life, their biosynthetic genes are ubiquitous in the currently sequenced genomes, and their structural diversity is vast. Lanthipeptides are members of this growing class, and many members are highly effective peptide-derived antimicrobial agents that display nanomolar minimal inhibitory concentrations (MICs) against pathogenic bacteria. These compounds are ribosomally-synthesized and post-translationally modified to install multiple cyclic thioethers. During their biosynthesis, a single enzyme typically breaks 8-16 chemical bonds and forms 6-10 new bonds, with high control over regio- and chemoselectivity. Until recently, the factors that determine the ring topology were entirely unknown. Our bioinformatics and biochemical studies suggested that the substrate peptides may control the ring topology of the mature products, and a group of enzymes have descended from kinases and phosphoThr lyases.

1.2 Microfabricated Hydrogel Patch for Bimodal, Dual Protein Drug Delivery

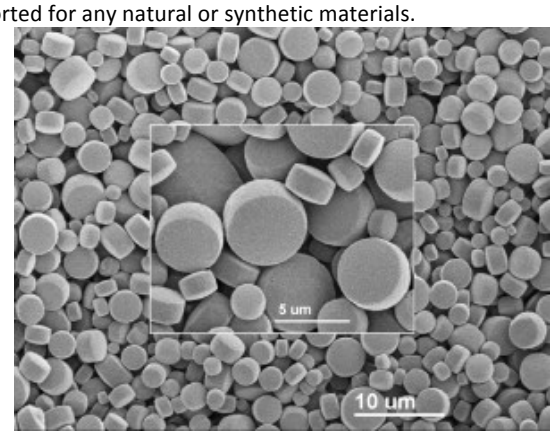
Nihan Yonet-Tanyeri (nyonet2@illinois.edu)
Chemical and Biomolecular Engineering, UIUC
Max H. Rich, Jae Hyun Jeong, Ross J. DeVolder, Hyun Joon Kong

Drug delivery via biomaterials-based approaches has the potential impact on therapeutic angiogenesis. The nature of the multifactorial process underlying the neovessel growth inspires researchers to design and engineer advanced synthetic devices to better understand the synchronized effect of various parameters on neovascularization. This talk will present our recent work to assemble a hydrogel patch enabling sequential dual drug delivery. This gel comprises of two distinct domains; a stable hydrogel of poly(ethyleneglycol) dimethacrylate (PEGDMA) and a rapidly degrading gel of polyethyleneimine (PEI)-polyethylenediacrylate (PEGDA). The hydrogel patch was fabricated by initially generating PEGDMA microwells via soft lithography and then filling the microwells with the PEI-PEGDA hydrogel. To demonstrate the capability of this gel to releasing dual drugs in a sequential manner, two different types of angiogenic growth factors, VEGF165 and VEGF121, were incorporated into these two hydrogel domains. VEGF 165 was encapsulated in the poly(lactic acid-co-glycolide) particles and then loaded into the PEGDMA hydrogel, while VEGF121 was directly loaded in the degradable PEI-PEGDA hydrogel assembled in the PEGDMA microwells. VEGF165 was released from the hydrogel patch over two weeks, while VEGF121 was being released from the material within one day. This hydrogel successfully increased the number of new blood vessels at an implantation site, as compared to a condition to release single type of simultaneously released VEGF165 and VEGF121. The biomaterial system assembled in this study will be broadly useful for controlling dual drug release rates in a more sophisticated manner and further improving therapeutic efficacy of drug molecules.

1.3 Synthesis of monodisperse micropills

A. Cuneyt Tas (actas@illinois.edu)
Materials Science and Engineering, UIUC

Everyone who has an interest in chemistry is familiar with processes that precipitate materials shaped as spheres, cubes, rods and needles. It is also not unusual to see rhombohedra, whiskers, tubes, flowers and rosette-shaped particles of inorganic/organic materials in the micron- or nano-scale. How about a pill-shaped particle? You know - round, with slightly out curving faces. Never seen that kind of precipitate? Apparently, the synthesis of monodisperse, biconvex pill-shaped microtablets, precipitated directly from an aqueous solution, has not been reported for any natural or synthetic materials.



Biconvex micropills of CaCO3 (of the vaterite form) were synthesized by first cooling (at 4°C) aqueous solutions of CaCl2 gelatin-urea and then heating the same at 70°C for 24 hours. This simple process yielded products "looking like those cute aspirin tablets everybody know, but synthesized for the first time in water-based solutions at the micron-scale." It should be noted that aspirin tablets and the like are produced by a compressing powders into a die for the desired pill shape. Biocompatible CaCO3 powders are widely used in pharmaceutical, cosmetics, biomedical, rubber, plastic, papermaking, printing ink, and food industries.

1.4 Environmental Fate and Transport of Gold Nanoparticles in Natural Water and Soil

Sam Lohse (slohse@illinois.edu)
Department of Chemistry, UIUC
Michael Zoloty, Michael Plews, Catherine J. Murphy

The increasing prevalence of functionalized nanoparticles (NPs) in a variety of applications will inevitably lead to an increase in nanomaterial soil and groundwater contamination. It has been shown that the size, shape, and surface chemistry of NPs strongly influence their interactions with biological and environmental systems, however, the influence of these properties on NP fate in soil and natural waters is still not well-understood. Gold nanoparticles are excellent model probes to assess the behavior of NPs in soils, because their size, shape, and surface chemistry

can be exquisitely controlled, and their progress through soils can be closely monitored. We prepared gold nanospheres and nanorods with different aspect ratios and surface chemistries using a poly-electrolyte layer-by-layer coating approach, and investigated how their properties influences their environmental fate and mobility. We found that the surface charge of the AuNPs had a stronger influence on their environmental behavior than their size or shape.

1.5 Computed optical coherence tomography for image-guided surgery of breast cancer

Steven Adie (sgadie@illinois.edu)
Beckman Institute, UIUC
Nathan D. Shemonski, Adeel Ahmad, Fredrick South, Eric J. Chaney, Ryan Nolan, Marina Marjanovic, Sarah Erickson-Bhatt, Guillermo Monroy, Partha Ray, Kimberly Cradock, George Liu, Jeffrey Putney, Donald Darga, Adam M. Zysk, Andrew Cittadine, P. Scott Carney, Stephen A. Boppart

Optical coherence tomography (OCT) has demonstrated significant promise to translate the time-consuming diagnostic capabilities of the pathology lab into real-time analysis in the operating room, providing the capability for both ex vivo and in situ imaging. However, due to long-standing limitations in optical imaging, obtaining isotropic histological resolution over the typical measurement volume in OCT remains a significant challenge. These traditional limitations severely limit the depth of-field and resolution in OCT. This talk describes two computed imaging techniques to overcome these limitations and optimize resolution in 3D-OCT – the first is interferometric synthetic aperture microscopy (ISAM) and the second is computational adaptive optics (CAO). These computed imaging techniques recognize and exploit commonalities between OCT and other modalities across the diverse field of imaging, such as synthetic aperture radar, digital holography, and astronomical adaptive optics. We also highlight the translational efforts underway to leverage these techniques for real-time feedback during the resection of breast cancer, including the construction and deployment of portable systems with handheld probes for in situ imaging within the surgical cavity.

2.1 Measuring Workplace Outcomes Using the ICF Model in Adult Survivors of Childhood Cancer

Alex Wong (wwong@ric.org)
Center for Healthcare Studies, Northwestern University Feinberg School of Medicine
David Strauser

Although earlier studies have indicated childhood cancer survivors are able to work, they demonstrate poor work outcomes compared to siblings. However, little research has been conducted to investigate what factors and how these factors contribute the poor workplace participation outcomes of childhood cancer survivors. In this study, we adopted the World Health Organization's International Classification of Functioning, Disability, and Health (ICF) model and used the structural equation modeling approach to investigate the relationship between personal and environmental factors and employment quality in survivors of childhood cancer who are currently employed. Our results indicated that both personal and environmental factors predicted the employment quality workplace outcomes of cancer survivors. Emotional health and social environment had both direct and indirect effects via work engagement on employment quality of cancer survivors. In addition, their physical health, age at diagnosis and social environment indirectly influenced the employment quality through emotional health. In conclusion, the ICF seems to provide a conceptual framework to guide the development of rehabilitation programs for childhood cancer survivors. Since treatment and health, personal and environmental factors both influence survivors' employment quality, tailored interventions targeting on the modifiable factors may support greater employment quality in survivors of childhood cancer.

