REGIONAL CONFERENCE 2016

NOTRE DAME, INDIANA SEPT 30 & OCT 1

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McAlister's Deli

2016 WISC SCHEDULE

CONFERENCE DAY 1 (September 30th)

Event	Time	Location	Details
Check In	5:00 pm - 6:00 pm	JHS: Galleria	Signing in for the conference.
Social Hour	5:00 pm - 6:00 pm	JHS: Galleria	Time to mingle with conference participants over hors d'oeuvres and drinks.
Poster Session	5:00 pm - 6:00 pm	JHS: Galleria	Poster presentations during social hour.
Keynote Speaker	6:00 pm - 7:00 pm	JHS: J101	Opening Keynote: Dr. Kelly Korreck.
South Bend Dinner Groups	7:00 pm - ?	---	Dinner at local South Bend restaurants based on your preference at check in.

CONFERENCE DAY 2 (October 1st)

Event	Time	Location	Details
Check In	8:00 am - 8:45 am	JHS: Galleria	Signing in for the conference.
Welcoming Keynote	9:00 am - 10:00 am	JHS: Galleria	Saturday Morning Keynote
Coffee Break	10:00 am - 10:15 am	JHS: Galleria	Relax
Oral Presentation Sessions	10:15 am - 12:00 pm	JHS: J101 and J105	Oral Presentations
Workshops	10:15 am - 10:45 am 10:55 am - 11:25 am 11:35 am - 12:05 pm	JHS: Classrooms (J322, J310, J325)	- The Value Proposition: discussion about the gender pay gap and tips on how to overcome it. - Grants and Fellowships: setting a funding timeline for your career - Mentorship: learning good expectations and standards of mentorship
Publishing Exhibition**	11:00 am - 1:00 pm	Hesburgh Library Lobby	
Lunch	12:15 pm - 1:15 pm	JHS: Galleria	Lunch with themed discussions at each table with ND faculty or graduate students.
Academic Advice Panel	1:30 pm - 2:30 pm + 15 minutes for questions	JHS: J101 and J105	Academic Advice Panel speakers on page 2.
Outside Academia Resume Reviews	1:30 pm - 2:30 pm	JHS: Galleria and Reading Room	People outside of academia reviewing resume/CVs.
World Outside Academia Panel	3:00 pm - 4:00 pm + 15 minutes for questions	JHS: J101 and J105	World Outside Academia Panel speakers on page 2.
Academia Resume Reviews	3:00 pm - 4:00 pm	JHS: Galleria and Reading Room	Academics reviewing resume/CVs.
Research and Publications Panel**	3:00 pm - 4:30 pm	Hesburgh Library: Cary Auditorium	
Keynote Speaker	7:00 pm - 8:00 pm	Gillespie Conference Center	Our Closing Keynote Speaker: Jeri Mulrow
Cocktail Networking and Dinner	6:00 pm - 9:00 pm	Gillespie Conference Center	Networking with conference participants over light hors d'oeuvres and drinks, followed by dinner.

*JHS = Jordan Hall of Science

** = Part of the Rigor and Relevance in Scholarly Publishing Conference

MEET THE WISC SPEAKERS

KEYNOTES

KELLY KORRECK
ASTROPHYSICIST
HAVARD-SMITHSONIAN
CENTER FOR ASTROPHYSICS

SUSAN COPPERSMITH
PROFESSOR
DEPARTMENT OF PHYSICS
UNIVERSITY OF WISCONSON

JERI MULROW
ACTIGING DIRECTOR
BUREAU OF JUSTICE STATISTICS
WASHINGTON D.C.

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KATHERINE MCMAHON
BACTERIOLOGY & CIVIL AND ENVIRONMENTAL ENGINEERING
UNIVERSITY OF WISCOSIN

VERONICA QUITALO
ASSISTANT PROFESSOR
MATHEMATICS
PURDUE UNIVERSITY

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ARGONNE NATIONAL LABORATORY

TESSA BERRY
SR. RESEARCH ENGINEER
DATA SCIENTIST
HERE: CHICAGO, IL

ORAL PRESENTATION SCHEDULE

Dr. Rebecca Wingert - Room J105

10:15 **Julia Beck**
The Role of Kringle Domain Lysine Binding Sites (LBS) of Human Plasminogen in Interacting with Group A Streptococcal M-like Protein (PAM)

10:35 **Kristen Johnson**
The Ebola Virus Matrix Protein and Membrane Fluidity

10:55 **Sarah Lum**
Capillary Zone Electrophoresis Automated Fraction Collection for the Forensic Analysis of Sexual Assault Evidence

11:15 **Cassandra Gohn**
MEOX2 regulation of fetal endothelial progenitor cell function

11:35 **Sarah Ohlemacher**
Functional Maturation and Long-Term Survival of Human Pluripotent Stem Cell-Derived Retinal Ganglion Cells

11:55 **Ashley Martin**
The C. elegans sarcoplasmic reticulum calcium-ATPase regulates nicotinic acetylcholine receptor ACR-16 expression

Tierney Miller - Room J101

10:15 **Claire Bowen**
Differentially Private Data Synthesis Partitioning for Big Data

10:35 **Courtney Henry**
A Simulation Tool to Evaluate Calcium-41 Experimental Study Designs

10:55 **Abigail Azari**
Saturn's Magnetosphere: Overview and Investigation of Plasma Interchange Events

11:15 **Katherine Schreiber**
Two Dimensional Electron Systems at Low Temperature and High Pressure

11:35 **Jessica Blaxton**
A Process-Oriented Approach on Dispositional Resilience, Daily Stress, and Daily Negative Affect

11:55 **Andrea Kalchik**
Location-Based Prospective Memory

ORAL PRESENTATION ABSTRACTS

Azari, Abigail – Saturn's Magnetosphere: Overview and Investigation of Plasma Interchange Events

ABSTRACT: Saturn's plasma environment is unique within our solar system and provides intriguing observations of planetary plasma physics. While Earth's magnetosphere is primarily composed of plasma from the solar wind and Earth's upper atmosphere, Saturn's magnetospheric plasma is also sourced by cryovolcanic outgassing from Enceladus, and experiences much larger co-rotational forces due to Saturn's rapid (~11h) spin rate. These effects contribute to the observed injection of energetic particles from the outer reaches of the magnetosphere to the middle and inner magnetosphere through a Rayleigh-Taylor like plasma instability. Commonly termed interchange injections, these events provide fascinating insights into the behavior of space plasmas surrounding fast rotating planets.

I will present an overview of Saturn's magnetosphere in comparison to other planetary bodies, and an evaluation of two clusters of interchange injection events, observed ~14-18 hours apart, for the potential of the two clusters being sourced from the same unstable plasma configuration. This research is applicable to the study of plasma instabilities in other astrophysical plasmas and rotating systems.

Beck, Julia – The Role of Kringle Domain Lysine Binding Sites (LBS) of Human Plasminogen in Interacting with Group A Streptococcal M-like Protein (PAM)

ABSTRACT: Plasminogen (Pg) conversion to the serine protease plasmin via host and exogenous factors results in activation of the human fibrinolytic system and ultimately degradation of fibrin and extracellular matrices. Group A Streptococcus (GAS), a bacterial pathogen responsible for diseases including rheumatic heart disease, impetigo, and necrotizing fasciitis, activates Pg through the extracellular protein, streptokinase (SK). This process is enhanced when virulence factors M or M-like proteins, i.e., PAM, found on the surface of GAS, bind to Pg. Pg has 5 kringle domains (K1-K5) which are homologous triple-disulfide-linked peptide regions of approximately 80 amino acids in length. It has previously been shown, by examining interactions of hPg and PAM fragments, that PAM selectively binds to the second kringle domain, K2, of Pg. Kringle domains, excluding K3, bind to ω-amino acids such as lysine and its analogues. The lysine binding site (LBS) is created by a minimum of five amino acids, two residues of Asp, one of Arg, and two of Trp/Tyr/Phe, within a defined binding pocket of the kringle. In this study, we have examined intact protein hPg/PAM interactions, by eliminating the LBS of each of the kringle regions in hPg. To accomplish this, mutations were constructed on one critical Asp residue of each kringle region (D->N), thus removing the anionic loci and abolishing the LBS. Native human Glu-Pg and mutants for kringles 1, 2, 4, and 5 were expressed in S2-Drosophila cells and purified by Sepharose-lysine chromatography. Binding analyses of Pg mutants to recombinant PAM were performed using surface plasmon resonance. The mutants bound comparably to PAM as to that of WT-hPg. However, no binding was detected for the K2 mutant. Additionally, Pg activation assays using two SKs from cluster 1 and cluster 2b were performed with the Pg mutants in the presence and absence of PAM. In comparison to WT-hPg, the mutants demonstrated a faster rate of activation in the absence of PAM. Upon the addition of PAM, native plasminogen showed increased activity. We have previously shown that the open conformation of hPg is more easily activated than the closed conformation. It is our hypothesis that the mutants also adopt this open conformation, and that PAM further shifts Glu-hPg into this open conformation. Analytical ultracentrifugation, in the absence and presence of LBS-directed ligands, has verified these changes in conformation. These studies serve to further elucidate the role of LBS in PAM binding and GAS virulence.

Blaxton, Jessica – A Process-Oriented Approach on Dispositional Resilience, Daily Stress, and Daily Negative Affect

ABSTRACT: We explore how dispositional resilience impacts the daily relationship between stress and negative affect (NA) and whether cross-sectional age differences moderate these relationships. The

participants came from the Notre Dame Study of Health & Well-Being (N = 964; Age 31 – 91; M = 59.06, SD = 9.78). They completed 56 days of daily diaries distributed every two years over an eight-year period and global questionnaires distributed each year. Three-level multi-level models revealed that greater within-person daily stress ($\delta 200 = 0.43$, $p < .001$) and within-person wave stress ($\delta 010 = 0.48$, $p < .001$) related to greater negative affect whereas greater between-person stress ($\delta 001 = -0.11$, $p < .001$) and higher dispositional resilience ($\delta 002 = -0.02$, $p = .033$) related to lower NA. Two-way interactions revealed that within-person dispositional resilience ($\delta 210 = -0.001$, $p = .005$), cross-sectional age ($\delta 201 = -0.01$, $p < .001$), and between-person dispositional resilience ($\delta 202 = -0.003$, $p < .001$) buffered the relationship between daily stress and NA. Moreover, a three-way interaction revealed that within-person dispositional resilience buffered the relationship between daily stress and NA differently depending on cross-sectional age, with dispositional resilience buffering the daily stress-NA relationship on days of high stress for younger adults but days of low stress for older adults ($\delta 211 = 0.0002$, $p < .001$). Findings highlight how both within and between-person differences in stress and dispositional resilience relate to daily NA and how these relationships diverge according to cross-sectional differences in age.

