2012 Fall Research Symposium Abstracts

Rates of Erosion Sediment Mechanisms determined from Geomorphic Landforms in 7 Mile Creek Park
Jake Bruihler, Gustavus Adolphus College Geology
1:30 NHS 305

The goal of this research is to determine the origins of geomorphic landforms in Seven Mile Creek Park, MN. Approximately 12,000 years ago, a massive volume of glacial melt-water carved the Minnesota River Valley. Seven Mile Creek, a tributary to the Minnesota River, experiences geomorphic change linked to the history of the larger Minnesota River Valley. This study examines tributary response to changes in base-level (elevation of body of water into which the stream flows) that occur as the Minnesota River valley evolves. In addition, changing human activities in the area are causing increased erosion in the area; this study may help quantify the magnitude of human-induced change.

This project targets landforms that were previously identified during a geomorphic mapping project (Bock, 2010). This project aims to determine the age and origin of a landform in the tributary valley. During the summer, two sediment samples were taken for Optically Stimulated Luminescence dating; dates have yet to be determined. Once obtained, they will give an estimate for the date of sediment deposition, thus providing an estimate of landform age and rates of erosion in the valley walls. In addition, seven samples and two vertical cores were taken for grain size analysis, and are now processing. Grain size analysis can test hypotheses of transportation mechanism; results from these samples will be compared to control samples from alluvial fan (valley wall) deposits and fluvial (sandbar) deposits. Overall, the project will yield rates of erosion and landform origin in the Seven Mile Creek Watershed following glacial retreat.

Application of a Two-Source Energy Balance Model to the Delano Vineyards
David Buckley, NASA Student Airborn Research Program-Land Group
2:55 NHS 201

Energy balance models are often used to estimate evapotranspiration over a variety of terrain and vegetation, but many of these models are impractical because of the large number of required input parameters or lack of detailed output. The ALEXI and disALEXI models, developed in Anderson et al. (1997), facilitate accurate and detailed evapotranspiration estimates on a regional scale. In general, ALEXI and disALEXI have the potential to provide water-use information with high spatial and temporal resolution to agriculturalists worldwide. ALEXI and disALEXI are complementary, using a two-source energy balance model as the foundation of their evapotranspiration estimations. In order to validate the use of ALEXI and disALEXI over differing vegetation, a two-source energy balance model was applied to the table grape vineyards in Delano, California. The model used remote sensing data acquired by the MASTER instrument from the NASA SARP 2012 Airborne Research Program. The two-source energy balance model being used, developed in Norman et al. (1995), was programmed in MatLab. Validation of the ALEXI and disALEXI models over differing types of vegetation strengthens the potential for their use in large-scale mapping of evapotranspiration and other useful quantities.

Photodegradation of the herbicide imazethapyr on corn and soybean wax
Megan Crow, Gustavus Adolphus College Chemistry, HHMI Scholar
4:30 NHS 201

Imazethapyr is an herbicide commonly used in the Midwestern U.S. on corn and soybean crops. Previous studies have observed photolysis as one of the major pathways of environmental degradation. The goal of this study was to determine the rate of degradation of imazethapyr on plant waxes, considering that the herbicide is applied directly to crops in the field. Imazethapyr solutions were irradiated on glass, aqueous, corn wax, and soybean wax surfaces under simulated UV light and analyzed using HPLC. The rate constants calculated for the degradation of imazethpayr on corn and soybean wax were irreproducible. However, photodegradation product identification was performed using LC/MS and a preliminary photodegradation pathway is proposed. Future work will include continuing the photolysis experiments to confirm the rate constants, as well as studying photodegradation of imazethapyr on intact plant leaves.

Linear Quadrupole Ion Trap Experimentation and Developement of a Time of Flight Mass Spectrometer
Grant Fitzgerald, Gustavus Adolphus College Physics, HHMI Scholar
2:40 NHS 201

The main goal of this research was to explore ways to improve ion loading, signal strength, and signal consistency of a previously home-built linear quadrupole ion trap. During the summer, considerable improvements to ion loading and signal consistency were made.
Investigations involved trapping frequency, quadrupole rod voltages, endcap voltages, and delay before activating the quadrupole rods. A major breakthrough also came via stabilizing the quadrupole turn-on phase, enabling our ions to be trapped and released in controllable
and repeatable electric fields each test. Stabilizing the phase vastly improved the consistency of ion trap loading, and allowed other investigations affecting signal strength. We also investigated improving the longevity of our sample spot, to reduce the effect of ion plume geometry on ion trap loading.