2.2 Mechanized GTD

Camille Goudeseune (cog@illinois.edu)
Illinois Simulator Laboratory, Beckman Institute, UIUC

Mechanized GTD quantitatively extends the personal productivity guidelines popularized in David Allen's 2002 book "Getting Things Done." This extension predicts completion dates of projects through Monte Carlo simulation. Each project has an estimated cost to complete, in units such as lab time, grant dollars, or even piano practice time. The simulation stochastically applies a daily budget for these units to these projects, until all projects are completed. After doing this a few thousand times, each project has a few thousand possible completion dates. Plotting these graphically reveals when, and with how much certainty, the project will complete. Overlaying the plots of projects, particularly those with similar cost vectors, can reveal inefficient scheduling. Decisions one can make from these plots include: making one project a prerequisite of another, to impose a partial order of execution; splitting a project into projects of smaller cost and scope; and abandoning a project because its cost threatens more important ones. This extension also warns of projects that have an endangered deadline, a missing or corrupt cost, or an internal violation of one or more GTD guidelines. This extension is implemented as one ASCII plaintext file per project (typically hundreds), and a Ruby script.

2.3 Interaction between declarative and procedural memory systems

Erick Paul (ejpaul@illinois.edu)
Beckman Institute, UIUC
F. Gregory Ashby, Matthew J. Crossley

It is largely accepted that multiple memory systems mediate human learning and memory. Within the domain of categorization, at least two systems are thought to facilitate learning: a cortical-based explicit (declarative) system, and a basal ganglia-based procedural (nondeclarative) system. Substantial evidence suggests that each system is optimally suited for learning particular tasks. However, it remains unknown how precisely these (and myriad other) memory systems interact to produce optimal learning and behavior. The present research investigated this hypothesized interaction via behavioral categorization tasks and simulation of categorization tasks using a well-known model of human category learning that includes both explicit and procedural learning systems (COVIS). The results support the hypothesis that one-way interaction between the systems occurs such that the explicit system "bootstraps" early learning in the procedural system. Thus, the procedural system initially learns a suboptimal strategy and later refines that strategy. It is theorized that this bootstrapping proceeds via motor projections carrying an efferent copy of motor signals to

the indirect pathway of the basal ganglia. Hence, the indirect pathway is responsible for early learning dictated by the strategy employed by the explicit system, whereas the direct pathway is responsible for later learning.

2.4 Perspective Taking and Evaluative Judgments in First Encounters: An fMRI Investigation

Sanda Dolcos (sdolcos@illinois.edu)
Department of Psychology, UIUC
Florin Dolcos

Effective social interactions require the ability to evaluate other people's actions and intentions, sometimes only on the basis of such subtle factors as body language. Such evaluative judgments may be performed either from the own (ME) or another (OTHER) person's perspective. However, little is known about the impact of affective body language and of the ME vs. OTHER perspective on evaluative responses in social settings and the associated neural correlates. In this study, fMRI data were recorded while 18 participants viewed and rated, taking either the ME or the OTHER perspective, videos of guest-host interactions displaying approach and avoidance behaviors that were preceded or not by a handshake. First, Approach was associated with more positive evaluations than Avoidance, especially when preceded by Handshake and evaluated from the ME perspective. Second, amygdala, superior temporal sulcus, and ventral striatum were linked to the positive evaluation of Approach and the positive impact of Handshake. Third, dorsal striatum and inferior frontal gyrus were linked to the positive impact of ME perspective in Approach. These findings shed light on the neural correlates of evaluating non-verbal social interactions taking the ME or OTHER perspective, and on the role of handshake as a way of formal greeting.

2.5 Positive effects of physical exercise and aerobic capacity on white matter in old age

Aga Burzynska (agaburza@illinois.edu)
Beckman Institute, UIUC
Chaddock-Heyman L, Wong CN, Voss MW, Lewis A, Wojcicki T, Gothe N, Olson E, Fanning J, Chung HD, Awick E, McAuley E, and Kramer AF

We investigated the missing links between physical activity (PA), aerobic capacity (VO2 peak), and micro- and macrostructural WM integrity in old age. We collected diffusion tensor and T2-weighted MR images to measure fractional anisotropy (FA) and volume of WM hyperintensities (WMH) in a sample of 60 healthy older women (60–78 years). We also describe WM characteristics of a 93-year old athlete, OK, who trains track and field since she turned 77 and holds over 20 world records in her age category. We found an age-independent correlation between VO2 peak and FA in the genu of corpus callosum (r=.23 p=.039), and between average (r=-.30 p=.010) and vigorous (r=-.35 p=.003) PA and WMH volume. These results suggest that PA and VO2 correlate with different aspects of WM integrity. OK had highest WMH volume from all our participants despite her high PA. She had good VO2 peak for her age (16 ml/kg/min). In most regions her FA was lower or similar to the comparison sample. OK's FA in the genu of the corpus callosum, however, was the highest of all our participants. This suggests that microstructural WM components of genu corpus callosum may benefit from sustained aerobic capacity in very old age.

3.1 Stress Corrosion Cracking Problem of Aged US Light Water Reactors

Bai Cui (cuibai@illinois.edu)
Materials Science and Engineering, UIUC
Ian Robertson

Most of 104 US nuclear reactors are about 30 years old, having safety issues such as aging and nuclear waste management. Stress corrosion cracking of austenitic stainless steels is an important aging problem that can lead to failure of core structures in a light water reactor. However, IASCC is a complex phenomenon that may be affected by irradiated microstructures, corrosive water environment and tensile stress. In my research, austenitic stainless steel samples were irradiated and strained in situ in the TEM, allowing direct observation of dislocation interactions with grain boundaries. This approach will help identify the mechanism of stress corrosion cracking.

3.2 Electrically Small RF Antennas: Novel Design, Fabrication, and Feed Strategies

Scott Slimmer (slimmer@illinois.edu)
Materials Science and Engineering, UIUC
Jacob J. Adams, Jennifer T. Bernhard, Jennifer A. Lewis

Our research focuses on conformal printing of electrically small antennas on three-dimensional surfaces. Compact wireless devices are a critical component in the transmission and analysis of data in the telecommunications, aerospace, defense, and intelligence fields. The need to continually improve the performance of such devices while simultaneously reducing their size requires the design and fabrication of miniaturized antennas. Antennas that are smaller than the wavelength at their operating frequency are known as electrically small antennas. One promising approach to the fabrication of electrically small antennas is omnidirectional printing of metallic nanoparticle inks. Silver nanoparticle inks can be used to fabricate flexible, stretchable, and spanning silver microelectrodes on both planar and non-planar surfaces. These silver microelectrodes can be printed in three-dimensional designs with features sizes as small as 2 microns. The goal of this research project is to use conformal printing to fabricate three-dimensional electrically small antennas with a variety of designs, sizes, and performance characteristics. The results of this project may be relevant to the design and fabrication of new antennas and compact wireless devices that would improve the quality of data transmission in numerous applications.

