

**Gustavus Adolphus College  
Sigma Xi Symposium  
Friday, May 2, 2008**

**Session 1A  
Nobel 105  
Scott Bur, Chair**

<b>1:45</b>	<p><b><i>Semantic Priming during Binocular Suppression</i></b> Brandon Baartman, Kristine McGlennen</p> <p>Advisor: Patricia Costello</p> <p>Recent research has demonstrated that familiar and recognizable stimuli such as upright faces and words presented in a native language possess an advantage of breaking suppression during binocular rivalry. In the current study, a visible prime was presented before either a semantically and conceptually related or unrelated word that was gradually introduced to one eye, competing against a standard high-contrast dynamic noise pattern presented to the other eye. We measured how long it took for semantically and conceptually related words to break out of suppression and compared the timing to a non-related word breaking from suppression. Preliminary results show that related words are faster to gain dominance. This suggests that words, even when suppressed and invisible, are processed faster when previously primed.</p>
<b>2:00</b>	<p><b><i>Preparation and Reactivity of [1.1.1] Propellane</i></b> Joel Rindelaub</p> <p>Advisor: Brian O'Brien</p> <p>Cubane and similar highly strained hydrocarbons have garnered a great deal of interest in recent years. They have been nitrated to form explosives 30% more powerful than HMX, and added to pharmaceutical compounds, increasing the lipophilicity and degradation time of drugs. We report our initial efforts in the preparation of [1.1.1]propellane, a grotesquely strained, yet kinetically stable molecule. The general synthesis involves a carbene addition to 3-chloro-2-(chloromethyl)-1-propene, followed by a metal-halogen exchange with methyllithium, with characterization by reaction with thiophenol, followed by <sup>1</sup>H NMR and <sup>13</sup>C NMR. Additional reactions aimed at polymerization or attachment to drugs may lead to advances in materials science and drug design.</p>
<b>2:15</b>	<p><b><i>Identification of an allosteric binding site in <math>\gamma</math>-glutamylcysteine ligase</i></b> Kelly Rozenboom, Colin Boettcher</p> <p>Advisor: Brenda Kelly</p> <p>Glutathione plays an important detoxifying role in nearly all eukaryotes. It has recently become of great interest due to its high abundance in cancer cells and its ability to slow or block chemotherapeutic effects. Therefore, by slowing or blocking glutathione synthesis, cancer cells may become more susceptible to these therapeutic techniques. The enzyme <math>\gamma</math>-Glutamylcysteine ligase (<math>\gamma</math>-GCL) catalyzes the first step in the synthesis of glutathione. In the present study, UV/Vis spectroscopy was used to identify analogs that alter the activity of <math>\gamma</math>-GCL, while fluorescence studies were used to probe conformational changes within the enzyme upon binding of the analogs.</p>
<b>2:30</b>	<p><b><i>Identification of an allosteric binding site in <math>\gamma</math>-glutamylcysteine ligase</i></b> Colin Boettcher, Kelly Rozenboom</p> <p>Advisor: Brenda Kelly</p> <p>Glutathione plays an important detoxifying role in nearly all eukaryotes. It has recently become of great interest due to its high abundance in cancer cells and its ability to slow or block chemotherapeutic effects. Therefore, by slowing or blocking glutathione synthesis, cancer cells may become more susceptible to these therapeutic techniques. The enzyme <math>\gamma</math>-Glutamylcysteine ligase (<math>\gamma</math>-GCL) catalyzes the first step in the synthesis of glutathione. In the present study, UV/Vis spectroscopy was used to identify analogs that alter the activity of <math>\gamma</math>-GCL, while UV/Vis spectroscopy of cobalt suggests that <math>\gamma</math>-GCL binds two equivalents of divalent metal.</p>

