2013 Fall Research Symposium Abstracts

Poster Abstracts

1:30-2:00, NHS Atrium

Lance Erickson

Mercury dynamics in sub-arctic lake sediments across a methane ebullition gradient

University of New Hampshire
Advisor: Dr. Julie Bryce

Recent studies have suggested that Arctic warming may play a key role in enhancing carbon (C) and mercury (Hg) export from permafrost peatlands, yet the mechanisms by which Hg is mobilized during thaw remain enigmatic. To elucidate the links between these chemical systems, we investigated Hg concentrations in cores taken in organic C rich sediments in lake Villasjön (avg. depth 1.5m) at the Stordalen Mire, Abisko, Sweden. We chose coring sites based on zones with significantly different ebullitive methane (CH_4) fluxes established in earlier studies and we hypothesized that the microbial community producing CH_4 is also potentially mobilizing Hg. Recovered sediment cores (~44 and 40cm in depth) are characterized by having roughly 30cm of organic-rich silt material on top of a transition to more clastic material in the bottom ~10cm. Cores were sub-sampled every 2cm, and the sediment samples were then freeze-dried and subsequently analyzed for extractable Hg via cold vapor inductively coupled plasma mass spectrometry. Mercury is most abundant in the upper portions of both sediment cores, after which concentrations decrease with depth. The high ebullition site had Hg concentrations exceeding 80 $ng_{Hg}/g_{sediment}$ at the core top that decreased to a low Hg concentration < 15 $ng_{Hg}/g_{sediment}$ at the core base. The low ebullition site had overall lower concentrations compared to the high ebullition site with more intermediate values (< 50 $ng_{Hg}/g_{sediment}$) starting at 2cm depth, dropping to < 15 $ng_{Hg}/g_{sediment}$ at ~ 26 cm. We found differences (≥ 50%) in overall Hg contents between both cores in the top layers of the core. Mercury content positively correlated with total organic C (TOC, R^2=0.74) and sulfur (S, R^2=0.92) in the high ebullition site. Mercury content also negatively correlated with dissolved inorganic carbon (DIC) in the high ebullition site (R^2=0.71). These relationships are only seen in the high ebullition site, whereas in the low ebullition site, Hg links with other geochemical data (e.g., TOC, C, nitrogen, S, DIC) were more variable. Our findings imply that (1) processes that enhance CH_4 mobilization may also affect Hg dynamics in sediment cores and (2) assessing overall Hg behavior in lakes requires cores in multiple locations.

Kendyl Greimann

Alzheimer's Disease and amyloid beta postsynaptic signaling through anchored calcineurin

University of Colorado, Anschutz Medical Campus
Advisor: Dr. Mark Dell'Acqua

Alzheimer's Disease (AD) is a serious neurodegenerative impairment that generally affects cognitive function and memory. This "mind robbing disease" is caused by the overproduction of

amyloid beta (Aβ) peptides, which are expressed from cleavage of the amyloid precursor protein (APP). Aβ peptides can accumulate to form soluble oligomers at synapses where they alter excitatory synaptic plasticity underlying learning and memory by inhibiting long-term potentiation (LTP), inducing long-term depression (LTD), and causing loss of postsynaptic dendritic spines. These deleterious actions of Ab are mediated in part through activation of the calcium dependent phosphatase calcineurin (CaN). In particular, CaN dephosphorylation of postsynaptic AMPA-type glutamate receptors and the transcription factor NFAT may contribute to decreased LTP, increased LTD, and associated spine loss. Studies from the Dell'Acqua lab and others show a key role for the postsynaptic scaffold protein AKAP 79/150 in targeting CaN to dendritic spines to control AMPAR phosphorylation and function during LTP and LTD. AKAP also promotes CaN activation of NFAT in response to Ca^{2+} influx through L-type voltage gated Ca^{2+} channels. Thus, we hypothesized that Aβ also signals through postsynaptic anchored CaN to alter synaptic plasticity and trigger spine loss. To test this hypothesis, I used an AKAP150ΔPIX mouse deficient in CaN anchoring due to the deletion of its docking motif. Overexpression of the familial AD APP Swedish mutant in hippocampal neurons from wild-type mice caused significant spine loss after 2 days, but this spine loss was greatly reduced in neurons from AKAP150ΔPIX mice. Acute 24 hr application of synthetic Aβ (1-42) peptides also led to spine loss in wild-type neurons, which was prevented by the AKAP150ΔPIX mutation. In conclusion, we found that Aβ postsynaptic signaling through anchored CaN has a negative effect on dendritic spine numbers, and that disruption of CaN anchoring to AKAP150 prevents Aβ-induced spine loss.