3.3 High-resolution imaging through scattering media by optical parametric amplification of ballistic photons

Youbo Zhao (ybzhao@illinois.edu)
Electrical and Computer Engineering, Beckman Institute, UIUC
Steven G. Adie, Haohua Tu, Yuan Liu, Stephen A. Boppart

In optical imaging of highly light-scattering tissues, there is a fundamental trade-off between resolution and imaging depth. The underlying reason is that, images with diffraction-limited resolution can only be attained with ballistic photons, but the image-bearing ballistic light is attenuated exponentially with depth, becoming extremely weak and eventually overwhelmed by multiply-scattered photons at large depth. The efficiency of

current methods for detection of ballistic photons is heavily dependent on the sensitivity of electronic photo-receivers, of which the quantum efficiency is already approaching the theoretical limit. Here we propose using an optical amplifier to boost weak light signals prior to electronic detection, so as to enhance the detection efficiency of image-bearing ballistic photons. A high-speed femtosecond (fs) optical parametric amplifier (OPA) is implemented, which inherently combines a nonlinear confocal gate, a narrow time gate (100 fs) and high gain of up to 38 dB, enabling highly efficient detection of ballistic photons from a strong multiple-scattering background. High resolution diffraction-limited imaging of targets in thick turbid media of up to 20 mean free paths is demonstrated. With the potential of noiseless amplification of many types of light signals, this OPA-based light detection technology could significantly enhance high-resolution optical imaging deep in tissue.

3.4 State Estimation for Stochastic Nonlinear Dynamical System using Contraction Analysis

Ashwin Dani (adani@illinois.edu)
Aerospace Engineering, UIUC
Soon-Jo Chung, Seth Hutchinson

In this talk we present recent results on the contracting behavior of any two trajectories of the continuous-time stochastic dynamical system represented by Itô stochastic differential equations. The contraction analysis is a useful tool to study the incremental stability properties of the nonlinear systems. The contraction properties of stochastic dynamical systems driven by two different noise processes are useful in many engineering related control problems, such as state estimation, synchronization, etc. We illustrate the results in the context of a state estimation (observer) problem for the stochastic nonlinear systems. A new approach is presented to design nonlinear observers for Itô stochastic systems with guaranteed stability. The effectiveness of the observer is shown using robot pose and landmark position estimation problem and state estimation of Lorentz oscillator from noisy sensor measurements.

3.5 A microfluidic chip for LCP crystallization and subsequent X-ray analysis of membrane proteins

Daria Khvostichenko (dkhvosti@gmail.com)
Chemical and Biomolecular Engineering, UIUC
J.M. Schieferstein, A.S. Pawate, P.J.A. Kenis

Membrane proteins (MPs) play a pivotal role in cellular processes. To elucidate their function and mechanisms, high-resolution crystal structures of proteins are necessary. However, growing sufficiently large, diffraction-quality crystals of membrane proteins remains one of major bottlenecks in structural biology. Crystallization from lipidic cubic phases (LCP) which uses a lipidic mesophase as the matrix to stabilize membrane proteins emerged in recent years as a powerful alternative to the traditional crystallization from solutions for MP structure determination. Some of the major breakthroughs enabled by the LCP method are the crystal structures of the human $\beta 2$ adrenergic receptor and κ-opioid receptor. Despite those successes, the method has not been widely adopted yet, presumably due to the difficulties of handling highly viscous lipidic mesophases and a more complex crystallization protocol compared to crystallization from solutions. Harvesting fragile protein crystals from gel-like lipidic mesophases is challenging even in the most user-friendly variants of the method. Here we demonstrate an X-ray compatible microfluidic platform for LCP crystallization of membrane proteins. We validated our approach by crystallizing a membrane protein, photosynthetic reaction center from *R. Sphaeroides*, followed by on-chip collection of X-ray diffraction data for structure determination. The 12-well microfluidic chip developed in this work enables simultaneous automated formulation of multiple crystallization trials and eliminates manual harvesting and mounting of protein crystals for X-ray diffraction analysis. The chip requires 60 nL of the protein solution and 12 nL of lipid per well, a 6-fold reduction relative to comparable macroscale methods. For fluid metering and routing the chip relies on the multilayer polydimethylsiloxane (PDMS) architecture with monolithic pneumatic valves. For X-ray transparency the chip is fabricated using thin polymer films with the combined thickness of ~200 µm. We successfully grew crystals of the photosynthetic reaction center from *R. Sphaeroides* of 5-50 µm in size and collected crystal X-ray diffraction data on-chip at room temperature for structure solution at 2.6 Å resolution. Efforts are underway to further reduce the amount of protein solution required per trial, to scale the platform to enable higher throughput, and to improve X-ray transparency to obtain higher-resolution data.

4.1 Human Optophysiology

Kyle Mathewson (kmathew3@illinois.edu)
Beckman Institute, UIUC

Why is all human skin tinted red? Biological molecules selectively absorb and scatter light of particular wavelengths. Each molecule and therefore type of biological tissue has unique ways of interacting with light. Interestingly, human biological tissue for the most part is transparent to light in the near-infrared range (650-1000 nm), providing what is essentially a window, through which we can peer, to better understand human physiological function. For example, we use near-infrared laser diodes to illuminate the human cortex, and measure the properties of the diffused light to estimate metabolic and neuronal activity. We have recently shown that optical brain imaging can measure coherent oscillatory alpha activity associated with attention. Recent advances in flexible electronics have provided the opportunity to develop less invasive and more portable optical imaging devices. We have performed early tests of this developing technology in a cognitive task, and are further developing other biomedical applications for such flexible near-infrared devices. Finally, since we are constantly being illuminated with natural and artificial light from a variety of sources, it may be possible to reconstruct some aspect of physiology from a simple video of an individual. Perhaps we are all performing Optophysiolgy when we look at each other.

4.2 Predictive Models and Uncertainty Analysis of Volatile and Nonvolatile Biomarkers Concentrations in Simulated Exhaled Breath Monitoring

Shih-Fang Chen (chen143@illinois.edu)
Agricultural and Biological Engineering, UIUC
Mary-Grace C Danao

Exhaled breath (EB) provides a noninvasive detection method and offers a low risk of infection, repeatable, and convenient for long-term clinical monitoring. Some metabolic products in exhaled breath were proven or promising to related to disease status and

can serve as biomarkers for diagnosis. However, volatile organic compounds (VOCs) and nonvolatile organic compounds (non-VOCs) were retained differently when sampling because of their nature properties (e.g. solubility, volatility). Sampling conditions, such as exhaled temperature, and breathing rate greatly affected the different intrinsic properties. The dearth of information on how sampling conditions affect the intrinsic properties of biomarkers hinders the use of breath monitoring in clinical use. Hence, the object of this research is to determine the behavior of VOC and non-VOC biomarkers in simulated exhaled breath (EB) and exhaled breath condensate (EBC) and develop the predictive model under varied sampling conditions by using ethanol and hydrogen peroxide as the model biomarkers. Akaike's information criterion and cross validation were adopted in predictive model selections, and uncertainty analyses were surveyed to further clarify the margin of doubt for the measurement of each sampling factors.

4.3 Multiple radiations of Passerines in the Andes? A phylogenetic perspective on species distributions

Julie Allen (juliema@illinois.edu)
Illinois Natural History Survey, UIUC
Jill Jankowskii, Sebastian Herzog

Species turnover is exceptionally high along Andean elevation gradients—individual species have narrow elevation ranges, and complete replacement of a given bird community can occur within 1000 meters. This aspect of beta diversity makes a critical contribution to the immense diversity observed in Andean landscapes. Patterns of species turnover are often related to contemporary ecological drivers such as climate, vegetation, and species interactions. While such factors may reinforce elevation ranges, they offer limited insight into the role of evolutionary history in shaping patterns of species turnover. Here we apply a newly developed phylogenetic tree of all birds to provide an evolutionary perspective to patterns of species turnover and diversification in the Peruvian Andes. We quantify community phylogenetic structure and phylogenetic beta diversity along three 3000-m elevation gradients from the Amazonian lowlands to treeline to identify regions with a strong signal of phylogenetic turnover within the Andean bird fauna. We find clustering in the higher elevation communities for many Passerine families, which correspond with areas of phylogenetic turnover. We couple this analysis with knowledge of Andean uplift events to understand the historical role of Andean elevation gradients in generating observed diversity across tropical bird families.