2:45	<p><b>Synthesis of a Pyrrolizidine Alkaloid</b> David Guptill and Nina Serratore</p> <p>Advisor: Scott Bur</p> <p>This project focuses on the synthesis of a bicyclic pyrrolizidine alkaloid derived from an amine and a carboxylic acid. The amine was synthesized from methionine by a series of reactions. The carboxylic acid was synthesized from methyl acrylate and nitromethane. The amine and the carboxylic acid were coupled with DCC and D-MAP to form an intermediary amide. We are currently working on the formation of the bicyclic alkaloid using a Lewis acid as a catalyst.</p>
3:00	<p><b>Studies on Diels-Alder Reactions of Substituted Siloxy-furans</b> Brittany Murphy</p> <p>Advisor: Scott Bur</p> <p>Previous research has shown a bicyclic system containing an aromatic ring next to a five-membered ring can be synthesized using an intramolecular Diels-Alder reaction of siloxy-furans. We are now trying to identify the scope and limitations of this mechanism by using variously substituted siloxy-furans; specifically, 4-methyl-2(5H)-furanone and 3,4-dimethyl-2(5H)-furanone will be synthesized. Our products will then be used to synthesize heavily substituted derivatives of aromatic rings.</p>
<p><b>Session 1B</b> <b>Nobel 305</b> <b>Jon Grinnell, Chair</b></p>	
2:00	<p><b>Niche partitioning between native and exotic earthworms in Costa Rica</b> Christine Askham</p> <p>Advisor: Jon Grinnell</p> <p>Niche preference for level of organic soil content, level of soil texture, and moisture was tested between native worms and an exotic species, <i>Eisenia foetida</i> (Lumbricidae), in Monteverde, Costa Rica. A significant difference for organic soil content level exists between native earthworms and <i>E. foetida</i>. Native earthworms avoided high organic content while the exotic earthworms preferred it. Both native and exotic earthworms were most abundant in the low soil texture level when tested alone.</p>
2:15	<p><b>Belowground Analysis of a Historic Botrychium Population in Bonny Prairie Natural Area, Colorado</b> Whit Hohman, Steph Lewis, Amy Waldner</p> <p>Advisor: Cindy Johnson-Groh</p> <p><i>Botrychium campestre</i> is a species of moonworts that produces prolific quantities of gemmae, underground reproductive structures. Most of the life cycle for <i>B. campestre</i> occurs belowground, however, very little is known about this about this stage. <i>B. campestre</i> is not federally listed as endangered or threatened, but, it is considered a sensitive species by the United States Forest Service. A confirmed location of <i>B. campestre</i> is the Bonny Prairie Natural Area, in Northeastern Colorado, with the last aboveground sighting in 1993. The population was discovered in 1990 and has never contained more than six aboveground plants per year. Because of the unusual life cycle of this plant, it is unclear if the populations have died or if they are simply dormant.</p> <p>The purpose of this study was to determine if viable gemmae were present in soil samples from this historic site in the Bonny Prairie. Presence or absence of belowground structures (gemmae) will have implications for the conservation management plans of the area. Thirty-seven soil samples were collected in the location in which previous sightings occurred using a spoke sampling design. Samples were dissected and analyzed using a centrifugation method, and gemmae encountered were photographed and preserved. We found gemmae in ten of the thirty-seven samples. Most of the gemmae appear healthy (turgid, not senescing) though a few were in poor health. These results reveal the long-term persistence of gemmae and have implications for conservation management of these populations.</p>

