2011 Sigma Xi Symposium Abstracts

Gustavus Adolphus College

May 6, 2011

Session 1: Oral Papers 2:45 pm – 5:15 pm Nobel 201	
2:45 pm	**Protected Areas and Conservation** Abby Williams Advisors: Anna Versluis and Amy Seham The focus of this project is to show the biology major the social impact of Protected Areas and other conservation plans. Several individuals going into a conservation science do not receive a significant background in cultural anthropology, ethics, or politics. Therefore, proposals and plans to protect habitats or animals fail a vast majority of the time, as the scientists do not understand the needs of the local people and governments. Through creating a workshop as a teaching tool and creating a course curriculum, I addressed these issues and brought up options to best suit the needs of the people and ecosystems. Throughout the developed curriculum, I introduce research from several fields including political science, sociology, anthropology, biology, social justice theatre, and geography.
3:00 pm	**Dissolved Organic Carbon and its Interaction with Metals in Aquatic Systems** Erik Swanson Advisor: Jeff Jeremiason Dissolved organic carbon (DOC) plays an important role in the transport of heavy metal pollutants in aquatic systems. In aquatic systems, DOC is a complex mixture of compounds composed mostly of humic substances that can bind to heavy metals as ligands. High performance liquid chromatography (HPLC) with a size exclusion chromatography (SEC) column is used to separate components of DOC based on apparent molecular size. This is coupled to a UV detector and an inductively coupled plasma mass spectrometer (ICP-MS) to determine interactions between metals and different components of DOC.
3:15 pm	**Effects of the Invasive Species *Phragmites Australis* on the Biogeochemical Cycle of Silica on the Platte River, Nebraska** Carson Smith Advisor: Laura Triplett In comparison to other major cycles such as those of carbon, nitrogen and phosphorus cycles, the silicon cycle is less well understood. *Phragmites australis* is a species of reed native to Eurasia that has recently invaded many wetland and aquatic ecosystems on this continent. We quantified the amount of silica that *Phragmites* takes up from river water and sequesters in sediments. The biogenic silica content in surface sediment samples from five stands of *Phragmites*, three stands of willow, and three unvegetated sandbars was taken in the Platte River, Nebraska, which is located on the Great Plains in the Midwestern United States. *Phragmites* sequestered 18,500 tons of silica in sediment over eight years, as compared to 4,625 tons by willow and 1,541 tons in unvegetated sediments. Therefore, we have shown that the amount of silica transported by rivers from land to sea can be significantly reduced by changes in riparian vegetation.

3:30 pm	**Analysis of Cytochrome P450 Variation in Benthopelagic Fishes from the Gulf of Mexico in Response to Oil Spill Exposure** Josh Hammer and Justin VerMeer Advisor: Joel Carlin To understand the genetic impact of the 2010 Deepwater Horizon oil spill, we obtained fish samples from NOAA groundfish surveys in the months before and after the oil spill. We hypothesized that in response to unfavorable conditions, groundfish populations would experience strong selection with respect to toxin and oxygen metabolism. Therefore we are studying the nuclear gene cytochrome P450 and the mitochondrial cytochrome b and cytochrome oxidase 1 genes. We have successfully isolated 180 DNA samples from four species and conducted 124 PCR optimizations of mitochondrial primers. While we have not obtained amplicons, new optimizations continue. We outline the conditions necessary for detecting selection at our chosen markers, as well as adding to the Barcode of Life Initiative and contributing information about these little-studied fishes.
3:45 pm	**Break**
4:00 pm	**The Effect of Histone 3.3A on *Drosophila melanogaster* Fertility** Stephanie Snyder Advisor: Margaret Bloch-Qazi Prolonged fertility is a critical component of an organism's reproductive success. A commonly overlooked stage in reproduction that is critical for female fertility is sperm storage, which occurs when sperm are retained in specific reproductive organs. Identifying and characterizing genes involved in female sperm storage can better help us understand its role in the reproductive process. A genetic screen of Drosophila melanogaster identified the gene Histone 3.3A as potentially having a role in female sperm storage. I examined the hypothesis that His3.3A is required for normal female sperm storage by examining total number of offspring produced and fertility longevity among females with reduced levels of His3.3A and controls. Females with reduced levels of His 3.3A had significantly longer fertility than controls, but did not produce the highest number of offspring. The difference in progeny production could be due to efficient sperm use or a deficiency in egg production. These results are consistent with His 3.3A having a potential role in D. melanogaster fertility.
4:15 pm	**Where does the Hindu God Stand?** Jean-Paul Noel Advisor: Jonathan Steinwand (Concordia College Moorhead) The Moral Typecasting theory holds that entities are exclusively perceived either as moral agents or moral patients. This brings about our perception of God as the "Ultimate Moral Agent", being totally capable of agency, but able of null experience. Now, it seems that this approach to morality is culturally limited; the dyadic nature of the moral relationship is heavily individualistic. It was hypothesized here, that a Hindu culture would perceive God as possessing both agency and experience, and therefore, not as the "Ultimate Moral Agent". The results confirmed the hypothesis, however, not finding a correlation between a decrease in the perceived agency of the deity, and a shift from an individualistic to a collectivistic approach to morality.
4:30 pm	**Attentional Effects of Natural Environments** Alex Gjorvad Advisor: Marie Walker The Attention Restoration Theory (ART) posits that certain environments, especially natural environments, can restore attention after it has been fatigued. The present study was designed to test which environments are most effective at restoring attentional capacities. Participants