Bowen, Claire – Differentially Private Data Synthesis Partitioning for Big Data

ABSTRACT: As the era of information and technology continues to dominate, big data offers tremendous benefits for education, economics, medical research, national security, and other areas through data-driven decision-making, insight discovery, and process optimization. However, one of the significant challenges in analyzing big data is the extreme risk of exposing personal information of individuals who contribute to the data when sharing it among collaborators or releasing it publically. An intruder could identify a participant by isolating the numerous connections to other contributors within the big dataset. One method that preserves differential privacy (DP), a condition on data releasing algorithms with strong mathematical guarantee for individual privacy protection, is differentially private data synthesis (dips). This approach generates synthetic individual-level data while guaranteeing privacy at a prespecified level from DP. We explore various partitioning methods for dips on datasets with a large number of observations to improve the statistical utility and compare them to provide guidance on practical feasibility.

Gohn, Cassandra – MEOX2 regulation of fetal endothelial progenitor cell function

ABSTRACT: In the United States, 10% of pregnancies are complicated by diabetes mellitus (DM). This syndrome can have long-lasting implications for the fetus, including cardiovascular morbidity. Previously, we showed that endothelial colony forming cells (ECFCs) from DM human pregnancies have both decreased vessel-forming ability and increased senescence. Further, we showed that nuclear Mesenchymal Homeobox 2 (MEOX2) is upregulated in ECFCs from DM pregnancies ($n=9$, $p<0.05$). MEOX2 is a transcription factor which inhibits angiogenesis by upregulating cyclin dependent kinase inhibitors.

The central hypothesis is that upregulated MEOX2 in fetal ECFCs from DM pregnancies decreases tube formation through increased senescence and altered cell cycle progression. Using lentiviral overexpression techniques, and lentiviral and siRNA knockdown techniques, MEOX2 protein level was manipulated in ECFCs from control and DM pregnancies, respectively. These cells were subjected to matrigel tube-formation, flow cytometric analysis of cell cycle progression, senescence-associated-β-galactosidase assays, and transwell migration assays. MEOX2-overexpression increased tube formation ($n=3$ transductions, $p<0.05$), altered cell cycle progression ($n=3$ transductions, $p<0.001$), and increased senescence ($n=4$ transductions, $p<0.01$), and migration ($n=5$ transductions, $p<0.01$). MEOX2-knockdown decreased tube formation ($n=12$ transfections, $p<0.01$) and migration ($n=6$ transfections, $p<0.01$), while cell cycle progression ($n=9$ transfections, $p>0.05$) and senescence ($n=5$ transductions, $p>0.05$) were unaltered. Taken together, these data suggest that alterations in cell cycle progression and senescence are not responsible for the disrupted vasculogenesis of ECFCs from DM pregnancies. Importantly, however, these data suggest that altered migration may be a key mechanism involved.

While initially believed to be maladaptive, the data suggest MEOX2 may serve a protective role, enabling increased vessel formation despite exposure to a DM intrauterine environment. Future studies will seek to further elucidate the mechanism responsible for the alterations in tube formation and the upregulated nuclear MEOX2 seen in samples from DM pregnancies. Ultimately, the goal is to establish MEOX2 as a potential therapeutic target to restore angiogenesis in children of DM mothers.

Henry, Country – **A Simulation Tool to Evaluate Calcium-41 Experimental Study Designs**

ABSTRACT: Osteoporosis is a progressive bone disease that reduces bone mineral density (BMD) leading to an increased risk of bone fracture. It largely affects post-menopausal women who incur a sharp decline in estrogen production, which has a key role in the proper growth and maturation of bone. Alternative and integrative health approaches for preventing disease occurrence, primarily through use of natural dietary supplements, are currently being sought due to the adverse health risks associated with conventional hormone replacement therapies. To assess the effectiveness of these disease interventions, a well-established novel and sensitive screening technique incorporating a biological tracer, calcium-41 (41Ca), is used to rapidly and sensitively monitor bone resorption. Urinary 41Ca:Ca isotope ratio, monitored by Accelerator Mass Spectrometry (AMS), is used to detect changes in bone calcium metabolism. 41Ca experimental studies use a randomized-order cross-over design to determine the final outcome measure for treatment effectiveness, expressed as net calcium retention, which is the ratio of urinary 41Ca in treatment periods compared with control periods, or percent calcium retained as compared with untreated periods.

We describe a 41Ca simulation study that serves as a tool to investigate how inputs of sample size, number of control periods, and number of control samples per period will affect the output: (1) the accuracy (standard error) of reported mean estimates of treatment effect, (2) the power of the study to detect given effect sizes, and (3) the cost of the experimental study. This tool will determine “optimal” 41Ca experimental designs, which are uniquely defined as the most efficient study designs that preserve the accuracy and reliability of the original experimental estimates but require a reduced number of experimental samples, which notably provides a cost reduction. Ultimately, these new designs will be implemented to further increase the practicality and utility of 41Ca methodology in future translational research studies, targeted to reduce the risk of osteoporosis.

Johnson, Kristen – **The Ebola Virus Matrix Protein and Membrane Fluidity**

ABSTRACT: Matrix proteins are essential components of a successful viral infection. In lipid enveloped viruses the matrix protein is responsible for forming the virus particle, in many cases they can do this independently of other viral proteins. Viral matrix proteins form a matrix through self-oligomerization and lipid binding that forms a solid coat of protein within the virus particle. While the interpretation of the word matrix, coating of a surface is representative of the functions of these proteins we are beginning to understand that there may be a more mathematical “matrix” design encoded into these proteins. In this code, the protein can detect x, y, and z planes, all are a requirement for function at a specific location. We now know that the Ebola matrix protein, VP40, requires interactions with specific lipid head groups (x), and interactions with itself (oligomerization, (y)) for function. Now we are beginning to decode a “z plane” requirement for function, lipid membrane fluidity and saturation. We believe that VP40 selection for membrane fluidity and lipid saturation may bear equal or greater importance to headgroup binding and self oligomerization as the lipid packing environment may be a prerequisite if not a co-requisite for the other two events. We are investigating the role of membrane fluidity in VP40 membrane binding and bending using imaging techniques, and liposome binding assays. Through this investigation we have identified several FDA approved drugs that modulate membrane fluidity and as a result block the VP40-membrane interaction. We aim to decode the mechanism of VP40 membrane fluidity sensing to prevent further Ebola virus outbreaks.

Kalchik, Andrea – Location-Based Prospective Memory

ABSTRACT: Background: The aim of this project was to explore a previously unstudied type of prospective memory (PM), namely, location-based PM. People often have to remember to do things when they find themselves in a particular location, such as buying tissues the next time they go to the supermarket. The event cognition literature has consistently demonstrated that location is important for structuring events in retrospective memory, which supports the idea that location-based cues are likely to be effective for prospective memory as well. However, as event cognition has not yet been used to examine prospective memory, the literature leaves open the question of whether multiple events will improve or impair performance on a PM task. To answer this, in the present experiment, participants were given either one or two PM instruction events, and either one or two target events (i.e., the location-based cues).

Method: Participants were psychology students from the University of Notre Dame. In this experiment, people delivered messages from store to store in a virtual shopping mall as an ongoing task. There were 24 trials, with two PM tasks per trial (e.g., If you happen to go to GAP, please help put up sales posters). Participants received those two tasks in either one common location or two different locations. Likewise, they later had to remember to do those two tasks in either one common location or two different locations. Thus, there were four between-subjects conditions in terms of instruction and target locations: 1-1, 2-1, 1-2, and 2-2, respectively. In addition, the number of stores a person was sent to prior to the PM target store varied on each trial, creating within-subject categories of short (3-5), medium (6-8), and long (9-12) delays.

Results: Participants had significantly improved performance when they received instructions from two locations and performed both tasks in one location. The other three conditions did not differ from each other. Across conditions, participants made fewer correct responses and more error responses as the delay length increased. When making errors, participants were significantly more likely to do the wrong task in the correct location than any other type of error, which suggests that people use location to structure PM like they do with retrospective memory.

Conclusion: Prospective memory was selectively enhanced when there were two instruction events and one target event. Thus, this study demonstrates for the first time that event structure, in this case defined by changes in location, influences how well people are able to remember prospectively.

Lum, Sarah – Capillary Zone Electrophoresis Automated Fraction Collection for the Forensic Analysis of Sexual Assault Evidence

ABSTRACT: There is presently an estimated half million national backlog in processing sexual assault kits in the US. The main challenge faced in crime labs analyzing these cases is the separation of purified male DNA from the mixture of primarily female DNA on a gynecological swab. Effective elution of the sample from the swab and efficient separation of intact sperm cells from epithelial cells and other debris allow for a successful polymerase chain reaction (PCR) amplification and short tandem repeat (STR) analysis of the perpetrator DNA. Capillary zone electrophoresis (CZE) is a promising avenue to perform the cell separation as it boasts three major advantages over present technologies: small sample size allowing for multiple analysis of limited available evidence, rapid separation time compared to standard methods and single cell detection and collection when interfaced with our automated fraction collector (FC). In this work, a buccal swab is used to generate epithelial cells, which are mixed with human sperm. The mixture is lightly agitated and eluted in buffer to release sample. The sample is directly electrokinetically or pressure injected into CZE where whole cells and lysed cellular matrices are separated by their unique charge and size ratios. Preliminary experiments utilize laser detection to determine the migration time of sperm cells. Results show that sperm migrate in a confined band in less than 15 minutes (compared to current methods taking up to 1 week to purify the sample). Using optimized CZE-LIF parameters, factors are replicated on a CZE-FC instrument where the sample is collected into individual wells on a 96 well plate. Light microscopy is used to confirm the separation and

collection of purified sperm cells. The isolated sample will then undergo PCR amplification and STR analysis for forensic identification.

Martin, Ashley – The C. elegans sarcoplasmic reticulum calcium-ATPase regulates nicotinic acetylcholine receptor ACR-16 expression

ABSTRACT: At the C. elegans body wall neuromuscular junctions (NMJs) there are two cholinergic ionotropic receptor types, one that is heteromeric and activated by levamisole (LAChR) and one that is homomeric, alpha-7-like, and activated by nicotine (NAChR). Conserved components of a novel synaptic cleft scaffold have been implicated in the clustering of LAChRs, but the expression of the colocalized NAChR appears completely normal when these proteins are absent. The only receptor subunit known to be required for the C. elegans NAChR is ACR-16, which can form functional homo-pentameric receptors. This suggests that other, unidentified proteins regulate ACR-16 receptor expression.