2:30	<p><b>Photolysis of Sulfonyl Group Herbicides: Nicosulfuron and Flumetsulam</b> Mallory Richards</p> <p>Advisor: Amanda Nienow</p> <p>Flumetsulam and nicosulfuron are relatively new classes of herbicides that function by inhibiting a plant's enzymes, eventually killing the plant. Nicosulfuron and flumetsulam were prepared in milli-Q water and filtered Mississippi River water, with each solution exposed to 245nm, 300, and 350 nm UV light in a Rayonet photoreactor. There was evidence of photochemical degradation of flumetsulam and nicosulfuron. The rate of photochemical degradation was notably faster for the milli-Q water prepared solutions than the Mississippi River water solutions upon exposure to 254 nm and 300 nm UV light for both herbicides. The difference in the rates is accounted for by the difference in the pH of the solutions. In experiments exhibiting photochemical degradation, by-product formation was observed in the HPLC chromatographs.</p>
2:45	<p><b>Excitation of Microcantilevers using Ultrasound Radiation Force</b> Eric Ofstad and Sam Barthell</p> <p>Advisor: Tom Huber</p> <p>Investigation of coupled dual microcantilever excitation using ultrasound radiation. Via dual-sideband suppressed-carrier amplitude modulation, a single transducer was used to excite the first and second transverse modes, and the first torsional mode. Additionally, it was demonstrated that two transducers may be used to selectively excite either symmetric or antisymmetric vibration in the first transverse mode by varying the relative phase between transducer signals. Furthermore, developed computer models accurately predicted system behavior at higher frequencies.</p>
3:00	<p><b>Correcting for Particle Size Selectivity of Unsupported Pb<sup>210</sup> and Nuclear Fallout Cs<sup>137</sup></b> Peter Philippi</p> <p>Advisor: Laura Triplett</p> <p>Landscape change in southern Minnesota has increased the amount of eroded sediment that enters the Minnesota River and pollutes downstream waters. Pb<sup>210</sup> and Cs<sup>137</sup> are radionuclides used for sediment dating and tracing sediment origin. Due to their preferential binding to small sediment grains, this experiment created an equation describing the relationship between Pb<sup>210</sup> and Cs<sup>137</sup> concentration and grain size. This curve corrects radionuclide concentration values to properly correlate sources of lake and river sediment.</p>
<p><b>Poster Session and Refreshments</b> <b>3:15-3:45 Nobel Lobby</b></p>	
	<p><b>ASIC3 and P2X involvement in ischemic pain sensation</b> Brandon Baartman</p> <p>Advisor: Heather Wenk</p> <p>Ischemic pain sensations likely occur due to the release of metabolites from working muscle tissue as a result of anaerobic respiratory processes. It has recently been suggested that the primary afferent receptors ASIC<sub>3</sub> (Acid-Sensing Ion Channel 3) and P<sub>2</sub>X<sub>5</sub> (receptive to ATP) are involved in the transduction of this nociceptive signal. Here we investigated the roles of these receptors using a novel <i>in vitro</i> muscle-nerve preparation from the hind foot of a rat to record sensory neuron response to electrically-induced muscle contractions in a simulated ischemic environment. Sensory signals were reversibly inhibited by the application of either ASIC<sub>3</sub> or P<sub>2</sub>X receptor antagonists, as well as the concurrent application of both (ASIC<sub>3</sub> receptor antagonist APETx2 at 10µM, P<sub>2</sub>X receptor antagonist PPADs at 100µM). These results may suggest that the transduction of this ischemic signal is dependent on activation of both receptor types.</p>

**Anion-exchange Resin-supported Sulfo-N-Hydroxysuccinimide:**

Drew Corbett

Advisor: Todd Swanson

An ion-exchange resin-immobilized sulfo-N-hydroxysuccinimide (sulfo-NHS) reagent has been prepared from the sodium salt of sulfo-NHS and Amberlyst A26 strong anion-exchange resin. The sodium sulfo-NHS was prepared from sulfo-succinic acid. Experiments are being carried out to prepare resin-immobilized active esters. Subsequent treatment of these resin-bound active esters with amines is expected to produce amide products that require minimal purification. While related covalently bound reagents are known, these electrostatically bound reagents are rather novel.

**The Investigation of Excited State Dynamics in 7-azaindole: Resonance Raman Spectroscopy and Computational Simulation Techniques**

Nathan Erickson, Molly Beernink, Nathaniel Swenson

Advisor: Jonathan M. Smith

Excited state proton transfer dynamics in 7-azaindole (7AI) are of great interest due to 7AI's biological significance as a model system. This phenomena has been studied by a range of methodologies in solution and the gas phase. In our computational and experimental work using resonance Raman spectroscopy we are afforded unique access to the early proton transfer dynamics mediated by solvent. We will present resonance Raman spectral simulations of monomer and dimer species and correlate these simulations with isotopic spectral data. We will report the relevance of our initial computational and experimental results to ongoing consideration of the mechanism of the excited state proton transfer in 7AI and related systems as a function of solvent.

