2009 Sigma Xi Symposium Abstracts

Gustavus Adolphus College

May 1, 2009

Session 1a—1:45 pm to 3:00 pm

Nobel 105

Chair: Brian O'Brien

1:45 pm *All-Vanadium Redox Battery*

Ryan Espy
Advisor: Charles Niederriter

The solution used in a vanadium flow battery is vanadium oxide, V_2O_5, dissolved in sulfuric acid and water. All conventional batteries must contain two unique solutions. Production of the solution is more space and time efficient, and it is impossible to contaminate the battery within itself. Another advantage is that the reaction is in aqueous solution and requires no phase changes. We are currently building a flow battery model to better understand how it works.

2:00 pm *Spectroscopic Investigation of the Pyrazole System*

Molly Beernink
Advisor: Steve Miller

The ligating character of pyrazole, a five-membered heterocycle containing two adjacent nitrogen atoms, was explored. Due to the placement of the nitrogen atoms in this ring, different complexing mechanisms may be possible when pyrazole interacts with a metal ion. The aqueous phase copper(II)-pyrazole complex was investigated using resonance Raman spectroscopy and computational modeling. Experimental and simulated Raman spectral results were used to propose a complexation mechanism for the system.

2:15 pm *The Preparation of New Hydrocarbon-Cisplatin Anti-tumor Drugs*

Joel Rindelaub
Advisor: Brian A. O'Brien

Bulky hydrocarbons have recently been added to current pharmaceutical compounds such as cisplatin, a common chemotherapy drug. This effect is thought to increase the lipophilicity of the drug and its degradation times, leading to more efficient and effective anti-tumor activity. These hydrocarbon-cisplatin analogs are gaining much interest as they are also effective against cisplatin-resistant cancer strains, which may indicate a new mechanism of activity. However, the synthesis of these strained hydrocarbons is often a difficult process. Thus, it is proposed a simple and inexpensive way to synthesize cisplatin analogs bearing a polycyclic nonane ring system. It is expected that these compounds will be biologically active and will have an increased anti-tumor effect compared to cisplatin itself. Though these will be prepared in small quantities initially, advances in conventional synthetic chemistry and novel catalysts offer hope for the production of these materia ls as commercial commodities.

2:30 *pm Ravine Development and Bank Recession of Ravine Z in Seven Mile Creek Park*

David Koppel
Advisor: Laura Triplett

The Minnesota River is faced with increasing sediment loads, which are a result of sediment erosion in watersheds linked to the river. Ravine Z is active, compared to surrounding ravines, but it is unknown if it is caused by stratigraphy, land-use change, or drain tile. Benchmark pins were installed and width and depth measurements were taken to monitor change over time. Also, modeling and photographs will be important in finding changes in the ravine.

2:45 pm *Evidence of a Paleochannel Prior to the Present Le Sueur River Channel in Mankato, MN*

Mikayela Munson
Advisor: Laura Triplett

The Le Sueur River is a tributary to the Blue Earth River, which flows into the Minnesota River. Approximately 9,400 years ago, Glacial River Warren rapidly carved out the Minnesota River Valley. The tributaries have responded by carving channels not proportional to water flow. Evidence suggests of a recent stream capture event, leading to an increased sediment supply. Rapid down cutting leads to erosion and sediment flowing into the Minnesota River creating water quality issues.

Session 1b—1:30 pm to 3:00 pm

Wallenberg auditorium

Chair: Sanjive Qazi

1:30 *pm Strategies for neural and immune responses to provide mechanistic understanding of Holistic Medicine*

Ashley Baumann, Rebecca Dove, Jeanifer Poon
Advisor: Sanjive Qazi

The central goal of Holistic Medicine is to activate the body's natural biochemical response to heal itself under periods of physiological stress. It recognizes that the mind-body network is an information system that exhibits complex dynamics and serves as a communication network between cells whereby activation of cellular receptors leads to gene transcription changes as part of the vital self-healing process. To demonstrate that specialized holistic treatments (i.e. Reiki, acupuncture, dance therapy, etc.) elicit a beneficial neuro-immune system response, we will take physiological measurements before and after treatment. Measurements include cortisol levels, skin conductivity, muscle activity and vital signs. We predict that these stress indicators will decrease during and after holistic treatments in subjects experiencing stress. This preliminary data will allow us to conduct more detailed and in-depth experiments in order to elucidate a specific biochemical me chanism of increased neuro-immune response to the administered treatments.