A forward genetic screen was performed to isolate candidate genes involved in ACR-16 expression. The screen utilized a single-copy integrant of ACR-16::GFP to isolate mutants that decrease the synaptic level of ACR-16::GFP. From this screen a mutant was identified, referred to as EMS28. Electrophysiological recordings demonstrated a reduction in the evoked NMJ response in this mutant. Further characterization suggested that LAChRs are unaffected as there was no change in response to pressure-ejected levamisole in the mutant and the fluorescence level of RFP-tagged LAChRs was also normal. Whole genome sequencing, using the Variant Density Mapping approach, has revealed the sarcoplasmic reticulum calcium-ATPase sca-1 as a likely candidate gene for the EMS28 mutation. A sca-1 reference mutant strain phenocopies the ACR-16::GFP expression defects, and also fails to complement the EMS28 mutant. The expression and localization of LAChRs and inhibitory GABA receptors seem unaffected in a sca-1 mutant background as levels of LAChR::RFP and GABAR::GFP fluorescence are wild type. Behavioral assays show a more severe uncoordinated phenotype in a sca-1;LAChR mutant background, implying an affect on ACR-16 receptors. The affects of sca-1 on ACR-16 receptor function are not caused by defects in NMJ patterning, as there is no change in the number of synapses and muscle structure is wild type in these mutants. Electrophysiological recordings show a significant reduction in the evoked response of sca-1 mutants suggesting a functional affect on the receptors. Responses to pressure-ejected nicotine in sca-1 mutants are wild type. This implies the receptors are mislocalized at the NMJ. The reintroduction of SCA-1 driven by a muscle specific promoter is able to rescue the reduction in levels ACR-16::GFP and the increased uncoordination seen in sca-1;LAChR double mutants. Continued characterization of the sca-1 mutant is ongoing and should reveal the mechanism by which ACR-16 is regulated.

Ohlemacher, Sarah – Functional Maturation and Long-Term Survival of Human Pluripotent Stem Cell-Derived Retinal Ganglion Cells

ABSTRACT: Retinal ganglion cells (RGCs) play an essential role in transmitting visual information from the eye to the visual thalamus in the brain. They are also the primary cell type affected in traumatic retinal injuries as well as optic neuropathies. Human pluripotent stem cells (hPSCs) provide an attractive source of cells that can be used for patient-specific cell replacement therapies, drug screening, and disease modeling. However, little is known about the functional maturation of these hPSC-derived RGCS. As such, the development of these neurons was evaluated over time, and methods in which to influence their maturation and functionality were tested. hPSCs were differentiated toward a neural lineage in a stepwise fashion as previously described, yielding highly enriched populations of optic vesicle-like neurospheres. Within 40 days of differentiation, presumptive RGCs differentiated in a temporally-appropriate manner and expressed a compliment of RGC-associated features as well as proper morphological features. In prolonged culture, subtypes of RGCs emerged over time, including melanopsin-expressing intrinsically photosensitive RGCs. The maturation of hPSC-derived RGCs in extended cultures was observed by extensive neurite outgrowth, and the development of synaptic-like structures was further examined by microscopy and electrophysiology. These results will facilitate the use

of hPSC-derived RGCs to study the progression of neuronal development and degeneration, the development of drug therapeutics and the use of hPSC-derived RGCs for cell replacement therapies.

Schreiber, Katherine – **Two Dimensional Electron Systems at Low Temperature and High Pressure**

ABSTRACT: When electrons are confined to two dimensions in very clean semiconductor nanostructures, cooled to a few thousandths of a Kelvin, and subjected to intense magnetic fields, novel electron phases form. One electron phase is the electronic nematic phase, whose signature is spontaneously broken rotational symmetry. Another very famous set of electron phases are the integer and fractional quantum Hall states. Perhaps the most intriguing of the quantum Hall states is the 5/2 state, still relatively poorly understood, but predicted to have unusual properties that could be used in quantum computing. Motivated to probe the 5/2 fractional quantum Hall state, we subjected our sample to another extreme condition: hydrostatic pressure up to 10 kbar. Hydrostatic pressure results in the shrinking of the lattice constant, allowing one to tune band parameters such as effective carrier mass, carrier density, and effective g-factor. In this manner, pressure acts as a probe into the properties of the 5/2 state.

In this talk, I will describe the physics of the quantum Hall effect and discuss the results of the application of high pressure. Excitingly, we observed a phase transition from the 5/2 quantum Hall state to the electronic nematic phase as we increased the pressure. This phase transition had not been previously observed, and has important implications for the understanding of the 5/2 fractional quantum Hall state.

POSTER PRESENTATION ABSTRACTS

Agrahari, Garima – Streptococcus pyogenes Employs Multiple Mechanisms of C3b Inactivation to Inhibit Phagocytosis

ABSTRACT: Group A Streptococcus pyogenes (GAS) is a spherical, Gram-positive bacterium that is responsible for numerous diseases with diverse clinical manifestations, specifically in humans. GAS can cause common illnesses such as impetigo, pharyngitis, and scarlet fever but can also cause life-threatening sequelae, such as necrotizing fasciitis, streptococcal toxic shock syndrome (STSS), and acute post-streptococcal glomerulonephritis. GAS infections remain a leading cause of global mortality and morbidity. Approximately 18 million prevalent cases are found to be severe with nearly 2 million new cases reported per year worldwide. Although GAS remains uniformly susceptible to penicillin, methods for the prevention of GAS associated diseases are inadequate. Therefore, a better understanding of the cellular and molecular mechanisms of GAS infection would facilitate in designing and developing broad-spectrum drugs and diagnostic tools. To establish infection, GAS must develop evolutionary strategies to evade the host innate immune system, especially complement-mediated elimination of the microbe. In general, GAS inhibits the amplification of the complement cascade on its cell surface by facilitating the degradation of C3b, an opsonin, to an inactive product, iC3b, catalyzed by Factor I (FI) and its cofactor, Factor H (FH), with or without participation of human host plasmin (hPm). GAS recruits FH to its cell surface via FH receptors, which are transcriptionally controlled by the two-component CovRS system. The manner in which FI/FH and hPm function together on GAS cells is unknown. Using the GAS strain AP53, which binds host human plasminogen (hPg)/hPm directly via a hPg/hPm surface receptor, Plasminogen binding Group A Streptococcal M-like protein (PAM), we have shown that both FI/FH and hPm sequentially cleave C3b. While FI/FH proteolytically cleaves C3b into iC3b, hPm cleaves iC3b into multiple smaller peptides. These results suggest that GAS utilizes diverse mechanisms to degrade C3b and thus protects bacterial cells from the host complement response.

Amenson, Emily – High Sensitivity CZE-ESI-MS Investigations and Proteomics Applications

ABSTRACT: In this study we demonstrate the high sensitivity of our in-house built electrokinetic sheath flow interface to couple capillary zone electrophoresis to a Thermo QE-HF mass spectrometer (CZE-ESI-MS). This interface is designed to provide exquisite sensitivity with a robust performance. HF-etched capillaries employed in these studies add to the sensitivity of the interface, while narrow inner diameters increase the resolution of the resulting electropherograms.

In these studies, we have examined this performance by determining a limit of detection via single reaction monitoring using a standard bovine serum albumin (BSA) tryptic digest spiked with an exact amounts of angiotensin II. A calibration curve of spiked angiotensin II in a constant concentration of the BSA digest showed linearity from 100 zeptomole to 10 femtomole loading amounts. Further dilutions of angiotensin II showed reproducible signals for 10 zeptomole loading amounts, and a limit of detection on the order of yoctomole loading amounts. Preliminary results of studies with even narrower ID capillaries have shown reproducible signal for 1 zeptomole loading amounts.

Further studies are ongoing in the detection of low concentration peptides naturally found within a protein digests of BSA and E. coli cells. In these experiments, we aim to build a library of accurate mass tags for a digest, and then apply this library to the analysis of small samples (i.e. single cells). The results of these studies will shed light on the system's usefulness for applications in proteomics and metabolomics studies.

Anderson, Elsa – Evaluating historic, local, social, and landscape drivers of species diversity in vacant lots in Chicago, IL, USA

ABSTRACT: Vacant lots represent a relatively large area of under-tended land in dense cities, and are also a confluence point of ecological and social processes. As such, vacant lots offer a unique study system for understanding the ways in which numerous variables across a socio-ecological spectrum influence urban biodiversity. During the summer of 2015, we visited 35 vacant lots in Chicago. In each lot, we measured plant diversity and other local factors, including human influence in the form of trash, footpaths, dumping, and parking. We combined this in situ data with current and historic parcel data and current census data for each neighborhood. We used generalized linear models to help determine the relative strength of four different drivers of plant diversity in vacant lots: (1) historic land use factors (2) socio-economic factors (3) local environmental factors, and (4) landscape-level environmental factors. Our results indicate that urban plant communities are influenced by many drivers and are highly heterogeneous across the landscape, but that there are certain human influences that restrict the community. This knowledge contributes to understanding and conservation of urban biodiversity by identifying management activities that can increase plant biodiversity and the ecosystem services plants provide to urban residents.

Barrett, Katherine – Evaluating changes in the benthic macroinvertebrate community of southwestern Lake Ontario following invasion by four Ponto-Caspian species

ABSTRACT: Beginning in the mid-1980s, the Laurentian Great Lakes underwent successive invasions by Ponto-Caspian species. We quantified major changes in the diversity and relative abundance of pre-invasion benthic macroinvertebrates at the same study site in southwestern Lake Ontario from 1983–2014. The zebra mussel Dreissena polymorpha Pallas arrived at the study site before 1991, the quagga mussel Dreissena rostriformis bugensis Andrusov and the amphipod Echinogammarus ischnus Stebbing arrived before 1999, and the Round Goby Neogobius melanostomus Pallas arrived about 2004. The macroinvertebrate community in 2014 was very different from 3 earlier communities in 1983, 1991, and 1999. In 2014, pulmonate and prosobranch snails and sphaeriid bivalves were absent, D. r. bugensis replaced D. polymorpha, E. ischnus replaced Gammarus fasciatus Say as the dominant amphipod, and a previously diverse community of benthic fish was replaced by abundant N. melanostomus. From 1983 to 1999, the relative abundance of prosobranchs and pulmonates declined 10-fold and rose 2-fold, respectively. From 1991 to 2014, the relative abundance of oligochaetes and chironomids increased 50- and 3.5-fold, respectively. The shifts we report probably are attributable to nutrient enrichment of the nearshore of Lake Ontario during the 1990s leading to a thick carpet of macroalgae, a change in the base of the benthic food web from dressenid feces and pseudofeces to macroalgal detritus, and predation by N. melanostomus on snails.

Caceres-Velazquez, Hildamarie – Protein half-life mediates a tradeoff between environmental responsiveness and efficient growth

ABSTRACT: Despite tremendous historical and ongoing efforts to catalog the taxonomic and genetic diversity of bacteria, microbial ecologists still possess a poor understanding of the factors that dictate the fitness of individuals in an everchanging environment and potentially maintain bacterial diversity. The rate at which a bacterium turns over its proteins, which appears to be a reasonably static trait, determines how quickly a bacterium can respond to changes in the environment. However, rapid protein turnover is energetically costly, at times consuming >75% of a bacterial cell's energy budget. We hypothesize that a tradeoff between growth efficiency and environmental responsiveness exists in bacteria, and that this tradeoff is mediated by protein half-life. We used a comparative biology approach to explore the potential for protein half-life to mediate such a tradeoff. Further, to understand the implications of this tradeoff, we used a mathematical model to generate predictions for the outcome of competition between bacterial strains that differed in their protein half-lives under temporally varying environmental conditions. We then validated this model using laboratory competition experiments. Our results suggest that our hypothesized tradeoff may be generally important in the study of bacterial community dynamics, regardless of ecosystem type.