Monica Johnson

Mapping the binding surface of cryptochrome (CRY) to period (PER)

Gustavus Adolphus College
Advisor: Dr. Karla Marz

Cryptochrome and period, or CRY and PER, are two proteins that have essential roles in circadian rhythms, repeating 24-hour biological cycles that are entrained by environmental cues. Learning what surface of CRY binds to PER improves understanding of the molecular level of the circadian rhythm. This knowledge gives clues about these proteins' functions, as well as what surfaces are available to bind with other proteins involved. In HEK293 cells, our experimental system, CRY is found in the nucleus, and a PER protein missing a portion at its N terminus is located in both the nucleus and cytoplasm. When both are present in a cell, both are in the nucleus together, indicating that CRY binding to PER shifts PER's location to the nucleus. We expressed wild-type and mutant CRYs (which had amino acids on their surface changed) with PER in cells, and then determined their locations using antibodies, two of them tagged with fluorophores, and fluorescence microscopy. Most of the mutants tested had no effect on the location of PER. Some, mCRY1 K95A, N142C, and E325A, as well as mCRY2 S62H and R90A, had small effects on PER location. One mutation, mCRY2 R501Q/K503Q, had a large effect. Based on which mutations on the surface of CRY affected co-localization with PER, it can be interpreted a large area on the surface of CRY binds PER.

Kory Kolis

Pollinator efficiency of* Echinacea angustifolia*: which bees get an A?

Chicago Botanic Garden
Advisor: Dr. Stuart Wagenius

Tallgrass prairie once spanned continuously from Canada to southern Texas, but it now is fragmented and less than 0.1 percent of its previous area remains. *Echinacea angustifolia* is a model species for restoration research because it is a long-lived forb native to tallgrass prairie. *E. angustifolia* populations are small and fragmented. *E. angustifolia* is self-incompatible, and relies on pollinators for reproduction. At least 26 native solitary bees, and several insect species from other orders have been observed visiting the flowers of *E. angustifolia.* These visitors may carry pollen between the plants. The size, behavior, and pollen basket location varies among these pollinators, therefore they may vary in their pollination efficiency. In this study, I investigated how effective eleven of the common visitors are at pollinating *E. angustifolia* flowers. When a style comes in contact with viable, compatible pollen, within 48 hours the style will shrivel. I quantified efficiency of a pollinator as the number or proportion of styles shriveled. Forty-nine times I observed a single pollinator landing on a virgin *E. angustifolia* head. After the pollinator departed, I counted the number of receptive styles and 24-48 hours later assessed style shriveling. Female *Melissodes spp.* had the highest proportion of styles shriveled, 40%, around four times larger than their male counterparts. *Andrena sp.* had the next highest proportion, 20%. *Ceratina calcarata* had the lowest efficiency, having less than 5%. This data suggest that each pollinator only plays a small portion of the total pollination, and that for a head to be pollinated, anywhere from three to upwards of ten visitors a day are needed. Understanding the impact of each pollinator visit allows for further insight into the reproductive biology *E. angustifolia* and the mutualistic relationship of the pollinators and *E. angustifolia*.

Carl Schiltz

***Examining the effect of endocytosis on membrane turnover in* C. elegans**

Fred Hutchinson Cancer Research Center
Advisor: Dr. Carissa Perez Olsen

The importance of proper membrane form and function is highlighted by the irregularities in membrane fatty acid composition observed in Alzheimer's disease, cancer, and natural aging; however, the role of membrane maintenance in disease is not understood as we have an incomplete knowledge of what pathways control membrane structure in healthy cells. Using the model system *C. elegans,* we sought to identify novel regulators of membrane maintenance and have performed a targeted RNAi genetic screen coupled with ^{13}C labeling to do so. This approach allows us to quantify fatty acid composition of the membrane as well as the contribution of dietary resources to the membrane for each gene screened. In this study, we investigated three genes involved in endocytosis and vesicle transport, *cav-2, chc-1,* and *vps-34,* as these are integral membrane processes. None of the genes resulted in any significant change to membrane characteristics; however, there was a trend indicating that the knockdown of each of the genes results in a decrease in the overall abundance of new fatty acids in the membrane. Due to these potential differences,