1:45 pm *Between Leaf Scars and Roots in the Fern Genus, Botrychium*

Colette Brandt and Ashley Grivna
Advisor: Cindy Johnson-Groh

Botrychium is a genus of ferns in the Ophioglossaceae family. One leaf is produced by the sporophyte annually when conditions are favorable. The apical meristem of the rhizome produces both leaves and roots. Unlike other plants, this apical meristem resulted from upward growth initiated several inches deep in the soil. Leaves are produced irregularly resulting in a crescent shaped scar on the rhizome. The purpose of this study was to determine the ratio of root production to leaf production (roots to leaf scars) which previously had been reported as a 1:1 ratio in the literature. Understanding this correlation will enable age estimates which in turn, will allow more effective management for declining populations. Using a dissecting microscope 129 samples were drawn and measured to determine the spatial relationships between roots and leaf scars. Quantifying the total number of roots between each leaf scar allowed us to statistically determine the ratio of leaves to roots. There is a strong statistical linear relationship. The average ratio of leaves to roots is 1:1.1 for all of the species and varied from 1:0.8 for *B. tunux* to 1:2 for *B. lunaria*.

2:00 pm *Cloning and Expression of Myohemerythrin and Metalloprotein II*

Jessica Moertel
Advisor: Brandy Russell

The proteins myohemerythrin (myoHr) and metalloprotien II (MPII), both present in the annelid Nereis diversicolor, have 80.8% amino acid sequence identity with all metal binding amino acids conserved. Yet, myoHr naturally binds to iron while MPII binds to cadmium. In this ongoing study, we have made attempts to transform plasmids containing the genes for myoHr and MPII into Escherichia coli cells. By optimizing expression, we hope to develop a replaceable protein supply which will be available for future exploration.

2:15 pm *Solvent Signal Suppression Using WEFT and Decoupler Pulse Sequences*

Veronica Taylor
Advisor: Brandy Russell

Biomolecular NMR is performed using a solvent ratio of 90% H_2O/10% D_2O due to exchangeable protein protons. This causes a large solvent signal to be present, that must be suppressed in order to collect NMR data. Unfortunately, Gustavus NMR lacks the pre-designed pulse sequences needed for this suppression. Modification of the WEFT (Water Eliminated Fourier Transform) pulse sequence and development of pulse sequences using the decoupler pulse were examined for solvent signal suppression.

2:30 pm *Gluek Pond Restoration Plan, Minnesota Regional Treatment Center*

Stephanie Erlandson
Advisor: Cindy Johnson-Groh

Reconnaissance fieldwork and literature review were conducted to assess current health and future needs of Gluek Pond located in Gluek Park, Minnesota Regional Treatment Center. Water quality testing, vegetation survey, and aquatic invertebrate sampling were conducted to determine current status. Gluek Pond is highly eutrophic and is surrounded primarily by lawn and a small wooded area with several invasive species. Specific best practice methods for effective restoration of the pond, including drawdown techniques, buffer strip implementation, invasive species control, and increased sinuosity of the input channel were outlined.

2:45 pm *Happiness and Related Components in Chilean and American Culture*

Emma Espel
Advisor: Marie Walker

The experience of happiness leads to numerous benefits. This study includes several happiness constructs, specifically optimism, life satisfaction, depression, and culture. A correlational analysis comparing Chile and the U.S, suggests that happiness relates to all studied variables. Chile and the U.S. rank differently on cultural constructs. Both cultures demonstrate a stronger correlation between happiness and individualism than collectivism. Variables within each culture have distinct correlations which implicate culture in this study.

3:00 pm-3:30 pm Poster Session and Reception in Nobel Lobby

Solar Power at Gustavus

Anna Schuh
Advisor: Chuck Niederriter

The energy efficiency of various solar panels has been studied using. One 80-watt panel was mounted almost flat on the roof of Olin Hall, while a 50-watt panel was mounted at approximately 40 degrees to horizontal, and two larger panels (175-watt and 200-watt) were mounted at 60 degrees. The data collected from these panels were analyzed to estimate the fraction of solar illumination one panel can turn into usable energy. From this, an estimate was made of the usable energy Gustavus Adolphus College could generate using solar panels on most building roofs. The effects of variables such as size, power, and panel angle will be discussed.

Optimization of Column Choice for Trace Analysis of Triclosan in River Water using Heartcutting Three-Dimensional High Performance Liquid Chromatography

Scott Simpkins
Advisor: Dwight Stoll

Detection and quantitation of compounds at trace level concentrations (â‰¤ ng/L) within complex mixtures is important in many disciplines. As a proof-of-concept, we are developing a multidimensional separation technique called heartcutting three-dimensional high performance liquid chromatography (h3D-HPLC) to detect and quantify triclosan, a contaminant found in river water, at levels as low as 50 ng/L. This study focuses on selection of a three-column system able to separate this contaminant from all components of river water.