Carothers, Katelyn – Identification of a host keratinocyte cell target of Streptococcus pyogenes toxin Streptolysin S

ABSTRACT: Streptococcus pyogenes, also known as Group A Strep (GAS) is a common colonizer of human skin and mucosal surfaces, and the causative agent of diseases ranging from mild skin and throat infections to severe invasive disease and post-infection autoimmune complications. One of the most potent virulence factors produced by GAS is Streptolysin S, or SLS. SLS is a small peptide encoded by the Streptolysin-associated gene (Sag) cluster, with genes for the pro-toxin and modifying enzymes. While the structure of SLS has not been fully elucidated, it is known to have cytolytic activity in a number of host cells, and produces a characteristic β-hemolytic phenotype in erythrocytes. Our lab has investigated the mechanisms by which SLS targets host cells and induces downstream cell signaling resulting in inflammatory responses and cell death. It has been previously demonstrated in our lab that SLS induces lysis in erythrocytes by osmotic imbalance via disruption of the ion channel Band 3. SLS is also known to have cytotoxic activity in keratinocytes that do not express Band 3, and this cytotoxicity can be reduced using the ion channel inhibitor DIDS. We therefore hypothesize that SLS is targeting an ion channel in keratinocytes and propose a strategy to identify this target using a biotin-tagged form of the ion channel inhibitor DIDS and a pulldown using biotin's high affinity for Streptavidin-coated beads. Identification of this keratinocyte target furthers our understanding of GAS pathogenesis during skin infection and how the bacteria may breach the epithelial barrier to cause more invasive disease.

Cao, Tianyuan – Hybrid Membrane Detection by Terahertz-Raman Spectroscopy

ABSTRACT: With the fast development of self assembled monolayer and comprehensive analytical techniques, model membrane system has been developed to mimic cell membranes under various conditions. Raman spectroscopy and imaging has been used to study the featured vibrational responses and the distribution of biomolecules in living cells. Phospholipid composition and structure, therefore, are believed to affect the interaction of biomembrane itself with other molecules present. Phospholipid membrane structure and composition in bacteria largely impact their biological process, including metabolism, cell communication and nutrients transportation, making predicting bacterial behavior not straightforward. Most current studies which employ Raman or Surface enhanced Raman spectroscopy (SERS) are focused on 1000 cm^{-1} to 1400 cm^{-1} region and 2800 cm^{-1} to 3000 cm^{-1} region which mainly represents the skeletal vibrations of C-C bonds and C-H stretching vibrations respectively. Here, we present a novel analytical platform of a wider Raman detection range named Terahertz (THz)-Raman spectroscopy. Equipped with a customized Rayleigh rejecting filter, THz-Raman technique is able to extend detection range to a lower frequency (~20 cm^{-1}) and allows access to discriminate compounds with slight structural differences featuring low energy vibrational modes. In this project, substrates are prepared by thermo evaporating silver (50nm) on filter paper, immersing in cetrimonium bromide solution overnight, and treating with different phospholipid vesicles. Stabilized samples are detected under Terahertz and surface enhanced Raman spectroscopy. Results show that characteristic peaks of a single layer with long alkyl chain molecules can be verified and utilized to support hybrid bilayer vibrational signals after introducing phospholipids to the system. Further assessment of THz-Raman/SERS techniques on bacterial membrane needs to be given to the complex effects on mosquito life traits, including the possible effect of redistributed bites to untreated individuals.

Chatterjee, Rusha – Visualizing the dimensionality-dependent evolution of a semiconductor's electronic structure

ABSTRACT: Despite numerous studies investigating the origin of the ~100 meV band gap differences between 1D and 0D nanostructures, no consensus exists as to when a 1D object transitions into a 0D one. We therefore demonstrate the use of spatial modulation single particle absorption spectroscopy to understand the dimensionality-dependence of CdSe's electronic structure as it transitions from a 1D to a 0D nanostructure. This approach has the unique advantage of measuring a nanostructures true optical response, free of

inhomogeneous broadening inherent to ensemble measurements. Furthermore, it serves as a better indicator of electronic structure than photoluminescence since absorption is unaffected by defect states. Specifically, we probe the absorption of equidiameter single CdSe nanowires (NWs), and nanorods (NRs) of varying lengths, using a home-built spatial modulation set-up. We unambiguously show significant blueshifts of the lowest energy transition in single 1D nanostructure absorption spectra as a function of length. Observed transition energies are modeled by accounting for both carrier quantum confinement, as well as electron-hole electrostatic interactions. Furthermore, we account for the aspect ratio-dependent interplay between these two contributions and find the critical length at which the 1D-to-0D transition occurs. We also find that the transition is diameter dependent and occurs only at lengths around or below twice CdSe's bulk exciton Bohr radius. We therefore demonstrate the 1D-to-0D transition of a semiconductor while simultaneously expanding the limits of conventional single particle optical spectroscopies.

Chesney, Tegan – Fitting a Model to Predict the Number of Fatalities Resulting from Terrorist Attacks

ABSTRACT: Based on the Global Terrorism Database collected by the National Consortium for the Study of Terrorism and Responses to Terrorism, the number of fatalities resulting from terrorist attacks appears to be increasing. The goal of this project is to assess this apparent trend in a systematic way. In our initial analysis, we fit a multiple regression model to the data that used year (1970 – 2015) and global region to predict fatalities in a particular year. Results from this model suggest significant differences among the rate of fatalities from terrorist attacks across regions in the world. Specifically, South Asia, the Middle East and North Africa, and Sub-Saharan Africa were found to have a significantly steeper increase per year and significantly higher rates than North America. Upon examining the residuals of our model, it became clear that the rate of fatalities from attacks across all regions follow a non-normal distribution. Because linear models assume that residuals follow a normal distribution, we used a Monte Carlo simulation study to assess if we could still rely on the test statistics from the linear model despite this non-normality. The settings of the simulation study were based on the results of our empirical analysis. We ran the simulation 10,000 times, aggregating the estimates and their p-values of the multiple regression analysis. Then, we evaluated the power for each significant predictor, type I error, and the relative bias of the model. Results from the simulation study indicate that the model still performed relatively well despite the violated assumptions. We conclude that if the residual error is indeed similar to the generated error, then we can justify the use of the linear model despite the violation of the assumption of normality, thereby supporting the conclusions drawn in our initial analysis.

Curtis, Kimberly – Mechanical Stimulation of Bone Marrow Alters Kinase Signaling to Induce Bone Formation in Trabecular Bone

ABSTRACT: Mechanical stimulation of bone acts to preserve or increase bone mass by eliciting a cellular response, yet how the mechanical signals are sensed by different cells remains poorly understood. Although osteocytes are believed to be the primary sensor of bone deformation, many cells in the marrow are also mechanosensitive. Thus, mechanical stimulation of marrow cells may contribute to bone adaptation in trabecular bone. The objective of this study was to elucidate the cell lineages and pathways involved in bone formation when marrow is subjected to mechanical stimulation. Specifically, a bioreactor that imparts shear stress to marrow cells via LMMS was used to culture porcine trabecular bone explants and 1) the rate of bone formation was quantified, 2) expression of activated kinases was analyzed in the marrow cell population, and 3) the relative expression of genes associated with mechanotransduction was quantified in the osteocytes. Two groups of eight trabecular explants were harvested from porcine cervical vertebrae and cultured for 28 d in growth media. LMMS was applied to one group, and the other was not stimulated (SHAM). Fluorochromes were administered to label forming bone. Expression of 45 phosphorylated kinases was measured in marrow cells from LMMS and SHAM treated explants after 5 and 28 d of culture using a protein array. Sclerostin expression was measured by IHC in explants cultured for 5 d. Bone explants were snap frozen, and RNA was reverse transcribed into cDNA. The relative expression of SOST, IGF-1, RANKL, OPG, Cyr61, and CTGF was measured using custom primers with ribosomal protein S2 (RPS2) as a reference.

LMMS induced more bone formation in comparison to SHAM culture. The bone formation rate was 35% higher in the LMMS group. Expression of phosphorylated kinases in the marrow was differentially regulated at both 5 and 28 d. Neither the percentage of sclerostin-positive osteocytes nor SOST gene expression differed in explants cultured with and without mechanical stimulation. Other genes associated with osteocyte mechanobiology were also similar between LMMS and SHAM explants.
The results demonstrate that mechanobiological signaling in the marrow can contribute to bone formation in trabecular bone. LMMS induced more bone formation compared to SHAM treated explants, which was associated with altered kinase signaling in the marrow cells. Osteocyte signaling did not appear to play a role. Marrow is composed of a heterogeneous population of cells in which kinase signaling may have differing effects. Stimulated marrow cells expressed higher levels of activated TOR, a kinase that mediates bone's anabolic response to mechanical stimulation in preosteoblasts, at both 5 and 28 d. Expression of activated ERK1/2, RSK1/2/3, MSK1/2/3, and JNK1/2 was lower in the stimulated explants at 28 d. These kinases are associated with inflammation in immune cells, which make up approximately 40% of marrow cells. Differences in kinase expression at the two time points could reflect rates at which the signaling pathways are activated by loading, or that marrow is adapting to the stimulation by altering cell-cell interactions, cell conformation, or relative population densities of cells.

Dasari, Mauna – Elucidating the Relationship between the Gut Microbiome and Darwinian Fitness

ABSTRACT: The vertebrate gastrointestinal tract is host to a complex community of microbes that provide a number of "ecosystem services" to the host, such as training the immune system, producing vitamins, resisting pathogens, contributing to host energy acquisition, and allowing hosts to occupy new ecological niches. However, we do not yet understand the forces that drive inter-individual variation in gut microbiome composition and how these compositional changes affect the ecosystem services microbiomes provide for their hosts. In particular, we do not know whether compositional changes in the microbiome affect individual health and Darwinian fitness in natural populations. For my PhD thesis, I propose to address this gap using a long-term data set spanning 20,000 freeze-dried fecal samples across 613 individuals, collected by the Amboseli Baboon Research Project over the last 15 years, as well as over 40 years' worth of corresponding demographic data, health measures, and social interaction data. Because of the unprecedented nature of this baboon gut microbiome dataset, we will be able to understand the gut microbiome's role in the aging process by monitoring how the different characteristics of a microbiome change over an entire lifespan. By correlating changes in these characteristics with measures of fitness such as overall lifespan and reproductive success, we will then be able to determine what factors are important for a healthy microbiome overall. Lastly, we will be able to determine why some individuals have better microbiomes than others by examining the role of social connectedness in seasonal microbial community assembly. By determining the factors that influence a favorable gut microbiome composition, the results of these analyses will inform studies of the human gut microbial system and thereby contribute, in application, to improving patient survival and fitness. This research will also contribute to the field of evolutionary biology by grounding the gut microbiome's larger role in the evolution of the body and of social behaviors overall.