4.4 Plasticity in honey bee aggression

Clare Rittschof (ccr22@illinois.edu)
Entomology, UIUC
Gene E. Robinson

Social interactions play an essential role in shaping behavior for most animals. In the honey bee (Apis mellifera), colony-level defensive response requires both rapid and reversible changes in individual behaviors (in response to the immediate threat), but also longer-term adjustments to individual defensiveness thresholds depending on the level of local predation and the number of other workers available to perform defensive tasks. While the social cues used to induce rapid changes in defensive behavior are known, the cues and mechanisms that lead to more persistent shifts in individual defensiveness thresholds are unknown. In the current study we experimentally simulated some of the social cues experienced by bees in highly defensive colonies and measured how these cues affected the development of defensive behavior. By physically agitating colonies on a chronic basis, we increased alarm pheromone release and individual movement, two features associated with highly defensive colonies. Agitated colonies had a diminished defensive response, lower rates of foraging activity, and changes in defense-related gene expression relative to control. This experiment provides a tractable paradigm for manipulating the defensive social environment, a first step towards understanding how colony environment "gets under the skin", leading to long-term changes in behavior.

4.5 Two is Better than One: How Opposing Motors Cooperate to Transport Cargo in Living Cells

Benjamin Blehm (blehm@illinois.edu)
UIUC
Melinda Tonks Hoffman, Hannah A. DeBerg, Derrick P. McVicker, Christopher L. Berger, Ahmet Yildiz, Trina A. Schroer, Kathleen M. Trybus, Yann R. Chemla, Paul R. Selvin

In the cell, motor proteins are necessary for a wide array of functions, such as cargo transport, an example of which is the transport of neurotransmitters in neurons. Dynein and kinesin are directional motors, each generally transporting cargo in one direction, toward the cell periphery (kinesin) or toward the cell center (dynein). We have discovered that beads coated with only dynein and kinesin display behavior explaining many previously mysterious in vivo behaviors. Fluorescence and optical trapping assays indicate our in vitro system reproduces in vivo force and motility behavior. By comparing our data with current intracellular transport models, we find that there is no need for reference to coordinating complexes or secondary proteins during basic transport. Most interestingly, dynein appears to remain attached during plus and minus-end directed motion, being dragged behind kinesin part of the time. This appears to cause synergistic behavior allowing obstacles to be more easily bypassed, improving the transport of cargos carrying both motors as opposed to one.

Poster abstracts

5.1 Discovery of Selective Androgen Receptor Degraders (SARDs) for prostate cancer through a high-throughput phenotypic screen

Jatinder Josan (jsjosan@illinois.edu)
Chemistry, UIUC
Alex A. Parent, Christopher G. Mayne, Chen Zhang, John D. Norris, Donald P. McDonnell, John A. Katzenellenbogen

While hormonal therapy in prostate cancer is often initially successful, metastatic tumors inevitably become resistant to first generation therapies, with no further treatment recourse. Remarkably however, several preclinical and clinical studies with abiraterone and enzalutamide (MDV3100) suggest that AR remains a viable target in most castration-resistant prostate cancer (CRPC) cases, despite AR mutations. Nevertheless, nearly half of CRPC patients respond suboptimally to enzalutamide and abiraterone, and many develop resistance to these second

generation therapies, with some occurrence of seizures from off-target effects. Thus, there is an unmet need for both efficacious AR competitive antiandrogens, as well as AR antagonists with novel mechanisms of action. Based on an AR-gelsolin phenotypic screen of an in-house library of 170,000 compounds, and detailed evaluation in cell-based assays, AR degradation studies, and AR-protein interaction conformational profiling studies, we have identified unique competitive and non-competitive AR leads. Further structure-activity relationship (SAR) studies revealed analogs with whole cell IC50 values in the range of 0.1-1 μM, in vitro inhibitory activity equivalent or superior to enzalutamide, and potent AR degradation activity (SARDs) surpassing HSP90 inhibitor, geldanamycin. Studies are underway on select compounds to fine tune SARs and optimize DMPK properties as well as in vivo xenograft studies.

5.2 Long Noncoding RNA MALAT1 Controls Cell Cycle Progression by Regulating the Expression of Oncogenic Transcription Factor bMyb

Vidisha Tripathi (tvidisha@life.illinois.edu)
UIUC
Zhen Shen, Arindam Chakraborty, Sumanprava Giri, Susan M. Freier, C. Frank Bennett, Kevin Becker, Myriam Gorospe, Supriya G. Prasanth, Ashish Lal, and Kannanganattu V. Prasanth

The nuclear speckle-localized long noncoding MALAT1 RNA is up regulated in cancer tissues, its elevated expression is associated with hyper-proliferation but the mechanism is poorly understood. We demonstrate that MALAT1 levels are regulated during normal cell cycle progression. Genome-wide transcriptome analyses in human diploid cells reveal that MALAT1 modulates the expression of cell cycle genes, and is required for G1/S and mitotic progression. Silencing MALAT1 leads to activation of p53 and its target genes and the cell cycle defects observed in MALAT1-depleted cells are sensitive to p53 levels, indicating that p53 is a major downstream mediator of MALAT1. MALAT1 depleted cells also display reduced expression of bMyb, an oncogenic transcription factor that is involved in G2/M progression, and the deregulation of bMyb is due to altered binding of splicing factors on bMyb pre-mRNA and aberrant alternative splicing. In human cells, MALAT1 promotes cellular proliferation by modulating the expression and/or pre-mRNA processing of cell cycle-regulated transcription factors. These results provide mechanistic insights on the role of MALAT1 in cell proliferation.

5.3 Some visual relation judgments are limited to a single dimension at a time

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Previous work shows that we can simultaneously compare multiple values across spatially separated objects (e.g., whether two shirts differ in both color and stripe pattern), but no existing work tests whether this is possible for relations (e.g., whether one shirt is darker and has wider stripes than the other). We tested this idea by asking participants to detect either value or relation changes for a single dimension and determined whether changes in a second irrelevant dimension influenced performance. Participants detected changes across sequential displays of pairs of gratings that varied in both contrast and spatial frequency. In the values task, participants judged whether the two pairs had exactly the same values, and either one or both values could change. Consistent with past work, changes in the second irrelevant dimension interfered ('same' responses were slower when values in the other dimension differed), suggesting that values were compared across both dimensions at once. The relation task was identical, except that all absolute values always differed, and participants detected changes to the relative values. Changes in the irrelevant dimension no longer interfered, suggesting that only a single relation was recovered at a time. In contrast to local recoding mechanisms, we suggest that when values are spatially separated, extracting relative values relies on far more capacity-limited processes.

5. 4 Engineered 3D matrices to study regulation of glioma cell malignancy

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Patients with glioblastoma multiforme (GBM), the most aggressive form of primary brain tumor, have a poor prognosis. With a rapid diffuse infiltration of tumor cells into normal parenchyma, these tumors present high rate of recurrence and traditional therapies - surgery, radiation and chemotherapy - provide only palliation. A major obstacle to understanding the role of extracellular matrix in the regulation of GBM invasion is the absence of model matrix systems that recapitulate the distinct composition and physical structure of brain tissue. Biomimetic culture systems will allow for in vitro tumor modeling and highly contribute to the understanding of cancer cell dependency on microenvironmental conditions. In order to study glioma cell behavior in a 3D physiologically-relevant context, we utilize hydrogel matrices to recreate the physiochemical properties of the native tumor tissues. This allows us to precisely control diffusion-mediated oxygen and nutrient transport, cell-cell interactions, and other key biophysical properties, such as matrix density and biodegradability, which significantly impact glioma cell morphology, proliferation, and motility.