All-Vanadium Redox Battery

Ryan Espy
Advisor: Chuck Niederriter

The solution used in a vanadium flow battery is vanadium oxide, V_2O_5, dissolved in sulfuric acid and water. All conventional batteries must contain two unique solutions. Production of the solution is space and time efficient, and it is impossible to contaminate the battery within itself. Another advantage is that the reaction is in aqueous solution and requires no phase changes. We are currently building a flow battery model to better understand function.

Shadow Analysis of Wind Turbines

Kyle Hulbert
Advisor: Chuck Niederriter

The shadow produced from the spinning blades of a wind turbine can produce a strobe effect in residences near the turbine site. Like any flashing lights these shadows have the potential to cause dizziness and nausea as well trigger seizures in people with epilepsy. To find the amount of time these shadows might affect a building a computer program was constructed that is able to calculate the maximum amount of time a shadow falls on a building in a given time frame. The program requires only the turbine and building dimensions, a time frame, and latitude and longitude to operate. The program includes scalable resolution, error analysis, and can account for elevation differences between the building and turbine.

You Mean I Came All This Way For Nothing? Investigation of Potential Sperm Storage Mutants in Drosophila Melanogaster

Pauline Jackson
Advisor: Margaret Bloch Qazi

Female sperm storage has a number of essential roles in fertility and provides several evolutionary advantages to both male and female organisms. Previous genomic screens in Drosophila melanogaster have identified seven genes with potential sperm storage effects, including CG5825, CG7296, and CG10746. Using a genetic approach, mutants for these genes were assessed with daily progeny and egg counts. The results of this study will increase knowledge regarding female sperm storage and may identify novel genes involved.

Hold On! Female Sperm Storage in Drosophila Melanogaster

Heather Rusk
Advisor: Margaret Bloch Qazi

The balance in reproduction has influenced many strategies, including female sperm storage and the last-male-advantage, where the last male to mate sires more progeny than previously mated males. Using D. melanogaster, we examined the female's ability to manage sperm use by altering transfer frequency to fresh media and introducing a second mating. We found that females transferred less frequently retain sperm longer, but that females did not control paternity of progeny between the two sires.

lozenge is Required for Normal Sperm Storage Patterns in Drosophila melanogaster Females

Isaac Weeks
Advisor: Margaret Bloch Qazi

Female sperm storage, a process by which sperm are retained in the reproductive tract, is exhibited by many animal species and is a critical component of fertility. However, the mechanisms by which it occurs remain poorly understood. Drosophila melanogaster is an ideal organism in which to study female sperm storage due to its fast generation time, ease of care, and the availability of genetic mutants. In this study, I report several effects of the gene lozenge on female sperm storage.

Session 2a—3:30 pm to 4:45 pm

Nobel 105

Chair: Laura Triplett

3:30 pm *Mineralogy and Metamorphism of the Stromatolite Bearing Layers of the Biwabik Iron Formation*

Dan Foley
Advisor: Jim Welsh

The 1.85 billion year old Biwabik Iron-formation of northeastern Minnesota contains some of the earliest forms of life on the planet, present in structures called stromatolites. Samples of the iron-formation were collected directly above and below stromatolite bearing horizons, to determine silicate mineralogy, as to ultimately understand the effects of metamorphism on the stromatolites.

3:45 pm *Geomorphology of Naran Khondii, Hoh Serh Range, Mongolian Altai, Western Mongolia*

Kathryn Ladig
Advisor: Laura Triplet

This study describes the geomorphology and climate history of Naran Khondii, a glacially formed U-shaped valley in the Höh Serh range of western Mongolia. Glacial reconstructions show that the surface area of a modern glacier in the drainage has decreased by 79% since the Last Glacial Maximum in the late Pleistocene, 51% since the neoglacial period, 38% since the Little Ice Age, and 4.3% since 2007.

4:00pm *The Stratigraphy of Seven Mile Creek Park And Implications For Ravine Growth And Other Geologic Processes Within The Park.*

Elliot Peterson
Advisor: Laura Triplett

The factors controlling ravine growth and expansion in Seven Mile Creek Park are unknown. One possible explanation is certain layers of till allow for faster erosion, while others slow the process. This research identifies the layers of till in the park so that future researchers may attempt to create a correlation between ravine erosion and tills. Understanding the park's underlying geology may also help future researchers better explain soil, vegetation and hydrologic processes and patterns.