**Analysis of the Homogeneity of the New Ulm Till of the Des Moines Lobe of the Laurentide Ice Sheet: Implications for a Deforming Bed**

Jessica Hill

Advisor: Jim Cotter, UMM

The dynamics of the Des Moines lobe of the Laurentide Ice Sheet have been modeled to suggest that a deforming bed may have influenced the lobes flow and geometry. Because some models are regional in extent there is an implication of a till layer that is working uniformly over an extensive area. This research project focused on the composition of the lowermost layer of the New Ulm till. The goal was to determine if till composition is homogenous or if there are local differences in composition that may have been the result of local differences in the lobes bed.

**Characterization of auditory responses in the ventral nerve cord of Periplaneta**

Asitha Jayawardena

Advisor: Mike Ferragamo

A variety of independent mechanisms for perceiving sound have been developed in insects including use of the temporal and SGO organs. The SGO of the Periplaneta americana may be an important evolutionary link in the detection of sound in insects. We present preliminary results using a digital acoustic presentation system to characterize acoustically-evoked unit responses in the ventral nerve cord. Single units demonstrate a variety of temporal response patterns to pure-tone bursts and broad tuning to frequency.

**Magnetic Interactions and the Mossbauer Effect in Ferrihydrite Nanoparticles**

Anna Lindquist

Advisor: Jim Welsh

Four synthetic samples of ferrihydrite ( $\text{Fe}_5\text{HO}_8 \cdot 4\text{H}_2\text{O}$ ) with organic coatings and one uncoated sample were obtained to investigate magnetic interactions between nanoparticles. When ferrihydrite particles are coated, inter-particle distances increase, blocking magnetic interactions. Particle size estimates from magnetic data are then more accurate. The data consistently showed a decrease in particle interactions for coated particles. Two natural samples were analyzed for consistency with the synthetic data. Their results further supported the findings from the synthetic samples.

3:15  
to  
3:45

***The Relationship Between Empathy, Mirror Neuron Activity, and Heart Rate***

Matt Novakovic, Eric Miller

Advisor: Timothy Robinson

We investigated the relationships between empathy, mirror neuron activation, and heart rate. Individuals with high empathy and low empathy were identified, and their mirror neuron activation and heart rate were measured with EEG and EMG, respectively. Participants engaged in conditions that involved watching a pendulum, static, and tapping motion, and conducting self-initiated tapping. The results indicate a significant correlation between mirror neuron activity and the personality variables of extraversion, conscientiousness, and empathy and a moderate correlation between heart rate and empathy.

***Characterization of Speech Intelligibility in Christ Chapel***

Jing Han Soh, Daniel Mellema, Benjamin Wolf

Advisor: Steve Mellema

The acoustical response of both the new and old Christ Chapel at Gustavus Adolphus College sound systems was characterized by Speech Transmission Index (STI) and Clarity Index C50 to determine the clarity of spoken voice through signal-to-noise measurements. Electronic and Acoustic System Evaluation and Response Analysis (EASERA) speech software was used to project and analyze the sound wave sent through each sound systems in Christ Chapel. The overall intelligibility metrics for the new sound system were found to have improved compared to the old system. Improved speech intelligibility was seen especially in the front rows of the main floor.

**Session 2A**

**Nobel 222**

**Jonathan Smith, Chair**

**3:45 *Co-Rumination and Autobiographical Memory***

Naomi Garbisch

Advisor: Mark Kruger

The study examines whether people who co-ruminate will remember more details about a problem they co-ruminated on than for neutral events. 33 college students completed the Nolen-Hoeksema and Morrow (1991) measure of rumination, the CESD measure of depression (Radloff, 1977) and the co-rumination measure (Rose, 2002). Students returned and recalled three memories from ninth grade: neutral, positive, and a personal problem, and answered questions regarding each memory. The results are currently pending. We will use the LIWC (Pennebaker, Francis, and Booth, 2001) to code the autobiographical memories.

**4:00 *Excited State Dynamics in 7-azaindole***

Nathan Erickson, Molly Beernink

Advisor: Jonathan M. Smith

Excited state proton transfer dynamics in 7-azaindole (7AI) are of great interest due to 7AI's biological significance as a model system. This phenomena has been studied by a range of methodologies in solution and the gas phase. In our computational and experimental work using resonance Raman spectroscopy we are afforded unique access to the early proton transfer dynamics mediated by solvent. We will present resonance Raman spectral simulations of monomer and dimer species and correlate these simulations with isotopic spectral data. We will report the relevance of our initial computational and experimental results to ongoing consideration of the mechanism of the excited state proton transfer in 7AI and related systems as a function of solvent.