5. 5 Engineering quantum dot calibration beads for the profiling of cellular heterogeneity

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Advances in quantum dot technology have provided novel approaches for multi-color imaging of cellular structure and function. Many recent studies have aimed to quantitatively calibrate fluorescence levels in heterogeneous cell populations. Combining these approaches towards quantitative multiplexing of cellular heterogeneity requires sensitive calibration standards. To this end, we have developed improved quantitative, quantum dot calibration beads using commercially available ITK-streptavidin quantum dots conjugated to biotin-coated polystyrene beads, with dimensions similar to cells. We have created quantum dot calibration beads at 525 nm, 565 nm, 605 nm, 655 nm, and 705 nm of emission. We assessed the amount of quantum dot loss during the bead isolation steps in the protocol used to make the calibration beads, and have also determined the relationship between theoretical quantum dot levels and actual quantum dot levels using inductively coupled plasma mass spectrometry. Our results show a linear relationship between fluorescence and quantum dot number. This study identifies the optimal conditions

for preparing quantitative calibration beads from commercially available quantum dots for different research applications.

5. 6 Resurrection of an Aged Acetylcholinestrase-Organophosphate Complex

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Acetylcholinestase (AChE) is an enzyme of key importance in both the central and peripheral nervous systems because AChE hydrolyzes the neurotransmitter acetylcholine, terminating synaptic transmission. Organophosphates (OP) can act as pesticides or chemical warfare agents (e.g. parathion or sarin respectively) by the covalent and irreversible inhibition of AChE, forming an AChE-OP adduct. The potency, chemical simplicity, and availability of OPs make them an attractive option as potential weapons (e.g. Syria). Thus, continued research towards more effective antidotes is needed because the standard agent 2-PAM is ineffective against several common OPs. Several OP agents undergo a secondary hydrolysis reaction once the AChE-OP adduct is formed. This reaction produces a stabilized monobasic phosphonate ion within the AChE active site, which is known as the "aged" AChE-OP complex. Formation of the aged adduct is a serious concern since soman, a common OP, ages with a half-life of approximately 3 min. No compound has previously been reported which can restore AChE activity once aging has occurred and the aged enzyme has been thought of as dead. Presented here is a family of novel compounds which display proof-of-concept in the "resurrection" of an aged AChE-OP adduct.

5. 7 Increasing CO2 and O3 concentrations reduce water use in major Midwestern crops: Implications for climate, hydrology and agronomy

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Anthropogenic activity has significantly altered the composition of the atmosphere. A key consequence of this activity is the increasing concentrations of atmospheric CO2, a stimulator of photosynthesis, and O3, a suppressor of photosynthesis. While it is well established that CO2 and O3 typically have disparate effects on photosynthesis, their effect on crop water use is less understood. Here we present the results of a multi-year experiment that quantifies the impacts of increasing concentrations of CO2 and O3 on the water use of maize and soybean. A micrometeorological technique was used to monitor water use of field-grown maize and soybean exposed to elevated concentrations of CO2 and O3 under open air fumigation at the Soybean Free Air Concentration Enrichment (SoyFACE) facility located in Central Illinois. A consistent reduction in crop water use was observed throughout the majority of the experiment for both maize and soybean grown at potential future concentrations of CO2 and O3. Further, increasing CO2 improved, while increasing O3 had a deleterious effect on water use efficiency. The presentation will conclude with a discussion of the impacts of interactions of crop water use with global change on regional climate, hydrology and agricultural productivity.

5. 8 Designing Simulation Studies to Investigate Assumption Violations of UIRT Vertical Scaling

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Unidimensional Item Response Theory (UIRT) vertical scaling has become a commonly used methodological process in Educational Testing. UIRT vertical scaling creates a developmental score scale which is a mechanism for representing students' scores along a continuum and as a student learns more they move higher along that continuum. UIRT vertical scaling makes the three strong assumptions; local independence, unidimensionality and similar reliabilities. Local independence and unidimensionality are assumptions of UIRT, and similar reliability of grade level tests is an assumption of vertical scaling. When the assumptions of local independence, unidimensionality, and similar reliability are met, the IRT parameter invariance property can make vertical scaling very useful in establishing a developmental score scale. However, research has shown that UIRT vertical scaling methods can be unpredictable especially in estimating grade-to-grade variability. There has been a lack of high powered simulation studies with multiple replications to examine this unpredictability. Therefore, the aim of this work is to investigate how simulation studies can be used to study how violations of the unidimensionality, local independence, and similar reliability assumptions affect the characteristics of the developmental score scales when UIRT vertical scaling is used.

5. 9 Perceptual Rivalry and the Relationship between Microsaccades and Pupil Dilation

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Microsaccade rate and changes in pupil size each have been linked to attention (Rolfs, 2009; Gabay et al., 2011) as well as to perceptual alternations in binocular rivalry (Van Dam & Van Ee; Einhaeuser et al., 2008), suggesting a relationship between microsaccade inhibition and pupil dilation. The two measures have been studied independently, though, so it remains unclear if these changes are related. Experiment 1 explored the relationship between the two measures. Microsaccade rate and pupil size were recorded using a video-based eye-tracker as participants viewed orientation-ambiguous figures such as a Necker cube. Increases in pupil size were accompanied by decreases in microsaccade rate while decreases in pupil size were accompanied by increases in microsaccade rate during transitions from one interpretation to the other, confirming that the measures are associated. This covariation either indexes a shared cognitive component such as effort (Valsecchi & Turatto, 2009; Norman & Bobrow, 1975) or a more general association such as an automatic physiological link. To determine whether they co-vary due to a physiological link, Experiment 2 manipulated pupil size by modulating screen luminance and measured changes in microsaccade rates. Although pupil size changed with increases and decreases in luminance, microsaccade rates were not associated with those changes. Consequently, the association between pupillary responses and microsaccades seems to require a shared cognitive component such as attention or cognitive effort.

5. 10 **Methylated-DNA detection with MBD using solid-state nanopore**

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Pigenetic modifications in eukaryotic genomes occur primarily in the form of 5-methylcytosine (5mC). These modifications are heavily involved in transcriptional repression, gene regulation, development and progression of disease, including cancer. Here, we report a new single molecule assay for the detection of methylated DNA using solid-state nanopores. Methylated DNA in complex with truncated MBD1 (MBD-1x) protein had a 3 fold increase in blockage current relative to unmethylated DNA. Furthermore, the discrimination of methylated and unmethylated DNA is demonstrated with high fidelity in the presence of only a single bound protein, thereby giving a resolution of a single methylated CpG dinucleotide. The extent of methylation of a target molecule could also be coarsely quantified using this novel approach. This nanopore-based methylation sensitive assay circumvents the need for bisulfite conversion, fluorescent labeling, and PCR and could therefore prove very useful in studying the role of epigenetics in human disease.

5. 11 **Silicon Photonic Optical Microring Resonators and Phospholipid Bilayer Nanodiscs: Technology Fusion for Investigating Membrane-Bound Targets in a Multiplexed Assay**

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Membrane-bound targets include the phospholipids of the cell membrane as well as membrane-bound proteins. Interactions occurring at the cell surface play important roles in cell communication, adhesion, and pharmaceutical development. There is therefore a need to adequately and appropriately recapitulate the native cell membrane. Additionally, in order to assess interactions at these membrane mimics, multiplexable analytical methodologies are also of upmost importance. To this end, the work presented here merges two technologies, phospholipid bilayer nanodiscs and silicon photonic optical microring resonator arrays. Nanodiscs incorporate membrane-bound proteins within a native-like lipid bilayer solubilizing and stabilizing membrane proteins and maintaining them in their native and thus active conformations. Optical microring resonator arrays are highly multiplexable, label-free devices used previously to characterize the interactions of proteins, DNA, and RNA. In order to tether nanodiscs to the microring substrate, several immobilization techniques are explored. Nanodiscs containing phosphoserine lipids, biotinylated lipids, glycolipids, and cytochrome P450 are combined in a multiplexed assay, demonstrating the capability of the optical microring biosensors to monitor multiple binding events simultaneously. The fusion of these two technologies, nanodiscs and microring resonators, represents a critical development towards characterizing interactions with membrane-bound proteins.