cav-2 was chosen to be used in a pilot pulse-chase experiment. Preliminary data from the pulse-chase assay suggest that inhibiting endocytosis processes via *cav-2* knockdown does not result in any appreciable change in membrane turnover; however, we will continue to examine other genes to look for an impact on membrane turnover in the hopes of expanding our knowledge of membrane maintenance, allowing us to more effectively treat and understand membrane-related diseases.

Brianna Titus

The role of autoantibodies in inherited neurological storage disorders

Sanford Research

Advisor: Dr. Michael Kruer

Lysosomal storage disorders (LSDs) and adrenoleukodystrophy (ALD) are rare, inherited storage disorders that affect the central nervous system of children and young adults. Both ALD and the LSDs share inflammatory features, and autoimmunity has been postulated to play a role in their pathogenesis. Using patient derived serum, plasma or cerebrospinal fluid (CSF), we were able to screen for autoantibodies directed against normal brain protein through the use of Western blot analysis. We describe possible autoimmune components in the LSDs mucopolysaccharidosis type VI (MPS VI) and fucosidosis and in ALD. We did not detect any evidence of an autoantibody response in infantile or late infantile neuronal ceroid lipofuscinosis (NCL), more commonly known as Batten disease. These studies suggest that while an autoimmune component may be present in some LSDs and ALD, it may be inconsistent. No definitive protein antigen target was identified for any of the disorders studied.

Presentation Abstracts

Jamie Brooks

Synthesis and characterization of gold nanospheres

Northwestern University

Advisor: Dr. Fernanda Cardinal

2:45, NHS 121

Gold nanospheres of 90 nm of diameter were successfully synthesized by employing and modifying three published protocols. All three protocols had their advantages and disadvantages, such as reaction duration, purity of the product, etc. The optical properties of the synthesized nanospheres were characterized by ultraviolet-visible (UV/Vis) spectrophotometry and the size distribution was extracted from the analysis of transmission electron microscopy (TEM) images.

Amy Christiansen and Alexa Peterson

Photodegradation of three imidazolinone herbicides: imazapic, imazamox, and imazaquin

Gustavus Adolphus College

Advisor: Dr. Amanda Nienow

3:25, NHS 121

Imazapic, imazamox, and imazaquin are herbicides commonly used on corn and soybean plants in the Midwest. Photolysis has been shown in previous studies of imidazolinone herbicides to be a major pathway of degradation in the environment. The purpose of this study was to determine the rate at which each herbicide degraded under different conditions and to propose photoproducts of the degradation. Several different systems were used for study: irradiation of the herbicides in aqueous solution, on glass, and on the epicuticular waxes of corn and soybean leaves. These herbicides were irradiated at different pH values using ultraviolet light, and the rates of degradation were analyzed using a high-performance liquid chromatograph (HPLC). To identify preliminary photoproducts, a liquid chromatograph-mass spectrometer (LC-MS) was used. Future work will include continuing to irradiate samples at different pH values, obtaining more data on the corn and soybean waxes, identifying photoproduct pathways, and observing how the herbicides degrade when analyzed on intact corn and soybean plant leaves.

John Danforth

Comparison of FMS to standard C18 and carbon phase RPLC columns using selectivities for aromatic isomers

Gustavus Adolphus College
Advisor: Dr. Dwight Stoll
3:40, NHS 121

The aim of this research was to compare fullerene modified silica (FMS) chromatography columns to common C18 phases and other carbon phase columns using the selectivities of aromatic isomers. The isomers analyzed by HPLC were polynuclear aromatic hydrocarbons (PAHs) which are chemically similar and difficult to separate, making them useful for comparing efficiency. Selectivities of several pairs of isomers analyzed were compared using bar graphs, the compounds compared were o-, m-, and p- isomers of phenyltoluene, and terphenyl, and the cis- and trans- isomers of stilbene. The columns used were standard C18, PAH, COZ, and PGC compared to six columns with four variations of FMS material: three columns containing varying μmols of C60, one containing C2 acyl groups with C60, one containing C6 Acyl groups with C60, and one containing C6 acyl groups with no C60 as a control. It was observed that the FMS containing acyl groups had much lower selectivity than other phases and the amount of C60 had little impact. The COZ and PGC columns had much higher selectivity, but also higher retention times making them less time efficient. The results of these experiments can be used to determine the usefulness of the new FMS material with regard to currently used carbon columns.