**4:15 *Direct and Indirect Photochemical Degradation Pathways of Imazethapyr***

Emily Pelton

Advisor: Amanda Nienow

The herbicide imazethapyr is a recent introduction to southern Minnesota and is considered an "emerging" agrochemical, indicating the absence of knowledge of its degradation pathways. Its structure suggests a propensity to undergo direct photochemical degradation and follow myriad indirect photochemical pathways. Ultraviolet photolysis studies were conducted to probe degradation pathways in phosphate buffers (direct photolysis) and Minnesota River water (indirect photolysis). The relationship between pH and degradation rate was also studied.

## Session 2B

### Nobel 201

Margaret Bloch Qazi, Chair

3:45	<p><b><i>Hemizygous effects on female sperm storage in <i>Drosophila melanogaster</i></i></b> Isaac Weeks</p> <p>Advisor: Margaret Bloch Qazi</p> <p>Female sperm storage consists of sperm retention within specific regions of the reproductive tract for extended periods of time. Previous research with <i>Drosophila melanogaster</i> identified several genes hypothesized to affect female sperm storage. I examined whether or not these genes are necessary for normal female sperm storage by measuring the effects of their absence on two storage-dependent female responses: latency to remating and long-term fertility.</p>
4:00	<p><b><i>Conservation genetics in the endemic streamfish <i>Cottus marginatus</i></i></b> Sarah Betzler</p> <p>Advisor: Joel Carlin</p> <p>Pre-colonial population status is difficult to estimate yet vital to conservation. This problem can be alleviated by estimating gene flow and genetic diversity, providing insight into the reproductive history and historical abundance of the organism. Population genetic parameters were estimated at microsatellite loci for the margined sculpin, <i>Cottus marginatus</i>, a freshwater benthic fish endemic to the Walla Walla and Wallowa river drainages in the Pacific Northwest. <i>Cottus marginatus</i> is listed as a species of special concern, and very little is known about its conservation status or population dynamics. Amplified nuclear microsatellites were visualized within 3.0% composite agarose electrophoresis gels to rapidly characterize genetic diversity.</p> <p>The number and frequency of alleles, heterozygosities and inbreeding coefficients were calculated between sample sites divided into categories based on land use and habitat quality. Variation was reduced in disturbed, low quality habitats, indicating that there has been a recent reduction in population size in those habitats. In addition, allele frequencies varied between high quality habitats separated by a stretch of disturbed, low-quality habitat, indicating that there is low gene flow between the two groups. This could indicate that habitat disruption caused by logging and farming may impact sculpin populations.</p>
4:15	<p><b><i>Electrophysiological Characterization of Primary Afferent Neurons Responsive to Cowhage-induced Itch</i></b> Danielle Gergen, Jenna Kesty, Nick Murray</p> <p>Advisor: Heather Wenk</p> <p>Chronic pruritus (or itch) is often resistant to medical treatment. A better understanding of the neural mechanisms underlying the sensation of itch is therefore needed. Previous research has indicated that C-afferent mechano-insensitive (CMI) fibers generally respond to itch of both histamine and nonhistaminergic origin. Here we present evidence suggesting that nonhistaminergic itch may be subserved by a larger variety of sensory neural subtypes than was previously thought. Spicules of the plant cowhage (<i>Mucuna pruriens</i>) provoke a nonhistaminergic itch response in humans and other animals. An in vitro skin-nerve preparation and teased-fiber electrophysiology was used to determine the primary afferent response to cowhage applied to rat hind-foot skin. Cowhage-sensitive units were identified and characterized by conduction velocity and sensory response properties. The conduction velocities of cowhage-activated units placed them into C and A<math>\delta</math> fiber categories. Some cowhage-activated units responded to cooling and heating and to bath application of the TRPV1 agonist capsaicin.</p>