Grieneisen, Laura – Sex-specific social behaviors shape the gut microbiome in wild baboons

ABSTRACT: The microbial composition of the gut has important functional consequences for an individual, ranging from metabolism to mental health. However, the role that sex-specific social behaviors play in shaping the gut ecosystem is largely unknown. We tested this idea using two troops of wild savannah baboons (Papio cynocephalus). Specifically, we predicted that social effects on gut microbiome composition would vary between sexes such that they would be stronger in adult females than in immigrant adult males. Consistent with this prediction, we found that the effects of social grouping was strongest in adult females, who spend more time grooming than adult males and live in the same social group their entire lives. Additionally, we found that males do not maintain a signature of their natal social group on their microbiome, but do have a signature of their current social group. Furthermore, we found that males that immigrate into a social group

acquire the group-level gut microbiome over time, and this acquisition may be driven by grooming relationships. These results provide evidence that sex differences in behavior and social transmission are important aspects of microbial acquisition.

Harrod, Karlyn – Infectious systems of uncertainty: how partially observed transmission networks affect estimates of full transmission networks

ABSTRACT: Ideally, when building a transmission network to trace the path of how a disease spreads through a population of hosts, one would have complete contact-tracing data. However, in practice, only a partial portion of the network is observed due to difficult nature of collecting contact-tracing data. Because contact-tracing data is often incomplete, it can introduce potentially bias inferences. After simulating a complete transmission network, we used different partial observation models to generate partial transmission networks, reflecting different assumptions about how case data might be obtained in practice. We then used both the full and partial networks to generate estimates of R0 and the dispersion parameter. Estimates of R0 obtained through chain-size distribution analysis were similar to the values of R0 that were used to generate the full transmission network, indicating that chain-size data could be a valid basis for estimating R0. The estimates obtained using the partial networks and the offspring distribution were slightly higher than the R0 values that were used to generate the networks. However, this increase in R0 can be attributed to the partial observation model in that when a node is deemed "unobserved," its children are assigned to the parent of that node, which then increases the overall number of children for the node's parent. The dispersion parameter can be used as a measure of transmission heterogeneity. In ongoing and future work, networks will be simulated under different assumptions about transmission heterogeneity to determine how those factors affect estimates of the dispersion parameter.

Hendershot, Allison – Potential New Malaria Vector Species in the Democratic Republic of Congo

With recent efforts directed at malaria elimination, there has been increased interest in better understanding transmission dynamics and their relationship to effective intervention strategies. The Democratic Republic of Congo, with 97% of citizens living in high transmission settings, offers a significant knowledge gap in species composition and bionomics of Central African mosquitoes. Preliminary investigation into vector morphology identified 311 specimens as An. paludis and 30 specimens as An. caliginosis. Molecular analyses of the ITS2 region of the An. paludis group suggest the possibility of two cryptic species, with introgression indicated by the CO1 region. Similarly, molecular analysis of those identified as An. caliginosis points to two potentially new species (with matched CO1 and ITS2 groups). Given novel sequencing data, accurate species determination is not possible. Preliminary tests to look for Plasmodium sporozoite DNA demonstrated that all An. caliginosis were negative. However, an unusually high rate (5%) of An. paludis specimens contained DNA for P. falciparum and P. ovale DNA. This data suggests potential novel vector species in the DRC and the need for additional research into this transmission system.

Hoffbauer, Melissa – Reactivity of a Palladium-μ-Sulfide Dimer

The formation of aryl sulfide bonds is important for the synthesis of natural products and pharmaceutically active molecules. A palladium bridged sulfide dimer supported by a PCP (PCP = (PCHP = bis[di-isopropylphosphinophenyl]methyl)) ligand system was synthesized through the reaction of a nucleophilic palladium(II) carbene and a palladium(II) thiol. In order to probe the group transfer ability of the bridged sulfide dimer it was treated with various para and ortho substituted aryl halides, where the substituents ranged from electron withdrawing to electron donating. The reactivity studies showed that the observed reaction rate increased in the presence of an electron withdrawing group. Trends in reactivity led to the proposal that in solution the dimer exists equilibrium between a negatively charged sulfide complex ((PCP)Pd-S-) and a cationic palladium species ((PCP)Pd-L+), where L represents a coordinating solvent. Reactions are currently being conducted to support this equilibrium.

Joiner, Raquael – Emotional Experience Across the Adult Lifespan: An Accelerated Longitudinal Design

ABSTRACT: Research investigating the course of emotional development across the adult lifespan has primarily used cross-sectional or longitudinal designs. These designs are limited in the information they contain about developmental trends across the life course. Cross-sectional designs confound age with cohort effects, which may not reflect a developmental course. Longitudinal designs provide information about age-related change, but the value is usually restricted by the narrow time scope, attrition of subjects, and the historical context of the cohort during which the data are collected. By using an accelerated longitudinal design, the trajectories of negative (NA) and positive affect (PA) from ages 29 to 82 were investigated, while minimizing the limitations associated with cross-sectional and longitudinal designs. Using data from 1283 participants from The Notre Dame Study of Health & Well-being (Mage=54, 58% female), NA showed a general decline into late adulthood, whereas PA showed a general increase into late adulthood. These trends, however, were not independent of cohort effects. In an attempt to explain cohort differences, income, marital status, education, and self-rated health were added into the model as covariates; nevertheless, cohort differences persisted. Possible mechanisms underlying cohort differences in affective experience throughout adulthood, as well as methodological limitations, are discussed.

Kessler, Julie – Dihydrogen Activation by Late Transition Metal PNP Pyrrole-based Pincer Complexes

ABSTRACT: A PNP-pyrrole ligand, (PNpyrP)H, containing di-iso-propylphosphine donors on late transition metals (Ni, Pd, Pt, Ir, Ru) was recently reported. When the iridium compound (PNpyrP)Ir(COD) is treated with an atmosphere of H2, cyclooctane is released and an iridium dihydride species, (PNpyrP)IrH2, is formed. This compound exists in a slow equilibrium with its dimeric form, which contains two terminal and two bridging hydrides, and the PNpyrP ligand spanning both iridium centers. Treating the unsaturated ruthenium species (PNpyrP)Ru(PPh3)Cl with H2 also results in the activation of H2 to give an asymmetric, hydride containing product. These hydride complexes were designed to be catalysts for hydrogen transfer events in approach to create renewable energy resources.

Kim, Ju-Young – Combination Of Surface Plasmon Resonance (SPR) And Surface Enhanced Raman Scattering Spectroscopy (SERS) for Elucidating Protein- Ligand Recognition

ABSTRACT: Protein-ligand binding plays a key role in chemical signaling across cellular membranes(1), yet the tools available to study these process leave many unresolved factors to fully understand the process-i.e. how chemical effects and structural changes affect the affinity of specific protein-ligand interactions.
To address these challenges, we have combined two promising biotechnologies, surface plasmon resonance (SPR) and surface enhanced Raman scattering (SERS). Due to its sensitivity and real-time performance, SPR has been widely used to analyze affinity and kinetics of molecular interactions. In addition, SERS can provide chemical specificity based on molecular structural information. Our homebuilt setup uses a sapphire prism with gold metallic film (50nm) as a SPR platform. On the film, biotinylated thiol is deposited first, followed by flowing streptavidin-functionalized gold nano-particles (AuNPs) solution over the Biotin. 633nm laser reflects on the prism-metal interface, then photodiode can detect the shift in the SPR angle associated with a change in the refractive index on the sample surface caused by adsorption. When streptavidin functionalized AuNPs bind to biotin on a gold thin film, the localized electromagnetic field in the AuNPs-gold film junction can enhance Raman scattering of the molecules attached to the gold particles. The SERS signal is excited by the evanescent field arising from the SPR measurement and collected by an objective lens placed over the sample surface. Preliminary results from this system have measured the SPR sensorgram and SERS spectra of a Raman reporter molecule on streptavidin functionized AuNPs as they bind to the biotinylated surface.
The ability to detect SPR and SERS simultaneously will be a useful tool for investigating protein-ligand interactions in the future.

Kowal, Katarzyna – Effects of LKE, a novel drug used in treatment of chronic model of MS, on proliferation, cell death of differentiated SH-SY5Y neuroblastoma cells

ABSTRACT: Background: Effects of LKE (lanthionine ketamine ethyl-ester), a novel compound used in treatment in chronic model of Multiple Sclerosis, has shown to be successful in reducing neurodegeneration, the progressive loss of structure or function of neurons. It is a cell-permeable synthetic derivative that enhances neurogenesis, decreases nitric oxide production from microglia, and reduces toxicity. LKE has been also been shown to provide therapeutic benefit in animal models of neurodegenerative diseases including ALS and MS. However, the direct actions of LKE on neurons is not well known. The purpose of this in-vitro study was to examine the effects of LKE on inflammation and neurodegeneration using SH-SY5H human neuroblastoma cells line, and to directly test if LKE increases proliferation or reduced cell death.

Loughran, Elizabeth – Aging Increases Susceptibility to Ovarian Cancer Metastasis in a Murine Allograft Model

ABSTRACT: Ovarian cancer (OvCa) is the leading gynecological malignancy in women in the United States. OvCa metastasizes uniquely, spreading through the peritoneal cavity and generating widespread metastatic sites. The vast majority of OvCa cases occur in women over 40 and the median age at diagnosis is 63 (SEER). Despite age being a significant risk factor for the development of OvCa, there is a paucity of studies addressing the role of aging in OvCa metastasis. To our knowledge, there are no reports utilizing old mice to investigate the effects of age on metastasis in vivo. We designed a study using a C57BL/6 model of aging where young (Y) mice are 3-6 months of age and aged (A) mice are 20-23 months of age, corresponding to young (20-30 years) and aged (60-67 years) humans. Using the C57BL/6 syngeneic ID8 mouse ovarian surface epithelial cell line, we tested the effect of aging on metastatic success in vivo. An allograft study was carried out with Y and A mice that were intraperitoneally injected with 3.7x106 ID8 RFP-tagged cells. The mice were imaged once a week starting at 4.5 weeks post injection and were sacrificed for dissection at 8 weeks post injection. Live imaging suggested OvCa metastasis was more efficient in the aged animals than in the young animals. After dissection, the abdominal organs were imaged ex vivo and tumor burden was quantified. The aged mice displayed heavier tumor burden in the gonadal fat compared to the young. Interestingly, no difference in metastasis to the omentum was detected. To investigate why gonadal fat is more receptive to metastasis in the aged animals, periovarian adipose from 4 young and 4 aged healthy non-tumor bearing mice was isolated for RNAseq analysis. Several immune pathways involving B cells were found to be significantly upregulated in the RNA from aged animals. Studies will be conducted to elucidate the status of B cells in aging periovarian adipose, including immunohistochemistry for CD45 and other B cell markers upregulated in the RNAseq dataset.