Will Doebler and Josh Wolanyk

The Gustavus time of flight mass spectrometer

Gustavus Adolphus College
Advisor: Dr. Jessie Petricka
2:30, NHS Auditorium

A time of flight (ToF) mass spectrometer was built and calibrated for the purpose of analyzing the trapped species held within a linear quadrupole ion trap. Trapped ions were produced using a high power laser tightly focused on a ceramic plate composed of SrF_2. The ablated ions were then trapped in the oscillating electric field created by the quadrupole trap. Previous measurements using this apparatus were unable to discern the chemical composition of the trapped ions. To solve this problem the ions were quickly accelerated towards the ToF by applying large DC voltages to the rods which make up the trap. The flight time of each ion-mass packet to reach the ToF detector is determined by the mass to charge ratio of the ion packet, allowing a mass (species) determination. Theoretical calibration was done by solving the differential equations of motion using Newton's Second Law and the Lorentz Force Law along with computer simulations of the electric field strength and direct measurements of the time dependence of rod voltages. The theoretical calibration was tested experimentally by ablating several different compounds and comparing the flight times to the theoretically determined mass curve. To improve flight time resolution, two ion lenses are used to focus the ion beam toward the detector.

Sydney Firmin

An unusual Mesoproterozoic carbonate unit: relic of a saline lake?

Gustavus Adolphus College
Advisor: Dr. Julie Bartley
4:35, NHS 121

The Rossport Formation of the 1.4 billion year-old Sibley Group is well-exposed in southern Ontario, Canada. The Rossport contains a prominent carbonate unit that is generally stromatolitic, containing layered dolomite and chert associated with microbial mat activity. While conducting field work on this stromatolite unit in islands along the north shore of Lake Superior, a carbonate horizon with an unusual texture was discovered in approximately the same stratigraphic location as the stromatolite unit. Rather than containing stromatolites, this carbonate instead displays a "chickenwire texture," which more closely resembles an evaporite rock, such as gypsum, than a carbonate. When the rock is broken it has a coarsely crystalline, sugary texture. In order to better understand this unit, we collected samples, which will be thin-sectioned and compared carbonate rocks of known origin. The hypothesis is that the rock was originally gypsum, and because gypsum is highly soluble, it was replaced by carbonate. This type of rock formation would indicate a saline lake environment during deposition of the Rossport, which would also help to explain other features observed in this portion of the Sibley Group.

Eric Hanson

Wireless power transfer

Gustavus Adolphus College
Advisor: Dr. Jessie Petricka
2:45, NHS Auditorium

Since the discovery of electricity, scientists have desired to develop an efficient and effective way to wirelessly transfer power. Nikola Tesla set this idea into motion with his work on alternating

current circuits. More recently, it has been discovered that wireless power transfer via strongly coupled magnetic resonances is possible and can be done with very high efficiency (ninety percent or higher). This summer at Gustavus, Eric Hanson paired with Dr. Jessie Petricka to attempt to recreate the wireless power transfer design that has been proven to work. This was done using numerical modeling with a computer program known as COMSOL Multiphysics as well as through experimentally building and testing circuits for resonance and coupling. For the theoretical nature of the research, a variety of geometric shapes were constructed using COMSOL and CAD software. These geometries were then tested for resonance using eigenfrequency and frequency domain studies. The results of these studies allowed for the calculation of the quality factor using the math modeling program Mathematica. The quality factor, which related the rate at which energy is lost to the rate at which energy is transferred, was compared to previous theoretical and experimental results and served as a guideline for how well the experimental circuits would work. This took into account energy losses due to internal loss and radiation into space. The experimental aspect of the research involved constructing a variety of the modeled geometries out of copper, capacitors, and resistors. Using an AC power source and oscilloscope, it was possible to determine the resonance frequency of each circuit and record maximum power transfer and efficiency for a full wireless power transfer system. An academic study of impedance matching was used to attempt to maximize these two quantities. Over the course of the summer, an efficiency of twenty-seven percent was achieved, representing twenty-seven milliwatts of power transfer. Theoretical research demonstrated the difference between resonant parallel and series circuits. This allowed for clearer results when applied to experimental research. The future of this project is expected to focus on the modeling of several more unique geometries and model a different method for wireless power transfer, adiabatic energy transfer. This method uses a time-dependent frequency sweep to instantaneously excite the power transfer system into making one efficient transfer of energy. In other words, there is a single transmission during which devices are excited for a brief period of time. Using the work done this summer, it will be possible to dive deeper into the understanding of wireless power transfer.