5. 12 **Simplicity of Design Principles underlying Tunable cis-Interactions within Shp2 Revealed by FRET**

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Protein functions are largely affected by their conformations. This is exemplified in proteins containing modular domains. However, the design principles underlying modular arrangement for the regulation of protein conformations remain elusive. Here we show that cis-interactions between the C-terminal phosphotyrosines and SH2 domain of a protein tyrosine phosphatase Shp2 can be tuned by an adaptor protein, Gbr2. The competitiveness of two phosphotyrosines for the same SH2 domain in Shp2 is governed by an antagonistic combination of contextual amino acid sequence and position of the phosphotyrosines (favorable position combined with adverse sequence and vice versa). Swapping the sequences at the two tyrosine sites resulted in one dominant form of cis-interaction and inhibited the trans-regulation by Grb2, which reprograms downstream ERK signaling. Thus, a simple antagonistic combination of sequence and position may serve as a basic design principle for proteins with tunable conformations.

5. 13 **Facilitated Transport of Weakly Hydrophobic Veterinary Antibiotic Florfenicol in Saturated Soil Columns: the Role of Manure Colloids**

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Field application of livestock manure introduces animal hormones and veterinary antibiotics into the environment. The manure colloids have potential to intensify the environmental risk of groundwater pollution by colloid-facilitated contaminant transport. The transport behavior of veterinary antibiotic florfenicol in saturated homogeneously packed soil columns has been investigated in both presence and absence of manure colloids. The results show that even though florfenicol is a weakly hydrophobic organic compound, facilitated transport is still a significant process in the presence of manure colloids. The dissolved organic matters (DOMs) in manure play a crucial role in facilitated florfenicol transport. Additional mechanisms, besides the previously known co-transport of florfenicol with organic colloids, were also found to contribute to facilitated transport. Florfenicol breakthrough curves (BTCs) were fitted well by a two-site nonequilibrium adsorption contaminant transport model. Model results suggested that DOMs decrease the adsorption capacity and suppress the time-dependent adsorption and desorption processes. A step-wise model fitting approach resulted in robust parameter estimation. The adoption of the non-linear Freundlich adsorption in the two-site nonequilibrium model significantly increased the model fitting to the tailing of the breakthrough curves.

5. 14 **ZNF286A and human-specific duplicate, ZNF286B, compete with REST to drive differentiation of precursor cells**

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The zinc finger transcription factor ZNF286A is conserved in all mammals and marsupials. However, in recent evolution, a gene duplication event has created a duplicate of ZNF286A called ZNF286B. Humans are the only species known to carry two functional copies of this transcriptional repressor. While the targets of these transcription factors are not yet known, early experiments show that they are involved in regulating the differentiation of neurons and the formation of axons during neurogenesis. ZNF286A and B may also modulate the function of another transcription factor, REST, which modulates differentiation in neuronal cells and represses neuronal genes in non-neuronal tissues. By comparing the human regulatory system to that in mice (where only one ZNF286 protein exists), we can make observations about how functional gene duplicates modify complex pathways in the brain.

5. 15 Toward point-of-care epigenetic testing: Microfluidic platforms with electrostatic microvalves and nanoporous membranes

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Variation in gene expression can involve many factors other than DNA sequence heterogeneity, e.g., transcription factor binding, DNA methylation, and covalent histone modifications. Protein-DNA interactions are implicated in the majority of these ancillary mechanisms. Currently, the most widespread method for probing protein-DNA interactions in an epigenetic context is chromatin immunoprecipitation (ChIP), which is typically limited to relatively large cell populations (> 10^6 cells) and is time and labor intensive. To address these limitations with ChIP, we are developing a microfluidic system with key advances in fluid control (electrostatic microvalves) and solid-state immunocapture (nanoporous membranes). The electrostatic microvalves are fabricated exclusively using soft-lithographic techniques and operated with hand-held electronics, while nanoporous membranes significantly improve the interaction between targets and capture antibodies. Together, the two technologies provide a promising step toward point-of-care epigenetic testing in clinical settings.

5. 16 Multiple receptors for sulfated Lewis X and sialylated N-acetyllactosamine are present on the boar sperm plasma membrane

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After insemination, a sperm reservoir is established in the oviduct by sperm binding to oviductal glycans containing sulfated Lewis X (LeX) and biantennary sialylated N-acetyllactosamine (SiLN) motifs. Based on a binding assay to fluoresceinated sLeX, SiLN or N-acetyllactosamine (LN) glycans, we localized glycan receptors on the sperm plasma membrane. Fluorescent staining revealed two binding regions: the anterior head region (AR) or both the anterior and posterior region (APR). sLeX bound preferentially to the AR (71.0% of sperm) and LN to the APR (98.9% of sperm) whereas SiLN bound to both regions, suggesting the involvement of two distinct receptors. Sperm preferentially bound to sLeX and SiLN compared to LN (61.5, 61.7 and 25.2% of sperm bound respectively, P=0.001), indicating the necessity of sialic acid and multivalency for optimal glycan recognition. Glycan blot analysis identified several proteins that bind specifically to sLeX with apparent molecular weights of 250, 130, 80, 55 and 47 kD. Bands of 70 and 37 kD recognized sLeX and SiLN, whereas a 15kD band recognized all three motifs. Based on these results, we determined that sperm recognition of the sLeX motif is mediated by multiple receptors that may also recognize the SiLN motif. Supported by USDA Grant no. 2011-67015-20099.

5. 17 CWD Mythbusters: fact checking common deer management procedures and outcomes

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Chronic wasting disease (CWD) is a prion disease that leads to neurodegeneration and death in cervids. Because mechanisms of CWD transmission and persistence are poorly understood, few management options currently exist. The Illinois Department of Natural Resources (IDNR) has been controlling CWD by selectively culling deer herds in localized areas where infected individuals have been found. The IDNR's goal of decreasing infectious foci has been heavily criticized as stakeholders are concerned about maintaining adequate deer herds. This issue has become a hot topic in the popular press but often based on misrepresentation of the data and exaggeration of facts. The objective of this study is to dispel common myths regarding the CWD management program in an effort to accurately inform the public of the impacts of sharpshooting on prevalence and hunter harvest. Using the IDNR's annual reports and long-term CWD test database, we found the majority of popular press statements regarding CWD management practices to be false and likely based on hearsay. We present the actual data to dispel rumors such as "hunters are actually responsible for taking the majority of the deer that test positive" and "the majority of animals infected are between 3 and 5 years of age."

5. 18 Replacing generic parameterizations of stomatal function in temperate trees with specific-specific functions allows modeling to resolve interspecific variation in carbon and water fluxes

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The Ball et al. (1987) stomatal conductance model is commonly coupled to the Farquhar et al. (1980) photosynthesis model in simulations of ecosystem carbon and water fluxes. The Ball et al. (1987) model predicts stomatal conductance as a linear function of photosynthetic CO2 assimilation rate, atmospheric CO2 concentration and atmospheric humidity. The slope of the linear function is commonly assumed to be 10.0 across diverse C3 species. We tested the hypothesis that stomatal function varies significantly among twelve temperate tree species, and therefore species-specific parameterization of the Ball et al. (1987) model is necessary to model interspecific variation in carbon and water

fluxes. Leaves of these twelve species, grown in a common-garden field experiment, were harvested and measurements of leaf gas exchange were performed in the laboratory to parameterize the Ball et al. (1987) and Farquhar et al. (1980) models. Model performance based on this parameterization was tested against in situ foliar gas exchange measurements during four periods of the summer of 2012. Our species specific parameterizations greatly improved the model predictions of in situ photosynthetic CO2 assimilation and stomatal conductance. This has significant implications for efforts to test the viability of these temperate trees as feedstocks for biofuel production.