	completed an attention task, which preceded viewing photographs of nature, images of art that are aesthetically pleasing, or geometric objects. Then, each participant completed a second attention task to determine if directed attention had been restored. It was hypothesized that participants who viewed photographs of nature would have higher post-test scores on the attention task than those who viewed pictures of beautiful artwork or geometric patterns. Electroencephalography (EEG) was utilized during the viewing process to determine if brain wave activity was correlated with any attention restoration.
4:45 pm	**Elimination of Standing Wave Effects in Ultrasound Radiation Force Excitation in Air Using Random Carrier Frequency Packets** Nathaniel Beaver Advisor: Tom Huber When using ultrasound radiation force excitation, and other continuous wave techniques, one of the challenges is the formation of standing waves between the transducer and object. These standing waves lead to an extreme sensitivity to transducer location and/or carrier frequency; minor changes in transducer location or carrier frequency can lead to constructive or destructive interference, which leads to large changes in the radiation force. A related problem, often observed when using the ultrasound radiation force for excitation in air, is random drifts in the response to ultrasound excitation. In the current study, to mitigate standing wave effects, instead of keeping the carrier frequency constant, the carrier frequency randomly varied in packets. In one measurement, the 270 Hz resonance in a brass cantilever was excited with the ultrasound radiation force where the carrier frequency was varied randomly between 535kHz to 555 kHz in packets of 10 cycles of the carrier. Since each packet had a different carrier frequency, a suppression of over 6x in the amplitude of standing wave artifacts was accomplished.
5:00 pm	**Physiological Allostatic Model of Theater Performance: Cortisol Response in Actors Following a Performance** Cassandra L. Breitenfeldt Advisor: Sanjive Qazi The relaxation response (RR) elicited through yoga and other movement therapies have been shown to reduce cortisol levels (Dusek et al, 2008). This study aimed to determine if participation in performance arts reduced cortisol levels and other electrophysiological measures of stress in subjects and to use bioinformatics analysis of gene expression profiles in studies that measured the RR in mice and humans to determine if genes switched on during cancer cells are down regulated through the RR. Immediately before and after dance or performance by the Mankato Mosaic theater group subjects completed a survey on emotive states and lifestyle. Salivary cortisol measurements, blood pressure and heart rate were also taken. Genes found to be differentially expressed between subjects with varied yoga meditation experiences were interrogated for brain and lung cancers in the OncomineTM database and RR signatures were assessed (Dusek et al, 2008). There were significant differences in pre-test heart function and cortisol levels between dance and theater performance participants. Responsiveness of cortisol levels was found to be driven by the nature of the activity and changes in heart variables. The RR increased expression of DUSP3 and reduced expression of TYMS. The results suggest that the responsiveness of cortisol is determined by the physiological context of the individual which supports of the Allostatic Model of stress response. This study also suggests that the RR elicited by performance art therapies can reduce harmful gene expression in cancer cells and can increase expression of cancer fighting genes.