Anna Huff

Photodegradation of methylmercury in the St. Louis River

Gustavus Adolphus College
Advisor: Dr. Jeff Jeremison
3:10, NHS 121

Mining operations in northern Minnesota have elevated sulfate concentrations in the St. Louis River which could potentially influence the amount of methylmercury (MeHg) in the river. Photodegradation is an important MeHg decomposition process which needs to be quantified to account for MeHg loss as it travels downstream from the mining-affected area. Effects of various wavelengths on degradation rates were characterized by irradiating samples in a photoreactor with controlled PAR, UVA, and UVB radiation. A field study measured MeHg concentrations of spiked river water after varying amounts of time of sun exposure and at different water depths to examine the attenuation of sunlight by dissolved organic matter (DOM) in the river. The results of the wavelength study showed that UVB radiation ($k=.0729\ min^{-1}$) degrades MeHg much faster than

both PAR (k=.001 min^{-1}) and UVA radiation (k=.0088 min^{-1}). Surface river samples had an ~10% MeHg concentration decrease over 4 hours and 50% decrease over three days, while submerged samples (from 10 to 40 cm) resulted in only up to 10% decrease over three days.

Michelle Hulke

n-3 PUFA regulation of sortilin 1 in diabetic hyperlipidemia

University of Kansas Medical Center
Advisor: Dr. Tiangang Li
4:05, NHS 201

Diabetic hyperlipidemia is marked by an abundance of free fatty acids and increased production of ApoB in the liver, creating elevated plasma triglyceride levels. Previous research has found that sortilin 1 (Sort1) is associated with plasma triglyceride levels and regulates lipid metabolism by modulating hepatic ApoB production. Other studies found n-3 PUFAs are able to lower plasma triglyceride levels in diabetic patients with hypertriglyceridemia by increasing hepatic ApoB degradation. In this project, it was hypothesized that n-3 PUFAs are able to lower plasma triglyceride levels by regulating liver Sort1. WT mice were fed formulated low fat and high fat diets with and without fish oil (n-3 PUFA) supplements for 8 weeks. In both mouse liver and plasma samples, n-3 PUFAs up-regulated Sort1 mRNA and protein levels, lowered triglyceride levels, reduced free fatty acid liver deposits, and decreased Sort1- repressing cytokines. Based on these results, it is suggested that dietary n-3 PUFAs prevent western diet-induced Sort1 down-regulation in mice by decreasing free fatty acid and cytokine levels. Sort1 may also mediate the triglyceride lowering effect of n-3 PUFAs in treating diabetic hyperlipidemia. Future research will look into the relationship and mechanisms of cytokine repression of Sort1 in the liver, as well as possible pathways through which n-3 PUFAs up-regulate Sort1 mRNA.

Marian Lund

***HyGRP stress response genes, qLTG3-1 and Glyma17g14850, improve seedling germinability under low temperature and salt stress conditions in* Arabidopsis thaliana**