5. 19 Stalk Quality Characterization and Sugar Determination in Dual-Purpose Sorghum

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Dual-purpose bioenergy crops, in which reduced carbon is harvested from multiple sources, are efficient feedstocks because carbon accumulation in any one organ is usually sink-limited. Carbon yield from the vegetative stalk can usually be increased without sacrificing starch yield from the grain. Sorghum is one type of dual-purpose bioenergy crop and it is highly tolerant to drought and requires lower inputs than maize. Resistance to lodging is critical to sorghum and increasing stalk quality yields must be accompanied by increased stalk strength to prevent lodging. The sorghum ortholog of a gene that improves stalk strength in many different genetic backgrounds. Direct measurement of stalk physical strength is more efficient breeding phenotype than lodging itself. Furthermore, stalk moisture affects harvest, transport, and storage strategies. Moisture and sugar levels in the stalk are correlated because sugar is hygroscopic. Therefore, identifying the sorghum varieties with stronger stalk strength can prevent lodging damage and differentiating the hybrids with higher sugar content can increase potential biofuel yield. Dwarf grain sorghum and photoperiod sensitive sorghum were sampled and the ground samples were scanned using an FT-NIR with hopes that chemometric models can be used to predict the sugar content of sorghum stalks in the field.

5. 20 Human TLR10 suppresses both Myd88 and Trif-mediated TLR signaling

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Toll like receptors (TLRs) have long been known to recognize a wide variety of microbe-associated molecular patterns and compose the front line of human immune responses. There are 10 TLRs in the human genome with TLR10 being the only orphan TLR. Little is known on the ligand recognition, downstream signaling pathway and function of TLR10 largely due to the lack of a proper animal model. In mouse, there is no functional copy of TLR10 due to multiple retrovirus insertions in the promoter and coding region of TLR10. To uncover the potential role of TLR10 in human immune responses, we have generated CMV-hT10 transgenic mice expressing human TLR10 (hTLR10). We have found that constitutive expression of hTLR10 in transgenic mouse suppressed the downstream cytokine production triggered by TLR agonists, such as Pam3CSK4 (TLR2/1 agonist), LPS (TLR4 agonist) and PolyI:C (TLR3 agonist). The suppressive effect is not restricted to TLR2 subfamily TLRs but is rather a broad suppression on all TLRs tested. More importantly, both Myd88- and Trif- mediated pathways are affected by hTLR10 as both IL6 and IFNb production were reduced in hTLR10 transgenic mice compared to the wild type. Intraperitoneal injection of LPS into mice triggered significantly less serum TNFa and IL6 production in the transgenic mice, supporting that hTLR10 is a suppressor of in vivo TLR signaling. We are currently in close examination of the role of hTLR10 in the sepsis shock model and in the context of pathogenic bacterial infection.

5. 21 Effects of an Acting Intervention on Functional Activation During a Relational Memory Task in an Aging Population

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The hippocampus and medial temporal lobe (MTL) are commonly associated with a range of memory tasks. In aging populations, increased blood-oxygen-level-dependent (BOLD) activity in these regions is found in relational memory tasks both during the encoding and retrieval phases. The aim of this study was to examine changes in BOLD activation during the recognition phase of a relational memory task in 45 older adults. Participants underwent functional magnetic resonance imaging while performing a relational memory task involving face-scene pairs, a task known to be critically dependent on the hippocampus and MTL structures. Results for Hits > Correct Rejections (CR) in the Control > Active Experiencing (AE) (Post > Pre) contrast showed significant changes in BOLD activity in the inferior occipital lobe, an area associated with object processing. Additionally, results for the Hits + CR cope in the AE > Control (Post > Pre) contrast showed a significant change in BOLD activity in the posterior cingulate gyrus, a region found to provide inputs to the MTL. No significant changes in BOLD activity were found directly in the MTL or hippocampus. These results suggest an effect of active experiencing training on functional activation during a relational memory task.

5. 22 What's going on the electrode-electrolyte interface? A Sum Frequency Generation Study on Electroreducion of CO2

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Electrochemical mechanisms occurring on the electrolyte-electrode interface still need to be elucidated. Sum frequency generation (SFG) is a powerful nonlinear surface-sensitive technique, a coherent combination of infrared and Raman spectroscopy, able to detect which species are present and how are oriented on the interface. Here, we present a preliminary SFG study on an electrochemical cell which reduces CO2 at lower potentials [1]. This collaborative work opens a new horizon on artificial photosynthesis, to gain more control in the conversion of CO2 to CO using ionic liquids as an electrolyte, with lower energy cost. [1] Brian A. Rosen, Amin Salehi-Khojin, Michael R. Thorson, Wei Zhu, Devin T. Whipple, Paul J. A. Kenis, and Richard I. Masel. Ionic liquid "mediated selective conversion of CO2 to CO at low overpotentials". Science, 334 (6056): 643–644, 2011.

5. 23 SNARE Complex Phosphorylation is Altered Prior to Mouse Sperm Acrosomal Exocytosis

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Phosphorylation can alter activity of phosphoproteins including all three core SNARE (soluble N-ethylmaleimide-sensitive-factor attachment protein receptor) proteins that have a critical role in intracellular membrane fusion events such as the acrosome reaction. During the final sperm maturation, known as capacitation, protein kinases and phosphatases are activated that may alter phosphorylation of SNAREs and other regulatory proteins. We hypothesize that during capacitation, SNARE protein phosphorylation changes, promoting SNARE complex formation in preparation for the acrosome reaction. To begin to test this hypothesis, we incubated mouse sperm in a specialized capacitating (dmKRBT) or non-capacitating (dmKRBT without BSA and –HCO3) medium and detergent-extracted sperm protein. To isolate formed SNARE complexes, sperm protein was immunoprecipitated with a syntaxin antibody and subsequently run on 12% SDS-PAGE gels, followed by immunoblotting with syntaxin antibody to verify that the complexes contained syntaxin. Samples were not boiled prior to SDS-PAGE to maintain the integrity of the SNARE complex. To detect changes in total phosphorylation of syntaxin-containing (SNARE) complexes, immunoprecipitated complexes were separated on an SDS-PAGE gel that was subsequently stained with Pro-Q Diamond. We observed phosphoprotein staining in 75, 100, and 150 and 230 KD protein complexes. Immunoblotting with a syntaxin antibody demonstrated that each complex contained syntaxin and was presumably a SNARE complex. Quantitation of SNARE complex phosphorylation showed that after 30 min of capacitation, overall phosphorylation was higher in the 75, 100 and 150 KD bands. To detect tyrosine phosphorylation of syntaxin and associated proteins, the anti-syntaxin immunoprecipitates were blotted with a phosphotyrosine antibody. Tyrosine phosphorylation of SNARE complexes decreased after 15 min of capacitation time. These data demonstrate SNARE complex phosphorylation is a dynamic process during capacitation and suggest that phosphorylation may regulate SNARE complex formation during capacitation in preparation for the acrosome reaction. This work was partially supported by a fellowship from COMSATS Institute of Information Technology, Pakistan and the University of Illinois.

5. 24 Localized culling can stabilize chronic wasting disease prevalence in white-tailed deer

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Chronic wasting disease (CWD) is a fatal prion disease affecting white-tailed deer (Odocoileus virginianus) throughout the United States. We examined effects of culling as a disease management strategy on chronic wasting disease prevalence and hunter harvest in free-ranging deer populations using data from state disease management programs and state harvest records. Since the start of the disease management program, CWD prevalence throughout northern Illinois has remained constant at 1%. Wisconsin had a similar prevalence of 1% while the state culled in CWD areas. After Wisconsin replaced culling with a hunter harvest focused strategy for removing animals, prevalence increased to almost 5% in five years. The Illinois disease management program has succeeded in maintaining low prevalence while reducing hunter harvest in only two counties. Statewide, Illinois hunter harvest has increased. Localized culling represents a successful disease management strategy by maintaining low disease prevalence without affecting recreational deer harvest at a broad scale.