4:15 pm *A chemical analysis of sediment sources in the Le Sueur River, southern Minnesota*

John Leaf
Advisor: Laura Triplett

Recently, it has been found that the Minnesota River is contributing a disproportionate amount of sediment to the Mississippi River. Much of this unnatural influx comes from the Le Sueur River watershed in Blue Earth County near Mankato, MN. For my senior thesis in geology, we used geo-chemical techniques in attempt to determine where the Le Sueur River sediment comes from. By using rare earth and trace elements as fingerprints, we analyzed topsoil, bluff, and ravine sediments of the river valley and compared them to the sediment in Le Sueur River to determine which source contributes the largest influx of sediment.

4:30 pm Strain analysis in Archean rocks of the Virginia Horn area of northeastern Minnesota

Ben Christensen
Advisor: Jim Welsh

The "Virginia Horn" area of the Mesabi Range, in northeastern Minnesota contains Archean metasedimentary and metavolcanic rocks affected by at least three deformational events. Strain analysis using the Rf/Phi method was performed on several rock samples from the area to determine if the method can be used to help further document the deformational history of the area.

Session 2b—3:30 pm to 4:45 pm

Nobel 201

Chair: Margaret Bloch Qazi

3:30 pm *Non-Contact Modal Excitation of Micro-Cantilevers using Ultrasonic Radiation Forces*

Brad Abell, Dan Mellema
Advisor: Tom Huber

Mass sensing and scanning probe microscopy utilizes modal excitation of nano and micro structures. Typically, these structures are observed using a mechanical shaking device to excite the structure. In order to prevent false resonances from the mounting apparatus, a non-contact technique must be used for observing modal excitation. We will present an ultrasonic excitation technique that eliminates false resonance peaks and allows for selective excitation of the symmetric or anti-symmetric resonance mode of coupled micro-cantilevers.

3:45 pm *Female response to oxidative stress depresses early stage fertility in Drosophila melanogaster*

Leah Hogdal
Advisor: Margaret Bloch Qazi

This study examined the energetic trade-offs associated with responding to a pre-mating oxidative stressor utilizing the stress resistant *Drosophila melanogaster methuselah* mutant. I found that females, regardless of genotype, subjected to oxidative stress produce fewer progeny in the first two days of progeny production than did unstressed females. Furthermore, stress-resistant (*methuselah*) mutants exhibited a smaller depression in fertility in response to stress suggesting an early fertility trade-off between somatic repair and reproduction.

4:00 pm *The effects of group synchrony on cooperation, prosocial beahvior, and mood.*

Susie Kramer
Advisor: Kyle Chambers

Involvement in groups displaying synchronous behavior (e.g., choirs) increases cooperation (Wiltermuth and Heath, 2009). Does synchrony also influence prosocial behavior and mood? Groups of undergraduates sang portions of the Australian national anthem with individuals within a group starting in unison or staggered. Next, participants completed prosocial behavior and mood questionnaires and played a token game, designed to measure cooperation. We predict that synchrony will lead to more cooperation, as previously found, but also increased prosocial behavior and mood.

4:15 pm *Allosteric behavior of monomeric E.coli gamma-GCL in the presence of non-substrate analogs*

Colin Boettcher and Chelsea Koepsell
Advisor: Brenda Kelly

Active site structural constraints of the enzyme gamma-glutamylcysteine ligase (gamma-GCL) were probed with non-substrate amino acid analogs (NSA), which substantially alter enzyme activity, either through activation or inhibition. Fluorescence titration confirmed that analogs bind to the enzyme and alter binding affinity of a cysteine substrate mimic in a cooperative manner. Gel-filtration chromatography results indicate that E. coli gamma-GCL is monomeric. These results suggest the presence of two binding sites that bind a cysteine substrate or NSA. The binding of an NSA significantly impacts whether enzyme activity is activated or inhibited relative to a control.

4:30 pm *Preparation of Fluorinated (P-Aryl)Phthaloylphosphines and New Phosphorus-based Fluorinated Anions*

Jason Schultz

Potassium phthaloylphosphide [K+][o-$C_6H_4(CO)_2P^-$] has proven to be a versatile reagent for preparation of P-substituted derivatives either by direct reaction (alkyl halides, pentafluorophenyl halides) or by irradiation with 420 nm blue light (CF_3CH_2I). Here we describe the preparation of fluorous ponytail phthaloylphosphines and their further transformation into primary phosphines ($RfCH_2CH_2$-PH_2). Characterization of the phthaloylphosphines and primary phosphines, along with details of preparation and further transformation, will be discussed.