Marquette University
Advisor: Dr. Michael Schläppi
4:05, NHS 121

The ability of plant seeds to germinate under low temperature and osmotic stress conditions is an important trait for agronomic purposes. Previous experiments have shown that hybrid proline-rich protein (HyPRP) or hybrid glycine-rich protein (HyGRP) genes such as *EARLI1* in *Arabidopsis thaliana* or *qLTG3-1* in rice, respectively, improve germinability under stress conditions. The objective of this NSF-REU summer research study was to determine whether the two HyGRP genes, *qLTG3-1* and Glyma17g14850 from rice and soybean, respectively, would improve seed germinability under low temperature and salt stress conditions in transgenic *Arabidopsis thaliana* lines when expressed from a strong constitutive promoter. Transgenic line and wild-type control seeds were germinated on agar plates containing half strength Murashige Skoog (MS) medium

under room temperature (22°C), cold stress (10°C), and salt stress conditions (half strength MS medium supplemented with 50 mM NaCl at 22°C). HyGRP gene expression was analyzed under all germination conditions using RT-PCR and real-time qPCR to quantify gene expression. *qLTG3-1* lines with high transgene expression had significantly better germinability rates under stress conditions than wild-type controls or lines with relatively low transgene expression. A similar result was obtained for transgenic lines with relatively high expression of Glyma17g14850. These results indicate that *qLTG3-1* and Glyma17g14850 have similar stress protective functions and suggest that they may help rice and soybean seeds, respectively, germinate under adverse conditions.

Brooke Meyer

Physiological, facial, and self-report anger responses following mindfulness meditation vs. self-regulation techniques

Gustavus Adolphus College
Advisor: Dr. Marie Walker
4:20, NHS 201

The practice of mindfulness meditation is becoming increasingly more common in both clinical and non-clinical settings as a means of regulating emotion. Past research indicates that changes in cardiac activity and facial expressions represent underlying emotional and self-regulatory processes. In the present study, the efficacy of mindfulness meditation in reducing anger was examined and compared to self-distancing and suppression techniques. Facial expression, blood oxygenation, blood saturation, heart rate variability, and self-reports of anger and forgiveness were compared across conditions.

Paige Miller

The Perfect Storm: Factors that lead to increased transmission and drug resistance emergence of heartworm in the United States

University of Georgia, Odum School of Ecology
Advisor: Dr. Andrew Park
3:10, NHS 201

Heartworm disease has been observed all over the world but is distributed heterogeneously where hotspots are thought to be promoted by factors such as climate, pet and owner demographics, and percent of canid population given medication. Recent concerning evidence has suggested the establishment of drug resistant worms in some areas of the United States. Because only one class of drugs exists to treat heartworm, resistance presents a large problem. Two of the first models for heartworm disease dynamics and drug resistance emergence, one deterministic and one stochastic, were developed in order to identify factors that could lead to higher rates of transmission or faster rates of resistant allele increases. Factors analyzed included vector abundance, treatment coverage, and fitness benefit of mutation. It was found that areas with high mosquito abundance and low treatment coverage are more likely to suffer from higher worm burdens in general. Speed of resistance emergence and probability of resistant worm invasion depend on the fitness cost of

mutation in heartworms and founding size of resistant worm population. Collectively, these models help to identify key factors and regions that are associated with successful and rapid establishment of drug resistant heartworm populations.

Rachel Mohr, Zach Van Orsdel, and Emily Ford

How is physical depositional setting related to silica chemistry in the Platte River, USA?

Gustavus Adolphus College
Advisor: Dr. Laura Triplett
4:20, NHS 121

Beginning in 2003, a non-native subspecies of *Phragmites australis*, a wetland grass, invaded the Platte River in Nebraska, USA. The plants' dense root and rhizome structures caused channel narrowing and increased deposition of fine sediment. We hypothesized that a significant proportion of the fine sediment was comprised of biogenic silica particles including terrestrial plant phytoliths. In this study, we determined a relationship between particle size and biogenic silica content in Platte River sediments, to help characterize when and where silica is sequestered in the riparian areas of rivers. Historically a wide, braided, largely unvegetated sand-bed river, the Platte has undergone several major changes since the early 1900s. The main anthropogenic impact on the Platte has been a ~75 percent reduction in flow, leading to channel narrowing and more vegetation occupying riparian areas. *Phragmites* is particularly effective at building islands and extending river banks because its roots add cohesion to sediment. We suspect that the presence of *Phragmites* in the Platte River has resulted in a reduction of bioavailable silica (dissolved and particulate amorphous particles) being exported to the downstream receiving waters, ultimately including the Gulf of Mexico. We want to better understand silica sequestration in riverine environments, because silicon is often a limiting nutrient for some phytoplankton (e.g., diatoms and radiolaria) in coastal oceans. In the Platte, lower water levels and increased vegetation density cause reduced flow velocity, allowing more silica particles to settle out of suspension. We hypothesized that silica content in the riparian sediments of the Platte River negatively correlate with particle size, and that the non-native subspecies of *Phragmites* uses more silica than the native variety. In order to quantify the effect *Phragmites* is having on the Platte's silica load, plant and sediment samples were prepared using a timed NaOH digestion and silica was measured using inductively coupled plasma mass spectrometry (ICP-MS).