5. 25 Depression, Family Support, And Body Mass Index In Mexican Adolescents

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Various studies have shown that a correlational relationship exists between depressive symptomatology and elevated Body Mass Index (BMI), and also between family support and low BMI. However, these results have been contested in further studies and gaps in research leave unanswered questions about the relationship between these three variables. Here we examine the strength of correlational relationships between depression, family support and BMI in a study of university students from Mexico. We hypothesize that positive family support mediates the association between depression and bodyweight responsible for overweight and obesity in adolescence. In doing so we explore if family support is correlated with depression and if depressive symptomatology is correlated with obesity. Results indicate that the relationship between depression and family support was significant ($r = -0.44$, $p = 0.004$). In contrast, we only found a significant relationship between depression and BMI ($r = 0.27$, $p = 0.08$) exclusively in women. When family support is included into the equation, the effect of depression on BMI was reduced to non-significance ($r = 0.19$). This observation indicates family support is a partial mediator between depression and obesity in adolescents. Our results are important and prompt an extended analysis of likely causative links between psychosocial parameters and health descriptors.

5. 26 Biomass High-throughput Phenotyping Sensing and Mapping by Site-specific Real-Time Remote Sensing Systems

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High-throughput plant phenotyping sensing and mapping can provide a boost for genomics in the 21st century. Three real-time remote sensing systems including standalone Tower-based Crop Monitoring System (TCMS), Close Proximity Data Collection Vehicle (Gantry) and Unmanned Aerial Vehicle (UAV) were developed for site-specific monitoring the biomass energy crop growth, healthy stress, yield estimation as well as data to knowledge of harvest readiness and scheduling. The remote sensing systems were capable of collecting real-time RGB, color infrared (CIR) images and canopy coverage of miscanthus, corn, switch-grass and prairie over the growing season. Site-specific prescription map was derived by image mosaic, ortho-rectification and geo-referencing. Normalized difference vegetation index (NDVI) was calculated for growth condition monitoring and biomass yield was predicted based on accumulated NDVI. The results show that the accuracy of the biomass yield prediction based on accumulated NDVI is more

than 90% comparing to the ground harvest data so that optimized instrumentation and data processing systems for crop growth, health and stress monitoring and algorithms for field operation scheduling as well data to knowledge was obtained for biomass feedstock mass production. Therefore the high-throughput phenotyping sensing and mapping method can provide a tool for genetic research and plant improvement.

5. 27 High-Field Transport and Thermal Reliability of Sorted Carbon Nanotube Network Devices

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Vinod K. Sangwan, Xuanyu Zhong, Feifei Lian, David Estrada, Deep Jariwala, Alicia J. Hoag, Lincoln J. Lauhon, Tobin J. Marks, Mark C. Hersam, Eric Pop

We examine the high-field operation, power dissipation, and thermal reliability of sorted carbon nanotube network (CNN) devices, with <1% to >99% semiconducting nanotubes. We combine systematic electrical measurements with infrared (IR) thermal imaging and detailed Monte Carlo simulations to study high-field transport up to CNN failure by unzipping-like breakdown. We find that metallic CNNs carry peak current densities up to an order of magnitude greater than semiconducting CNNs at comparable nanotube densities. Metallic CNNs also appear to have a factor of 2 lower intrinsic thermal resistance, suggesting a lower thermal resistance at metallic nanotube junctions. The performance limits and reliability of CNNs depend on their makeup, and could be improved by carefully engineered heat dissipation through the substrate, contacts, and nanotube junctions. These results are essential for optimization of CNN devices on transparent or flexible substrates which typically have very low thermal conductivity.

5. 28 Hypothyroidism and Its Effects on Hippocampal Structure

Gillian Cooke (gcooke@illinois.edu)
Department of Psychology, Beckman Institute, UIUC
Sinead Mullally, Neuman Correia, Shane O'Mara, James Gibney

Thyroid hormones are essential for the adult brain, particularly in regions of the hippocampus including the dentate gyrus, CA1 and CA3 regions. The hippocampus is a thyroid-rich region of the brain involved in learning and memory; subsequently, alterations in thyroid hormone levels have been reported to alter hippocampal associated learning and memory, synaptic plasticity, and neurogenesis. While these effects have been shown largely in developing and adult rats, little is known about effects in humans, particularly adults. We wanted to establish whether hippocampal volumes are decreased in patients with untreated adult-onset hypothyroidism compared to age-matched healthy controls. High-resolution MPRAGE (magnetization-prepared rapid acquisition with gradient echo) scans were performed on 10 untreated hypothyroid adults and 8 age-matched control subjects. Volumetric analysis of the right and left hippocampal regions, using functional magnetic resonance imaging of the brain (FMRIB) integrated registration and segmentation tool (FIRST), exhibited significant volume reduction in the right hippocampus in the hypothyroid patients relative to the control group. While the numbers are small, these findings provide preliminary evidence that hypothyroidism results in structural deficits in the adult human brain. Decreases in volume in the right hippocampus were apparent in patients with adult-onset overt hypothyroidism, supporting findings in animal models.

5. 29 Carbon forestry and poverty alleviation: The more things change, the more they stay the same

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Global carbon forestry programs such as the reducing emissions from deforestation and forest degradation in developing countries (REDD) promises to contribute to poverty alleviation. However, the design phase of such programs show that the principal actors implicated in keeping forest dependent people poor remain in the driver's seat in designing the new carbon forestry economy. Are we then to realistically expect a different set of results? This paper addresses this problematic by presenting provisional results from research carried out on a REDD program in Nigeria, West Africa.

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- O 9:00 – 9:15 Qi Zhang *(1.1)*
  Evolution of Lanthipeptide Synthetases
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  Microfabricated Hydrogel Patch for Bimodal, Dual Protein Drug Delivery
- O 9:30 – 9:45 A. Cuneyt Tas *(1.3)*
  Synthesis of monodisperse micropills
- O 9:45 – 10:00 Sam Lohse *(1.4)*
  Environmental Fate and Transport of Gold Nanoparticles in Natural Water and Soil
- O 10:00 – 10:15 Steven Adie *(1.5)*
  Computed optical coherence tomography for image-guided surgery of breast cancer

Session 2

- O 10:30 – 10:45 Alex Wong *(2.1)*
  Measuring Workplace Outcomes Using the ICF Model in Adult Survivors of Childhood Cancer
- O 10:45 – 11:00 Camille Goudeseune *(2.2)*
  Mechanized GTD
- O 11:00 – 11:15 Erick Paul *(2.3)*
  Interaction between declarative and procedural memory systems
- O 11:15 – 11:30 Sanda Dolcos *(2.4)*
  Perspective Taking and Evaluative Judgments in First Encounters: An fMRI Investigation
- O 11:30 – 11:45 Aga Burzynska *(2.5)*
  Positive effects of physical exercise and aerobic capacity on white matter in old age

Session 3

- O 1:45 – 2:00 Bai Cui *(3.1)*
  Stress Corrosion Cracking Problem of Aged US Light Water Reactors
- O 2:00 – 2:15 Scott Slimmer *(3.2)*
  Electrically Small RF Antennas: Novel Design, Fabrication, and Feed Strategies
- O 2:15 – 2:30 Youbo Zhao *(3.3)*
  High-resolution imaging through scattering media by optical parametric amplification of ballistic photons
- O 2:30 – 2:45 Ashwin Dani *(3.4)*
  State Estimation for Stochastic Nonlinear Dynamical System using Contraction Analysis
- O 2:45 – 3:00 Daria Khvostichenko *(3.5)*
  A microfluidic chip for LCP crystallization and subsequent X-ray analysis of membrane proteins

Session 4

- O 3:15 – 3:30 Kyle Mathewson *(4.1)*
  Human Optophysiology
- O 3:30 – 3:45 Shih-Fang Chen *(4.2)*
  Predictive Models and Uncertainty Analysis of Volatile and Nonvolatile Biomarkers Concentrations in Simulated Exhaled Breath Monitoring
- O 3:45 – 4:00 Julie Allen *(4.3)*
  Multiple radiations of Passerines in the Andes? A phylogenetic perspective on species distributions
- O 4:00 – 4:15 Clare Rittschof *(4.4)*
  Plasticity in honey bee aggression
- O 4:15 – 4:30 Benjamin Blehm
  Two is Better than One: How Opposing Motors Cooperate to Transport Cargo in Living Cells (4.5)

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