Luther, Jamie – Paper Based Technology for Detection of Adulterated Milk (MilkPAD) in Developing Countries

ABSTRACT: In developing countries, regulatory oversight and resources are often lacking. As a result, these countries suffer from seedy practices that can lead to serious health and social issues in a population. For example, milk is adulterated to meet increasing demand, increase profit, and prolong shelf life. Common adulterants include starch, urea, formalin, melamine, peroxide, sucrose, and sodium chloride. Consumption of adulterated milk can cause long and short-term health problems such as diarrhea, headaches, eyesight problems, hypertension, kidney stones, and even death. A chemical analysis, often using advanced instrumentation, is needed to assess milk quality. Limited funds, lack of regulatory oversight in the supply chain, no access to electricity, and a shortage of trained individuals makes chemical analysis in a developing area impractical. Without these resources, low quality milk will continue to infiltrate markets and households. In light of this, I am developing an inexpensive, field friendly paper analytical device (PAD) for detection of low quality milk in developing areas.

Paper is an inexpensive platform for analytical devices, which can be patterned rapidly using commercial

printing. Specifically, paper can be custom patterned using a wax printer and baked in an oven to melt the wax, forming a three-dimensional barrier. Chemical reagents and biochemical entities, including whole cells, enzymes, or DNA, can be applied to the paper where they are stored until use.

I am developing the MilkPAD, which is a paper analytical device that can detect adulterants in a sample of milk in minutes. It contains colorimetric spot tests for starch, protein, peroxide, formalin, and urea, which were developed using established chemistry and biochemistry. Application of milk to the test spots produces a unique colorimetric code, which provides qualitative information about the milk contents. Additionally, spot tests for sugar, salt, and pH will be developed. The MilkPAD cannot identify all possible adulterants in a sample of milk. Using MALDI mass spectrometry, I will create a spectral library of milk proteins and adulterants. Milk samples identified as suspicious via colorimetric tests will be dried to a detachable storage zone, assessed with MALDI mass spectrometry, and compared to the library of standards. Initial studies demonstrated that spectral protein profiles of milk-spotted paper substrates were the same as those generated from milk spotted directly on to the metal MALDI target. Using this technology, samples of milk from international locations can be assessed. Implementation of the MilkPAD in developing areas would allow faster detection of poor quality milk products, which could change the illicit supply chain practices responsible for milk adulteration.

Martinez, Brandy – Examining religious coping as a stress-mitigating emotion regulation strategy

ABSTRACT: Negative feedback refers to the self-regulating mechanism of the hypothalamic-pituitary-adrenal (HPA) stress axis. Emotion regulation strategies that minimize the negative emotional impact of stress promote adaptive HPA-axis regulation. Using mid and later-life cohort data from the Notre Dame Study of Health and Wellbeing, this study examined: 1) whether religious coping buffers the effect of psychological stress on negative affect, and 2) if this interaction influences negative feedback. The effects of perceived stress, religious coping, and their interaction on negative affect was assessed via daily diary (56 days) data collected April 2013 - March 2014. Negative feedback data was collected between November 2013 and June 2016, and determined by taking a subtraction of plasma adrenocorticotrophic hormone levels following .1mg/kg administration of hydrocortisone in one session, and placebo saline in another. Results of multi-level modeling (MLM) suggest religious coping modifies the stress-negative affect interaction only in the later-life cohort ($\beta = 0.019$; $p < .01$). The random effects derived from the MLM were then used as indices of intra-individual variability, and correlated with negative feedback. Results indicate although religious coping modifies the effects of stress on negative affect, this effect is not significantly correlated with negative feedback functioning.

McGinnity, Tracie – Hafnia Nanoparticles as a New X-Ray Contrast Agent

ABSTRACT: Nanoparticles (NPs) composed of gold, tantalum oxide, and other heavy metals have been investigated as contrast agents for computed tomography (CT) in place of iodinated molecules. Hafnium was predicted to provide the best overall performance compared with a number of prospective high-Z contrast agents in simulations due to the favorable location of the K-edge (65.4) within clinical CT X-ray source energy spectra (25-140 keV). Moreover, hafnia (HfO_2) NPs could be prepared at a lower cost compared with Au NPs. Therefore, the objective of this study was to investigate hafnia NPs as a new X-ray contrast agent. HfO_2 NPs of controlled size were prepared by calcining a polymerized complex resulting in relatively spherical and monodispersed HfO_2 with a mean diameter ranging from ~7-31 nm, which is suitable for in vitro labeling and in vivo delivery. HfO_2 NPs were characterized by X-ray diffraction and transmission electron microscopy. The X-ray attenuation of HfO_2 NPs was measured and compared to Au NPs and iodine which are the most prominent X-ray contrast agents currently used in research and clinical imaging, respectively. Imaging phantoms at concentrations ranging from 0.5 to 50 mM were prepared by dispersing HfO_2 NPs, Au NPs, and iodine (iohexol) in 1% agarose to maintain homogeneity and stability for imaging by multiple CT instruments. Both HfO_2 and Au NPs exhibited significantly greater contrast compared to iodine at relatively low tube potentials used in laboratory micro-CT; however, Au NPs exhibited significantly higher contrast compared to

HfO2 NPs. The low tube potentials used in micro-CT produce a mean photon energy which is well below, and not optimal for leveraging, the K-edge of hafnium relative to gold and iodine. At clinical tube potentials (>80 kVp), HfO2 NPs exhibited superior or similar contrast compared to Au NPs while both contrast agents exhibited significantly greater contrast compared to iodine, due to the favorable location of the K-shell absorption edge for hafnium and to a lesser extent gold. Therefore, HfO2 NPs were shown to outperform iodine and perform comparably, if not advantageously to Au NPs. Imaging phantoms were also imaged using a novel spectral (multi-energy) CT system utilizing a photon counting detector. Spectral CT enabled simultaneous quantitative molecular imaging of HfO2 NPs, Au NPs, iodine, bone, and water due to energy-dependent differences in the X-ray attenuation of each agent.

Nguyen-Beck, Triet – Black-box, real-time simulations of electronic dynamics

ABSTRACT: Rational design of functional materials requires a strong understanding of the characteristic dynamics of electronic excited states. However, simulating these processes is challenging since they involve timescales separated by many orders of magnitude. Real-time time-dependent density functional theory (RT-TDDFT) is a powerful yet affordable ab initio technique for modeling sub-nanosecond electronic dynamics in molecular systems. It propagates the electronic density of the system-of-interest in real time, but lacks any treatment of energy dissipation. In this talk, I will present time-dependent open self-consistent field at second order (OSCF2), a black-box RT-TDDFT method we recently developed that includes dissipation and naturally relaxes the system to the correct population distribution at long time. The method assumes no model Hamiltonian, and we have shown that it can be used to qualitatively reproduce several features of electronic dynamics in insulators and semiconductors.

O'Neill, Molly – Talking for baby: Understanding attachment relationship development through parent-infant interactions and mind-mindedness.

ABSTRACT: Infancy is not only a period of rapid development; it is also a period of rapid change in the lives of parents. Such changes can equip mothers and fathers with skills that help infants survive and thrive. One such skill, mind-mindedness (MM), entails the appropriate attribution of other's internal states (Meins & Fernyhough, 2010). Mind-minded parents recognize that infants have internal desires, thoughts, and intentions separate from their own. Despite its novelty in infant research, MM is a significant predictor of infant-parent attachment (Meins & Fernyhough, 2010). However, little is known concerning the trajectory of MM from early infancy leading to the development of the attachment relationship. Moreover, little research has focused on father MM (Lundy, 2003).

The current study addresses the relation between MM and parent-infant interaction quality as the attachment relationship develops. Mothers, fathers, and infants visited the laboratory when infants were 3, 5, 7, 12, and 14 months old. During the first 3 visits, mother- and father-infant dyads participated in the Still Face Paradigm (SFP; Tronik et al., 1978) in which infant affect, parent sensitivity, and parent internal state language (ISL) were coded ($\alpha \geq .8$). ISL was labeled as positive, negative, or physiological (e.g. tired) to assess a parent's attribution of internal states to their infant. At the 12 (mothers) and 14 (fathers) month visits, dyads participated in the Strange Situation (Ainsworth & Witting, 1969) in which infants' attachment classifications were identified ($\alpha \geq .8$). Attunement (i.e., accuracy of ISL) coding is in progress and will address the underlying mechanism of MM in further analyses.

Analyses examining parent sensitivity, ISL, and infant-parent attachment revealed that ISL is related to mother and father sensitivity. For example, mothers who showed more positive ISL at 5 months were rated higher in behavioral sensitivity ($r = .26$, $p \leq .01$). Multilevel modeling assessed relations between ISL and infant-parent attachment. Specifically, infants were more likely to be classified as avoidant (est= .31, $p < .05$) or resistant (est= .20, $p < .05$) when mothers showed higher initial levels of physiological ISL. Also, infants were more likely to be classified as avoidant with fathers if fathers showed higher initial levels of physiological ISL (est= .28, p

<.01), but decreased their use of physiological ISL over time (est= -.09, p <.05). The complex relations between ISL and the developing attachment system reflect a dynamic process that requires further investigation. Preliminary analyses examining attunement and sensitivity, revealed that attunement at 3 and 5 months predicts later sensitivity for mothers (R2 = .13, p <.01) and fathers (R2 = .12, p <.01). After attunement coding is completed, relations between MM and infant-parent attachment will be assessed. We expect that more mind-minded parents will be more sensitive and more likely to develop a secure infant-parent attachment. Current results suggest parent's verbal attribution of infant's affective and physiological responses is important to the developing attachment system. By improving parents' interpretation of an infant's signals, parents may better respond to infant cues and thus foster secure relationships within the family.

Oidtman, Rachel – Disentangling the relative roles of imported cases and weather in driving the interannual variation in dengue transmission in Guangzhou, China

ABSTRACT: In 2014, the city of Guangzhou, China experienced a dengue virus outbreak with nearly 40,000 locally transmitted cases. Prior to the 2014 outbreak, the average number of locally transmitted cases was less than 300, making the factors that precipitated this unusually large outbreak unknown. To determine whether imported dengue cases or anomalous weather conditions caused this large outbreak, we used many iterations of modified TSIR models, which incorporated a mechanistic description of weather data and imported cases from different years and compared those simulated data against observed case numbers. The best fit model included average temperature and average rainfall as predictors of locally transmitted dengue cases, with imported cases implemented as an offset. Lag periods of 5-20 days and 59-60 days were necessary for average temperature and average rainfall, respectively. Our stochastic model was generally capable of reproducing seasonal patterns of transmission and outbreak size. However, reproducing both the severity of the 2014 outbreak and reduced transmission in prior years was more challenging. For these reasons, our results suggest that they may be additional factors not accounted for by our model that precipitated such a sizeable outbreak in 2014.