Reina Nielsen

Variation in ecophysiological traits

Gustavus Adolphus College
Advisor: Dr. Pamela Kittelson
3:25, NHS 201

Habitat fragmentation is a serious conservation problem affecting many systems including prairies. Prairie fragments may contain small plant populations susceptible to decreased genetic diversity and fitness, which results from inbreeding depression, genetic drift and/or reduced reproduction. We explored the feedback between genetic diversity on morpho-physiological traits and herbivory

by using three genetic crosses of *Echinacea angustifolia* (purple coneflower): inbred, within the same remnant population, and between remnants. Photosynthetic rates, water use efficiency, herbivore damage, and various leaf traits were measured on 560 plants in two experimental gardens. Genetic diversity affected photosynthetic rates and water use efficiency. Inbred plants had lower rates of both, while plants crossed between remnants showed the highest rates. Leaf traits also varied. These data suggest that inbreeding in *Echinacea angustifolia* could lead to reduced growth, survival and reproduction in plants possibly explaining patterns in plant fitness.

Travis Sigafoos

The relationship between salicylate-induced tinnitus and circadian rhythmicity by means of the acoustic startle paradigm

Gustavus Adolphus College
Advisors: Drs. Michael Ferragamo and Janine Wotton
2:05, NHS Auditorium

Tinnitus, a condition that affects 1 in 5 people, is defined as the constant perception of a phantom sound (e.g., tone) that is debilitating for many patients. In order to study whether the percept varied over the course of a day, tinnitus was induced temporarily in four Long-Evans rats with an IP injection of sodium salicylate (350 mg/mL) and the magnitude of the acoustic startle reflex was measured (in Newtons). Each rat was tested at 0800, 1200, 1600, and 2000 hours on a 12:12 hr LD cycle (0400 lights-on; 1600 off) with either a gap in noise or a noise pulse as a warning signal preceding the startle pulse. A linear hierarchical model analysis revealed that there were significant measured differences in the force observed, in response to the pulse alone, between light/dark conditions ($p = .015$) and injection and paradigm interaction ($p = .001$). In addition, the paradigm ($p = .004$) and the injection and paradigm interaction ($p = .027$) had significant effects on the suppression of the acoustic startle response by a preceding gap in noise. Although this is a widely used model for tinnitus, these tests reveal that the two paradigms are affected differently by sodium salicylate, and this may transform the approach to future tinnitus research.

Michael Sterling

Enantiodivergent synthesis of a nipecotic acid derivative and determination of its catalytic activity in antisymmetric Mannich reactions

University of Southern Mississippi
Advisor: Dr. Douglas Masterson
2:30, NHS 121

Nipecotic acid, a valuable unnatural amino acid, has been shown to have applications as a GABA reuptake inhibitor as well as having potential to serve as a precursor to other natural products. GABA (γ-amino butyric acid) is unquestionably the most important inhibitory neurotransmitter in the central nervous system (CNS), and complications of GABA transportation can cause diseases like Parkinson's and Huntington's. These diseases are alleviated through the inhibition of GABA uptake, as it increases the concentration of GABA in the CNS. For this reason, development of novel GABA reuptake inhibitors is extremely valuable. There are very few

literature reports of an optically enriched synthesis and no asymmetric synthesis of nipecotic acid and its derivatives. Accordingly, a straightforward stereoselective and entantiodivergent cyclization approach to the synthesis of nipecotic acid derivatives via a δ-lactam intermediate was developed. Specifically, an α-methyl nipecotic acid analogue was targeted and a synthetic route with eight steps from readily available materials was developed. While most steps are performed under inert atmosphere, only a few require conditions deviating from standard ambient temperature and pressure (e.g. 95°C). Despite being under somewhat extreme conditions, the lowest yield reported was 60%. Due to retention of stereochemistry, consistently high yields, and generally mild reaction conditions, the pathway investigated is a facile and reliable route for the synthesis of α-methyl nipecotic acid.