Part 2: Poster Papers
In association with the *Celebration of Creative Inquiry*
5:00 pm – 7:00 pm
Jackson Campus Center

Trace Metal And Dissolved Organic Matter Cycling In An Ombrotrophic Bog

Ben Carlson
Advisor: Jeff Jeremiason, Stephen D. Sebestyen (USDA Forest Service), Randall K. Kolka (USDA Forest Service)

The transport and biogeochemical cycling of trace metals in peatland systems is often related to the type and amount of dissolved organic matter present. Trace metals, dissolved organic carbon (DOC), and other parameters were measured monthly from June to October 2010 in porewaters of an ombrotrophic bog to assess movement of trace metals from the upland towards the center of the bog. Significant gradients in pH, DOC, and other parameters were observed in the porewater transects extending from the upland towards the center of the bog, although these varied monthly. Some trace metal concentrations were correlated with DOC (e.g. Pb) and generally increased in concentration moving from the upland towards the center of the bog. This behavior suggests a central role for DOC in controlling speciation and transport of these metals. Others metals (e.g. Ca) decreased in concentration towards the center of the bog, suggesting runoff from the upland as a major source and potentially less interaction with DOC. A redox model will be presented to help explain trace metal speciation and elucidate potential transport mechanisms in the bog.

Preparation of 1,3,2-Oxazaphospholidine-2-oxide Derivatives as Models for the Development of Novel Chiral Auxiliaries

Steven Lundberg
Advisor: Todd Swanson

The objective of this research is to prepare novel phosphorus based chiral auxiliaries for use in asymmetric synthesis. Model 1,3,2-oxazaphospholidine-2-oxide derivatives, patterned after the well-known oxazolidinone and oxazolidinethione auxiliaries of Evans and Crimmins, were prepared from simple reagents. Phosphorus oxychloride was reacted with diethylamine followed by ethanolamine to produce 2-diethylamino-1,3,2-oxazaphospholidine-2-oxide as one of the derivatives. Methylphosphonic dichloride, prepared from phosphorus hexachloride and dimethyl methylphosphonate, was reacted with ethanolamine to prepare the 2-methyl derivative. This model synthetic pathway could potentially be used to make phosphorus based chiral auxiliaries that may have complementary utility to the widely applied auxiliaries of Evans and Crimmins.

Analyte Retention and Column Performance of Drugs in Hydrophilic Interaction Liquid Chromatography on Carbon-on-Silica Columns

Laura Secor and Carrie Johnson
Advisor: Dwight Stoll

Hydrophilic interaction liquid chromatography (HILIC) is a form of high performance liquid chromatography employing a high proportion of organic solvent in the mobile phase. It is used as an alternative to normal-phase or reversed-phase chromatography, and typically uses bare silica or polymer particles with polar substituents as the stationary phase. In this work we describe the HILIC retention of drugs on a novel carbon-on-silica stationary phase. HILIC conditions yielded retention patterns orthogonal to those observed under reversed-phase conditions, indicating the compatibility of the two modes for multidimensional analysis. A systematic study of the effect of both water and acetonitrile dilution of the injected sample was conducted. Water dilution showed that large-volume, dilute injections yielding narrow peaks and better column efficiency. Acetonitrile dilution had the opposite effect. These results are the opposite of the expected effect of strong and weak solvent dilutions. In an independent analysis of the specific case of midazolam, increased carbon content on the stationary phase led to increased retention.

Assessment Of College Adjustment And Autonomy In Relation To Parenting Styles

Caroline Hendrickson
Advisors: Mark Kruger and Dick Martin

College students at a small private Midwestern college were administered questionnaires asking about their relationship with their parents and how much contact they had with their parents. The purpose of this study was to discover if there is a relationship between a college student's adjustment and autonomy in relation to the style of parenting they were raised with. Participants were given an Ego Identity Process and the Parental Authority Questionnaire (Buri 1991). Buri states that there are three distinct parenting styles: permissive, authoritative, and authoritarian. Initial results from data previously collected demonstrate that there is a relationship between parental communication and student's autonomy. There is also evidence of a relationship between student's perceived autonomy and adjustment to college. These preliminary results also suggest that students who were raised by authoritative parents are the best adjusted to college as compared to students who were raised by either permissive or authoritarian parents. Final results and analysis are still pending.