Ray, Alyssa – XCT-MEDIATED AMPA RECEPTOR LOSS IN HIPPOCAMPAL CA3-CA1 REQUIRES MGLUR5

ABSTRACT: Synapses in the mammalian brain are exposed to two biologically active pools of glutamate: 1) transient synaptic glutamate resulting from neuronal vesicular release and 2) ambient nonsynaptic glutamate released from both neurons and glia through a variety of molecular mechanisms. While the role of synaptic glutamate has been extensively studied, much of the function of nonsynaptic glutamate remains unknown. Several lines of evidence have shown that changes in nonsynaptic glutamate are linked to developmental, physiological, and behavioral defects in mammals. Approximately 60% of extracellular glutamate in the mouse hippocampus is released by the xCT transporter, a cystine-glutamate antiporter which is highly expressed and active on astrocytes surrounding CA1 pyramidal neurons. Mice lacking a functional xCT transporter (xCT-/-) show both enhanced synaptic strength and increased AMPA receptor abundance at hippocampal CA3-CA1 synapses. Additionally, mutant xCT-/- miniature excitatory post-synaptic potentials (mEPSCs) are phenocopied by incubating control slices in glutamate-free solution. Here, we show the effect of incubation in Group I metabotropic glutamate receptor (mGluR) antagonists on both control and xCT-/- slices and propose a possible mechanism by which extracellular glutamate acts through mGluR5 to modulate synaptic strength at hippocampal CA3-CA1 synapses.

Richards, Katherine – CANCER-ASSOCIATED FIBROBLAST EXOSOMES REGULATE SURVIVAL AND PROLIFERATION OF PANCREATIC CANCER CELLS

ABSTRACT: Cancer associated fibroblasts (CAFs) comprise the majority of the tumor bulk of pancreatic adenocarcinomas (PDACs). Current efforts to eradicate these tumors focus predominantly on targeting the proliferation of rapidly growing cancer epithelial cells. We know that this is largely ineffective with resistance arising in most tumors following exposure to chemotherapy. Despite the long-standing recognition of the prominence of CAFs in PDAC, the effect of chemotherapy on

CAFs and how they may contribute to drug resistance in neighboring cancer cells is not well characterized. Here we show that CAFs exposed to chemotherapy play an active role in regulating the survival and proliferation of cancer cells. We found that CAFs are intrinsically resistant to gemcitabine, the chemotherapeutic standard of care for PDAC. Further, CAFs exposed to gemcitabine significantly increase the release of extracellular vesicles called exosomes. These exosomes increased chemoresistance-inducing factor, Snail, in recipient epithelial cells and promote proliferation and drug resistance. Finally, treatment of gemcitabine-exposed CAFs with an inhibitor of exosome release, GW4869, significantly reduces survival in co-cultured epithelial cells, signifying an important role of CAF exosomes in chemotherapeutic drug resistance.

Schooley, Alicia – Heliospheric Suprathermal Electrons during Filament-Associated ICMEs

ABSTRACT: We are undertaking a study of solar wind plasma and suprathermal electron pitch angle distributions during interplanetary coronal mass ejections (ICMEs) to trace the plasma back to its solar origins, addressing the magnetic topology and initial structure of the ICME. We present initial results for case-studies of filament-associated ICMEs observed by ACE. Although counterstreaming suprathermal electrons are widely regarded to be a signature of closed heliospheric magnetic field lines associated with coronal mass ejections (CMEs), thorough investigation indicates that counterstreaming electrons are not observed continuously in ICMEs and recent work indicates that very narrow suprathermal electron strahl is commonly observed in ICMEs. We present initial findings on the occurrence of counterstreaming and narrow strahl during filament-associated events.

Schroll, Monica – Fasting to Augment Colorectal Cancer Treatment

ABSTRACT: Fasting has become a hot topic in pop culture, but also in the scientific world. Intermittent fasting where calorie intake is cut between 20-90% for two days a week, has shown to be able to decrease disease rate in humans. My project in Dr. Amanda Hummon's lab is focused around understanding the effect that fasting, or nutrient restriction, has on cancer. It has been shown that fasting can reduce the risk of cancer development; our project looks at the effect of fasting on cancer progression, using established colorectal cancer tumor mimics and examining tumor cell death and protein production. The use of nutrient restriction is a potential cancer treatment that could be used in tandem with current cancer regimes to increase their potency. The reason for this improvement of therapy is because of the molecular processes that cancer cells undergo when subject to nutrient deprivation. Autophagy, the process in which cells maintain cellular metabolism by recycling their cellular components, is activated by cellular stress. Autophagy is induced in particular by nutrient deprivation, as the autophagy pathway functions to support cell survival by recycling essential nutrients. Autophagy is an important pathway that cancer cells utilize to support cell survival under conditions of nutrient restriction. For my project, I treat 3D cell cultures, i.e. spheroids, with nutrient deprivation and examine the proteomic changes and cell death using imaging mass spectrometry (IMS), immunofluorescence (IF) live cell imaging, and LC-MS/MS. The results indicate nutrient restriction causes lower apoptotic and higher autophagy rates in HCT 116 spheroids. In addition, proteins shown to be differentially regulated by both glucose and serum restriction were similarly regulated.

Spano, Tyler – Structural Stability and Thermodynamics of Uranyl Vanadate Minerals

ABSTRACT: Uranyl vanadate minerals are highly insoluble and are widely disseminated in uranium ore deposits and mine and mill tailings in which primary uranium and vanadium minerals are undergoing oxidation. Understanding the crystal chemistry, materials properties, and thermodynamics of uranyl vanadate minerals is an essential step for predicting and controlling the long term environmental behavior of uranium. Delineating crystal chemical changes as related to thermodynamic properties enables prediction of stable structural arrangements. Uranyl vanadate mineral analogues have been synthesized using mild hydrothermal methods. Synthetic uranyl vanadate mineral analogues were investigated using high-temperature drop solution calorimetry. Calculated standard-state enthalpies of formation were found to be -5233.97 ± 14.594, -

6028.41 ± 9.36, and -4908.78 ± 12.59 kJ•mol-1 for carnotite ($K_2[(UO_2)_2(V_2O_8)]•3H_2O$), francevillite ($Ba[(UO_2)_2(V_2O_8)]•5H_2O$), and curienite ($Pb[(UO_2)_2(V_2O_8)]•5H_2O$), respectively. Enthalpies of formation from oxides for uranyl vanadate minerals exhibit a positive linear correlation as a function of the acidity of oxides. Overall charge deficiency (OCD) is presented as a quantification of the balance of bond strengths between structural units and interstitial complexes. A negative exponential correlation was observed between OCD and structural stability (enthalpy of formation from oxides) for the studied minerals. Additionally, OCD and oxide acidity exhibit a positive exponential correlation where decreasing oxide acidity results in an exponential decrease in OCD. The number of occurrences of uranyl vanadate mineral species is found to correlate with both enthalpy of formation from oxides and OCD.

Sridhar, Akshayalakshmi – Elucidating Early Patterns of Three Dimensional Retinal Differentiation from Human Pluripotent Stem Cells

ABSTRACT: Human pluripotent stem cells (hPSCs) allow for the unprecedented ability to recapitulate early stages of human development which are otherwise inaccessible to investigation. This is especially true for one of the earliest events in human development, the establishment of a neuroretinal fate from an unspecified pluripotent population. To test the ability of hPSCs to serve in this capacity, these cells were directed to differentiate into retinal cells using a three dimensional approach and cells were analysed for their ability to successfully recapitulate early events of human retinal development. Therefore, hPSCs were first directed to an anterior neural phenotype, which was marked by the appearance of 3D neural rosettes. These rosettes were indicative of the neural tube closure in vivo, which was confirmed by analysis of stage-specific neural transcription factors via immunocytochemistry and quantitative RT-PCR. Next, the cells were directed to an optic vesicle-like stage, where the presumptive retinal cells were identified by the expression of appropriate transcription factors. Finally, 3D optic vesicle-like retinal neurospheres were identified, isolated, and further analyzed by immunocytochemistry for the expression of markers associated with differentiated cell types of the neural retina. Upon establishment of the 3D differentiation protocol, this system was further utilized to study the timing and organization of retinal cells as they progressed through analogous stages of retinogenesis. Overall, the results of this study help to demonstrate the suitability of hPSC-derived 3D differentiation as an effective tool to elucidate early events of human development.

Stemple, Brooke – Cell surface display fungal laccase as a renewable biocatalyst for degradation of persistent micropollutants bisphenol A and sulfamethoxazole

ABSTRACT: Fungal laccases have high activity in degrading various persistent organic pollutants. However, using enzymes in solution for water treatment has limitations of non-reusability, short enzyme lifetimes, and high cost of single use. In this study, we developed a new type of biocatalyst by immobilizing fungal laccase on the surface of yeast cells using synthetic biology techniques. The biocatalyst, referred to as surface display laccase (SDL), had an enzyme activity of 104 ± 3 mU/g dry cell (with 2,2-azinobis-3-ethylbenzothiazoline-6-sulfonate (ABTS)). The SDL retained over 90% of the initial enzyme activity after 25 days storage at room temperature, while in contrast, activity of free laccase declined to 60% of its initial activity. The SDL could be reused with high stability as it retained 74% of initial activity after eight repeated batch reactions. Proof-of-concept evaluations of the effectiveness of SDL in treating contaminants of emerging concern were performed with bisphenol A and sulfamethoxazole. Results from contaminant degradation kinetics and the effects of redox mediator amendment provided insights into the factors affecting the efficacy of the SDL system. This study reports, for the first time, the development of a surface display enzyme biocatalyst as an effective and renewable alternative for treating recalcitrant organic contaminants.

Tait, Cheyenne – The neurophysiological basis of odor preference in the apple maggot Rhagoletis pomonella

ABSTRACT: The host plant shift of the native tephritid fruit fly Rhagoletis pomonella from hawthorn to domesticated apple approximately 180 years ago is an example of ecological speciation in action. One key adaptation differentiating the ancestral hawthorn host race from the derived apple-infesting host race of R.

pomonella involves olfaction. Apple flies positively orient to the volatile compounds emitted from the surface of apple fruit and tend to be deterred by hawthorn volatiles, while the reverse is true for hawthorn flies. Because R. pomonella mate only on or near the fruit of their host plants, these behavioral differences in olfaction result directly in differences in mate choice and prezygotic reproductive isolation, and thus divergence and speciation. If we can understand where and how the neurobiology of the fly changed to result in such rapid evolutionary divergence, we get closer to answering the question posed by Darwin – what is the origin of species? How does new biodiversity form?