Beth Wiese

Inhibition of γ-glutamylcysteine ligase

Gustavus Adolphus College
Advisor: Dr. Brenda Kelly
3:40, NHS 201

γ-Glutamylcysteine ligase (γ-GCL) is the enzyme that catalyzes the rate limiting step in the synthesis of glutathione. Glutathione is biologically essential in detoxifying cells and has been found to be upregulated in some cancer cells leading to chemotherapy resistance. Therefore, studies of the enzyme that synthesizes glutathione are therapeutically important. One of my summer research objectives was to further develop an understanding of the structure of the active site by analyzing the effects of two inhibitors, L-2,3-diaminopropionic acid and D-ethionine, on γ-GCL activity. The effects of inhibitors L-2,3-diaminopropionic acid and D-ethionine on purified *E. coli* γ-GCL activity was analyzed using Michaelis-Menten kinetics . D-ethionine was found to be an uncompetitive inhibitor, suggesting that it does not bind directly to the active site. Inhibition with L-2,3-diaminopropionic acid inhibited the enzyme in a manner that was not consistent with Michaelis-Menten behavior. Thus, we are unsure of the mechanism of inhibition by this compound. Future work will include further analysis of L-2,3-diaminopropionic acid along with other inhibitors similar to L-2,3-diaminopropionic acid.

Greg Wiessner

Developmental expression of calbindin-D_{28K} in the chorioallantoic membrane of viviparous* Zootoca vivipara *under manipulated ex-utero calcium provision

East Tennessee State University
Advisor: Dr. Thomas Ecay
2:05, NHS 121

Zootoca vivipara is a reproductively bimodal lizard with geographically distinct oviparous and viviparous populations. Viviparous neonates contain only 75% of the calcium of oviparous hatchlings. A possible explanation for this difference is greater efficiency of shell calcium uptake by oviparous embryos compared to placental uptake by viviparous embryos. Investigation into this nutritional difference considers the possibility of either limited mobilization ability of the

viviparous embryo or limited uterine calcium secretion by the viviparous mother. A crucial step in probing this uncertainty is determining the viviparous embryo's physiological responsiveness to differential calcium provision. We manipulated calcium provision to *ex utero* viviparous *Zootoca vivipara* eggs during the latest stages of gestation in order to observe the outcomes on the ontogeny of calbindin-D_{28K}, a calcium-transporting protein, within the chorioallantoic membrane. Expression of calbindin-D_{28K}, a marker for calcium transport activity, is significantly greater at stage 40 for embryos cultured in 2 mM calcium than in the absence of calcium. Additionally, calbindin-D_{28K} expression is maintained in media supplemented with calcium, but declines in the absence of available calcium. These results demonstrate that chorioallantoic membrane calbindin-D_{28K} expression is sensitive to culture media calcium. As such, results from future manipulations of calcium provision to *ex utero* embryos may indicate either up or down-regulation of calbindin-D_{28K} expression.

Bryan Voigt

Determination of methylmercury-dissolved organic matter(DOM) binding constants

Gustavus Adolphus College
Advisor: Dr. Jeff Jeremison
4:05, NHS 121

A competitive ligand exchange – solid phase extraction (CLE-SPE) method has been utilized by other researchers to determine distribution coefficients for several metals to organic matter and other ligands. In this work we have adopted the CLE-SPE method to quantify binding coefficients between methylmercury (MeHg+) and dissolved organic matter (DOM). Isolates were obtained of the hydrophobic acid and transphilic acid fractions of the DOM from four sites in the St. Louis River watershed. To measure binding constants with the hydrophobic portion of the DOM, hydrophilic L-Cysteine was utilized as the competing ligand. Similarly, hydrophobic 1-dodecanethiol was used to measure the binding constant to the hydrophilic portion of the isolates. Results suggest binding constants on the order of log KMeHgDOM = 15-21. These results suggest a very strong complex between MeHg+ and DOM, which has large implications regarding the bio-availability and transportation of MeHg+ through watersheds.