Photodegradation of Flumetsulam and Nicosulfuron Herbicides

Derrick Berndt
Advisor: Amanda Nienow

In recent years, the photochemistry of many herbicides has become an area of interest to researchers due to the identification of herbicides in surface waters (such as Minnesota rivers) from farm run-off and the potential of sunlight to transform these herbicides into other compounds. The purpose of this study is to determine the photoproducts and rate constants associated with the photodegradation of flumetsulam and nicosulfuron, two herbicides used occasionally in Minnesota. Rate constants were determined for the photolysis of flumetsulam and nicosulfuron solutions containing varying amounts of natural organic matter (NOM) in an effort to mimic real aquatic systems. The photolysis of each solution was carried out in a lab bench photoreactor with 254 and 310 nm lamps. The required analyses for the kinetic studies were performed using HPLC and the isolation/identification of photoproducts was performed with LC/MS/MS. The results of this study will add to a growing body of knowledge about the photochemistry of agriculturally relevant compounds and could have implications for the ways in which these herbicides are used.

Acoustical Studies of Bjorling Recital Hall

Benjamin Wolf
Advisor: Steve Mellema

The acoustical response of Bjorling Recital Hall at Gustavus Adolphus College was characterized with reverberation time, gain, and weighted energy. EASERA SysTune software was used to compare the direct sound from several live ensembles to the sound in the hall for different settings of the acoustic curtains. These data were used to determine the optimal settings for different types of ensembles.

A Renewed Look at Renewables

Amanda Hochstatter and Hasanga Samaraweera
Advisor: Charles Niederriter

With the environmental challenges facing the world today, renewable energy and sustainability are being thrust into the public arena. This increased visibility is raising the need for these issues to play a greater role in science at Gustavus. Creating labs across the sciences that incorporate renewable energy and sustainability will both entice students to join these classes as well as increase their knowledge of these pertinent subjects. These are a few of the projects that were designed: a light board powered by a bicycle to help students qualitatively feel the amount of energy needed to power light bulbs, use of bomb calorimeters to quantitatively show the amount of energy in various substances, transferring high ethanol yielding plasmids to demonstrate cutting edge research in ethanol production, and demonstrating the greenhouse effect through a simple experiment using Alka-Seltzer tablets. These and many other experiments can be utilized by various

science classes and the campus as a whole to bring renewable energy and sustainability to the forefront of Gustavus' collective conscience.

Environmental Context Effects on Lexical Processing

Laura Kientzle, Caitlin Bayer
Advisor: Kyle Chambers

When you hear a word, related words are "activated" facilitating their identification. This is called semantic priming. For example, "nurse" activates related words such as "doctor," "medicine," and "hospital," making it easier for you to recognize these words when spoken immediately after "nurse" (Altmann, 1997). Previous research has also demonstrated that other types of linguistic information such as word frequency and sound similarity affect lexical activation (Marslen-Wilson, 1977). The current study explored whether non-linguistic environmental information such as the place where a conversation takes place also influences the activation level of words and language processing. Participants performed the experiment either on a laptop in a lounge or in a kitchen. They viewed a word that was a kitchen-related word, a non-kitchen-related word, or a non-word, and indicated whether the string of letters was a word or not (i.e., lexical decision task). Through this process we were able to see how active and "retrievable" each word was compared to other words by measuring how quickly the lexical decision was made. We predicted that participants would be quicker to decide that the string of letters they saw on the screen were a word when the word was a kitchen-related word and they were taking the test in the kitchen, and not the lounge. This would provide the first evidence that the mental lexicon stores environmental contexts with related words.

Interaction of Negative Ions with X-Rays

Amy Audette
Advisor: Ileana Dumitriu

Negative ions are a special class of atomic systems with properties very different from neutral atoms and positive ions. From a theoretical point of view, the study of negative ions allows us to understand the effects of electron-electron correlation. We only have the complete picture for the Hydrogen atom, but we do not yet have a proper model to describe many-particles systems, such as the other 104 atoms in the periodic table. The outer-shell electrons being far away from the nucleus may be detached by a laser. The inner-shell electrons being closer to the nucleus are bounded more strongly inside of the ion, and to detach these inner-shell electrons we need high energy photons. We can get these kinds of photons only from an advanced light source. An ion beam merged collinearly with a photon beam in an interaction region produces photodetached neutral atoms and positive ions. The positive ions are detected as a function of photon energy. The number of positive ions can then be displayed versus photon energy. This spectrum will provide information about the energetic structure of the ions and the dynamics of photodetachment process. Negative ions play an important role in various branches of physics, ranging from astrophysics, atmospheric and plasma physics to surface physics and accelerator physics. This information will allow the physics community to better understand negative ion behavior and potential use.