Thus here I show the results of our characterization of the structures of the nervous system of R. pomonella. We have worked to describe both the peripheral and central nervous system. First we used scanning electron microscopy (SEM) to visualize the sensory hairs on the antennae. Then we conducted electrophysiological recordings from the sensilla on the antennae to identify and label individual olfactory sensory neuron (OSN) types. We also used immunohistochemistry and 3-D reconstruction techniques to determine the morphology of the Rhagoletis antennal lobe in the brain. In addition, we are developing optical imaging methods to anchor future studies characterizing activity in the antennal lobe as flies respond to apple vs. hawthorn fruit volatiles, searching for the key neurophysiological difference between the diverging host races.

ten Bosch, Quririne – Community-Level Effect of Spatial Repellents for Dengue Control

ABSTRACT: In the absence of effective drugs or established vaccines, efforts to control and prevent the spread of dengue virus currently rely on interventions acting on the mosquito vector, *Aedes aegypti.* There is need for the development of new, broadly applicable vector control tools to augment the currently available options. Spatial repellents SRs are sub-lethal agents that prevent mosquitoes from entering human-occupied spaces, thereby reducing the risk of disease transmission in a way that is more sustainable in light of insecticide resistance and applicable in semi-enclosed environments. Studies to date have shown that SRs have the potential to reduce malaria transmission, but their impact on dengue is uncertain. The force of infection (FoI) is a fundamental epidemiological quantity that relates aspects of mosquito life history to the rate at which susceptible individuals become infected. SRs potentially impact multiple components of FoI, including the mosquito life span, biting rates, and movement rates, making predicting its epidemiological impact not straightforward. Here, we describe a novel mathematical framework to parse experimental data on the effects of SR on mosquito traits and make assessments of the population level epidemiological impact of these products. We present the expected relative reduction in the FoI as a function of population coverage and compound dosage. High population coverage (80%) is required to reduce the FoI by 70%. A large portion of the expected effect is attributable to the toxic effect of the compound. These results demonstrate the utility of this mathematical framework in guiding the development and deployment of novel mosquito control tools. Further assessment of SR products on a population level is warranted but explicit account needs to be given to the complex effects on mosquito life traits, including the possible effect of redistributed bites to untreated individuals.

Weaver, Brooke – The transcription factor tfap2a directs progenitor fate decisions during nephron development

ABSTRACT: Vertebrate kidney development consists of the differentiation and intricate patterning of specialized epithelial cells into discrete segments that form the nephron. However, the molecular and genetic pathways involved in cell fate decisions during nephrogenesis are poorly understood. The zebrafish provides a powerful, conserved system to discover developmental mechanisms driving nephron formation. By performing a forward genetic screen and utilizing whole mount in situ hybridization to assess nephron segmentation, we isolated a mutant line with abrogated distal segment development. Whole genome sequencing revealed that the genetic lesion disrupted splicing of transcription factor AP-2 alpha (tfap2a), which has been described as essential for neural crest and epidermis differentiation, but was not known to be active during renal ontogeny. We found that tfap2a exhibits a dynamic expression pattern in renal progenitors, eventually restricting to the distal segments of developing nephrons. Deficiency of tfap2a recapitulated the mutant phenotype, and tfap2a mutants also failed to complement a previously

characterized tfap2am819 strain, which encodes a missense mutation that also disrupts transcript splicing. In addition to distal tubule defects, tfap2a abrogation was associated with a significant increase in multiciliated cells, which supports the hypothesis that tfap2a may mediate cell fate choice within the nephron. Taken together, these studies support a novel role for tfap2a in epithelial cell fate decisions during nephrogenesis. Interestingly, during mouse embryogenesis, tfap2a expression is abundant within the developing urogenital tract encompassing structures such as the ureteric tip, early tubule, and late tubule. Thus, our continuing efforts to characterize the molecular activities of tfap2a in renal progenitors may uncover aspects of nephron formation that are relevant to human kidney development and disease states.

White, Audra – Characterization and Cloning of a Novel Zebrafish Kidney Mutant

ABSTRACT: The kidney is responsible for essential physiological processes in the human body such as excretion and water balance, and it regulates these vital functions through functional units known as nephrons. How the segment cell types of the nephron arise remains a major unresolved question in the field of nephrology. The zebrafish embryonic kidney, or pronephros, has become a progressively prevalent model to analyze renal development and disease. The zebrafish pronephros is composed of two nephrons that contain a series of functional proximal and distal segments, comparable to mammals. To discover the repertoire of genes that direct nephron segmentation, a novel haploid forward genetic screen was conducted after random mutagenesis with ethylnitrosurea. The screen was performed on approximately 700 genomes and resulted in the collection of 15 mutant lines to date. Ongoing complementation studies have suggested that these mutations represent at least 12 different nephrogenesis genes. Here, we report the characterization and cloning of a recessive, embryonic lethal mutation that affects kidney development. The 154 line exhibits phenotypic alterations that are hallmarks of defect retinoic acid (RA) biosynthesis such as pericardial edema development, lack of pectoral fins, reduced proximal segments, and expanded distal segments. To test this, we performed complementation analysis with aldehyde dehydrogenase1a2 nz15 (aldh1a2), which revealed that 154 is a novel allele of aldh1a2. In addition to characteristics of RA deficiency, the 154 line displays reduction in multiciliated cells (MCCs) and disfigured podocytes. The investigation of this RA mutation will provide a useful resource to uncover how RA impacts genes that direct nephrogenesis pathways and may provide new models to study human congenital kidney defects.

Wen, Alainna – An examination of avoidance in remitted and currently depressed individuals

ABSTRACT: Major Depressive Disorder (MDD) is a prevalent and burdensome psychiatric disorder, with its impact exacerbated by high recurrence rates. One vulnerability factor for depression that has recently garnered interest is avoidance, defined as escaping from an action, person, or thing. Literature on avoidance in depression re-emerged with the introduction of behavioral activation (BA) therapies for depression, which has demonstrated treatment efficacy equivalent that of cognitive therapies and antidepressant medications. To facilitate research on the relationship between avoidance and depression, Ottenbreit and Dobson (2004) developed the Cognitive Behavioral Avoidance Scale (CBAS), a multidimensional self-report measure of avoidance that consists of four subscales representing cognitive versus behavioral and social versus nonsocial dimensions of avoidance. Studies employing the CBAS have found a positive relationship between depressive symptoms and all of the CBAS avoidance dimensions and the full scale. However, it is unclear whether individuals with remitted depression continue to show heightened avoidance. If avoidance persists upon remission from depression, then avoidance may be conceptualized as a stable vulnerability factor that maintains risk for future episodes. To our knowledge, however, no studies have examined cognitive and behavioral avoidance in remitted depressed individuals. The primary purpose of the present study was to evaluate levels of avoidance, including Behavioral Social, Behavioral Nonsocial, Cognitive Social, and Cognitive Nonsocial avoidance, in a remitted depressed sample compared to a nonclinical control sample. In this study, currently (n=58), remitted (n=65) and never depressed individuals (n=55) were first administered a diagnostic interview to confirm diagnostic status, and then completed the CBAS. As expected, both currently and remitted depressed groups scored significantly higher on all four measures of avoidance compared to the

nonclinical control. Currently depressed participants also scored significantly higher than remitted depressed participants on measures of Behavioral Social, Cognitive Social, and Cognitive Nonsocial avoidance. There were no significant differences across the depressed groups on Behavioral Nonsocial avoidance. These results suggest that high levels of cognitive and behavioral avoidance exist in both current and remitted depression. The implications for the behavioral activation approach of depression vulnerability and future research directions will be discussed.

Zenk, Julaine – A Shift in Conversation: Effects of WeHab in Therapeutic Interactions

ABSTRACT: Balance rehabilitation is often a main focus of therapy after a stroke or other traumatic brain injury. However, equipment needed to assess and strengthen balance is expensive and therapists struggle to make time for both thorough assessment and therapy exercises. Due to the expense, therapists often settle on rudimentary instruments that lead to a non-collaborative, therapist-controlled sessions. This leaves patients with a decreased sense of self-awareness and therapeutic understanding. In response, the WeHab system was created as a low-cost, time-saving option for balance therapy and assessment. The name highlights the collaborative therapist-patient interaction that can result with the system's use and alludes to both its low cost and central hardware component. This collaborative interaction was explored and compared to traditional balance therapies in partnership with physical therapists at Memorial Hospital in South Bend, IN. Transcripts of both WeHab and traditional therapy sessions were created and coded to observe the WeHab's effect on therapeutic conversation. Overall, it was observed that the WeHab system lessened the therapists' burden to give constant verbal feedback. Instructions and explanations did not need to be reiterated with the WeHab system and more time was allotted for rapport-building and conversations to build patients' therapeutic understanding.

Zhang, Yushan – Membrane Separation of Biomolecules: A Coarse Grained Molecular Dynamics Study

ABSTRACT: Monoclonal antibodies are derived from natural antibodies, which are made by the body to fight foreign invaders such as bacteria and viruses. Monoclonal antibodies can be used to prevent rejection of organ transplants and for the treatment of cancer, allergies, and other over 50 diseases. They are important components in home-testing kits for determining ovulation, pregnancy, and other conditions. The widespread usage in clinical settings has been prevented due to the high cost of production and isolation. Membrane separation of biomolecules with similar size, which could be cheaper than current chromatography methods, was studied using molecular dynamics simulations. A coarse grained model, with two beads to represent each protein amino acid, was chosen to balance between the time scale and detailed representation. With theoretical insights gained from this method, corresponding experiments could be designed with more accuracy. To determine the validity of both computation and experimental methods, transport properties were cross validated. The smallest natural folding protein HP-36 was simulated. The simulation model was first examined through comparison with the experimental radius of gyration (9.7 Å). Then the protein was inserted into a carbon nanotube and potential of mean force was computed. Different systems where the pores were represented with different hydrophobicity were compared. By tuning the hydrophobicity of the pore, therefore the interaction between the protein and pore, different free energy profiles were produced. We show that the hydrophilic protein prefers the inside of the pore when the pore is more hydrophilic. These results suggest that the selective separation of proteins can be achieved by decorating the membrane pore accordingly.

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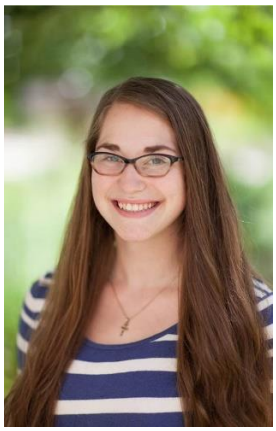

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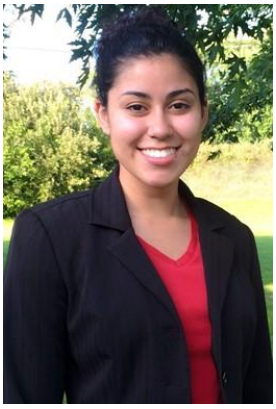

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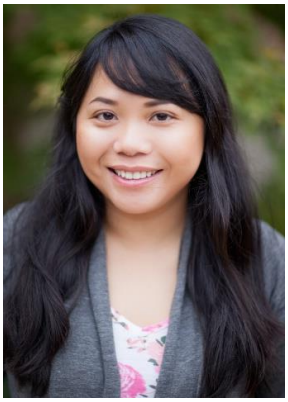

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