Another goal of this research was to install a time of flight drift tube mass spectrometer onto our linear quadrupole ion trap to determine the masses of trapped ions. Extensive work with electronics to provide the power at the proper timing to make the ions travel up the drift tube and into the detector instead was done. Design and construction of home built power supplies has been completed. Work on fast (microsecond) switching continues. In addition, the time of flight drift tube was wired and assembled. Due to the nature of the construction, special attention to straightening of the tube was needed. This research was funded by the Howard Hughes Medical Institute.

Molecular Dynamics Simulation of a Peptide Amphiphile-Heparin Complex
Ian Gibbs-Hall, Northwestern University
2:15 NHS 105

The formation of a supramolecular complex consisting of 180 heparin-binding peptide amphiphile (HBPA) molecules and 20 heparin molecules 18 mer in length was analyzed in an aqueous and physiological ion concentration using atomistic molecular dynamics simulations. Each HBPA molecule was created by attaching a hydrophobic fatty acid tail to the N-terminus of the sequence Ala-Ala-Ala-Ala-Gly-Gly-Leu-Arg-Lys-Lys-Leu-Gly-Lys-Ala. It is known that a collection of peptide amphiphile (PA)

molecules will undergo self-assembly into roughly cylindrical nanofibers and this structure has shown to display numerous medical applications through its binding of angiogenic heparin. The internal energies and final geometry of the HBPA-heparin complex are analyzed to gain an understanding of the structure at a nanoscale level. The results from these simulations will be useful in the development of new HBPA fibers that can promote greater biological activity.

Multi-Elemental Fingerprinting of Modern and Ancient Carbonates
Jennifer Hanson, Gustavus Adolphus College Geology
1:45 NHS 305

Calcium carbonates (aragonite, high-Mg calcite, and low-Mg calcite) are a family of precipitated minerals that form within the ocean. The chemistry of the world's oceans has fluctuated through time, producing carbonates composed dominantly of aragonite + high Mg calcite or dominantly of low Mg calcite. These times of "aragonite seas" and "calcite seas" correspond to major shifts in Earth's climate and global sea level that can be traced as far back as the early Phanerozoic Eon (~540 million years ago). During the Proterozoic Eon (prior to 540 million years ago), it remains unknown whether ocean chemistry oscillated in this way.

After deposition, the carbonates undergo a process of recrystallization to the more stable low-Mg calcite or dolomite (a secondary mineral). To determine primary mineralogy of ancient rocks, we look for relict features of the original minerals. Previous work suggests that, during stabilization, carbonates may retain their original trace element composition. If the original composition of a stabilized carbonate can be determined and matched with primary polymorphs, one could reconstruct the chemistry of Proterozoic oceans. To begin this process, we analyzed the trace element composition of modern high-Mg calcite, low-Mg calcite, and aragonite using mass spectroscopy. Using a multivariate mathematical analysis, we evaluated the data for elemental concentration clusters that distinguished calcium carbonate polymorphs chemically. A Discriminant Function Analysis successfully distinguishes among aragonite, high-Mg calcite, and low-Mg calcite when data sets have a sufficient number of samples. Our data sets haven't yet produced strong clusters due to sample size and possible inaccurate mineralogy identification. Additional analysis of true mineral composition of modern carbonates is needed to proceed with the statistical analyses. Future work will examine ancient, stabilized carbonates to determine whether elemental clustering is effective in determining original mineralogy.

Mechanistic Approach to Plant Demography
Mike Howe, Gustavus Adolphus College Biology
2:15 NHS 305

Habitat fragmentation is becoming a large problem for many habitats. Tallgrass prairie, which used to cover much of the Midwest, has become fractured and isolated because of agriculture. It is therefore useful to assess the sustainability of a population which can be modeled by establishing a model built from demographic data. We believe that in a fragmented habitat, the population will be affected by pollen limitation. My work this summer provided the groundwork for continued research next summer. I have determined how to best design a practical and effective study as well as established plots to assess demographic transitions.