Isolation, Transformation, and Characterization of *S. cerevisiae fumarate dehydrogenase* Point Mutations

Daniel Rohlf and Justin Anderson
Advisors: Jeff Dahlseid, Kirk Anders (Gonzaga University), Brenda Kelly

The fumarase enzyme catalyzes the conversion of fumarate to malate within the citric acid cycle, a vital metabolic pathway for organisms that rely upon aerobic respiration. Therefore, in humans, fumarase is an essential enzyme. While null mutations in the human fumarase gene are lethal, hypomorphic mutations are correlated with a variety of disease states, including uniparental isodisomy, Leydig cell tumors (LCT), leiomyomatosis, renal cell carcinoma, and fumarate hydratase deficiency (FHD). Six such fumarase point mutations were found with high frequency in the Swedish population (R101P, P174R, M451I, H135R, V394L, and S158I). Although known to be non-lethal, the effect of these mutations on fumarase activity has not been characterized. To permit their characterization, Gonzaga University undergraduate research students

advised by professor Kirk Anders created analogous mutations (K79P, Q152R, M432I, H114R, I372L, and S137I) in the Saccharomyces cerevisiae (baker's yeast) fumarase gene. Plasmid DNAs carrying the mutant alleles were obtained, transformed into Escherichia coli for amplification, and isolated. Our goal is to separately introduce each plasmid DNA into S. cerevisiae lacking the fumarase gene and phenotypically characterize the resulting yeasts.

Post-transcriptional Regulation of Metalloprotein II (MPII)

Xiu Xiao, Krishan Jethwa, Gamachu Melkamu, and Nick Guttormson
Advisor: Jeff Dahlseid

Nereis diversicolor (hagworms) are known to live in contaminated sediments that have levels of toxic metals that are usually incompatible with biological organisms. Nereis diversicolor might be able to survive under these conditions, at least in part, because of the function of a cadmium binding protein, Metalloprotein II (MPII), found in the worm's gut. We sought to determine whether MPII plays a direct role in cadmium resistance through two approaches. Using Saccharomyces cerevisiae (baker's yeast) as a model system, we tested the growth of yeast with and without MPII on media with and without cadmium. Our result shows that there is no difference in the growth of yeast with MPII compared to those without on media containing cadmium, indicating MPII confers no detectable cadmium resistance to yeast. For our second approach, we are comparing the MPII gene sequence isolated from worms that are metal resistance to that from those that are not, in order to see if there are any genetic differences. If there are sequence differences, it would be consistent with a role for MPII in cadmium resistance. We will then directly test whether the genetic differences are responsible for an increase in cadmium binding and/or resistance using the yeast system. A second and future goal is to see if and how MPII is regulating itself by measuring the RNA and protein levels in the presence and absence of cadmium. To that end, we have made antibodies in rabbits to detect MPII.

Identification of New Brain Cancer Target Sites from Bioinformatic Analysis of Acupuncture Studies

Courtney Murphy
Advisor: Sanjive Qazi

Through growth and differentiation, stem cells develop into progenitor cells, which further grow and differentiate into specialized cells. Proliferation and apoptosis take place to regulate this process, but when there is an unregulated proliferation and predominance of anti-apoptotic mechanisms, cancer develops. Factors that upregulate proliferative signals in cancer cells can be targeted for therapies. We propose that complementary medicine, and more specifically, acupuncture that affect gene switching in the brain can counter proliferative or anti-apoptotic signals to aid drug therapies. In this research, we obtained gene signatures from two acupuncture studies and analyzed their up- or downregulation in specific brain cancers using Oncomine, a cancer-gene profiling database. We found that 19 genes were significantly downregulated and 26 genes were significantly upregulated. Genes downregulated in cancers mimicked the regulation of genes in low responders to acupuncture. Genes that were up-regulated in cancers were also up-regulated in response to acupuncture. We surveyed for over representation of the acupuncture induced gene signature in other databases to characterize KEGG pathways, chemical and genetic perturbations, microRNA targets, transcription factor targets, and microarray expression data of these genes. These databases enabled development of hypotheses for gene mechanisms involved in brain cancer progression, which can be targeted to alter their expression through cross-referencing with drug databases. This can assist in finding differences in subjects on a genetic level and allow for feasible personalized medicine. Through this understanding, we can better advise in care delivery and decision-making, one of the most perplexing and demanding aspects of cancer treatment.