Synthesis of a Novel Bifacial Ligand: 1,6,7,12-tetraazaperylene
Mike Howe, Gustavus Adolphus College Chemistry
4:45, NHS 201

1,6,7,12-tetraazaperylene (TAP) , a potentially useful molecule for its theoretical conducting properties was attempted to synthesize following a previous procedure. Multiple different conditions were attempted, but none have yet yielded a valid pathway to the synthesis of TAP. Current and ongoing work will be focused on finding a successful pathway to synthesize TAP.

Characterization of Ni(II)-Pyrazole Complexes
Anna Huff, Gustavus Adolphus College Chemistry, HHMI Scholar
4:30 NHS 105

Spectroscopic data were collected for multiple solutions of nickel (II) chloride and pyrazole for absorbance over the 360-800 nm range. Absorbance data were collected for solutions of varying concentrations of Ni^{2+}, pyrazole, and NaCl (used to change the ionic strength) to find the number of metal complexes that existed in equilibrium, as well their molar absorptivity profiles and equilibrium binding constants. There were some obstacles during the data collection process that resulted in a modified method for both collecting and analyzing the absorbance data. Corrected absorbance data for the Ni^{2+} solutions were then statistically analyzed to generate information on metal complexes in solution. The results suggest that three absorbing ligand species, NiL, NiL_2, and NiL_3, exist in equilibrium and their respective free energies of complexation are -45.241 kJ/mol,
-10.491 kJ/mol, and -5.284 kJ/mol.

The Binding of Two Circadian Rhythm Proteins, Cryptochrome and Period
Mariecus Jarvis, Gustavus Adolphus College Biology, HHMI Scholar
3:25 NHS 305

Circadian clocks control many rhythms in organisms, often by telling them to produce different proteins at different times. These biological clocks function through negative feedback loops that are completed every twenty-four hours. Two proteins, Cryptochrome (Cry) and Period (Per), travel from the cytoplasm, where they are made, to the nucleus, where they inhibit their own transcription as part of a feedback loop. In order to further understand the mechanisms that produce circadian rhythms in most organisms, it is necessary to study the binding behavior of Cry and Per. Charged amino acids on the surface of the Cry body were altered in order to see what part of the Cry protein is necessary for it to bind Per. DNA sequences coding for both proteins were placed in mammalian cells, and the resulting proteins were located by fluorescent microscopy. Cry often helps pull Per into the nucleus, so retention of Per in the cytoplasm could be a sign of reduced Cry-Per binding. Several Cry mutations studied appear to subtly disrupt the binding of Cry to Per.

Photodegradation of Imazamethabenz-methyl
Riley Lass, Gustavus Adolphus College Chemistry
3:10 NHS 201

Imazamethabenz-methyl (IMBM) is the active ingredient in several pesticides found commercially around the Midwest. A toxic chemical, IMBM has been shown to photodegrade when exposed to ultraviolet light. With a growing focus on the quality of human drinking water sources and what farmland runoff contributes, IMBM was chosen to learn more about its behavior under ultraviolet conditions. The rate constants for the photodegraation of IMBM were obtained in solutions with different pH values and, using liquid chromatography, irradiated IMBM solutions were analyzed to observe and identify photoproducts.

The Synthesis of Novel Low-Symmetry Phthalocyanines
Anna Looby, Gustavus Adolphus College Chemistry
3:25 NHS 201

The goal of is this research is to search for routes to reduce the symmetry of phthalocyanine molecules from four-fold symmetry to a lower symmetry (i.e. A_2BC symmetry) with the intention of then building structures that have the ability to incorporate phthalocyanines into them. This synthesis is done by building an open-ring substructure that contains three of the four corners while retaining the conjugation of the molecule. From there, various fourth corners will be added to customize the final molecule. This project was started over the summer and has seen a completion of six out of seven of these initial synthetic steps.

Age affects female reproductive behavior and physiology in *Drosophila melanogaster*
Paige Miller, Gustavus Adolphus College Biology, HHMI Scholar
1:30 NHS 105

For many animals, the process of aging, a decline in physiological function over time, begins while they are reproductively active. The model organism *Drosophila melanogaster* is an ideal system for studying aging and previous work found that males mated to old females had lower fertilization success than did males mated with young females. To explore how this age affect occurs, I compared the mating behavior, fecundity and fertility of old females to that of young females. Old females had significantly longer courtship durations, lower fecundity, and lower fertility than young females. Neither latency to courtship nor copulation duration was found to be significantly different in young and old females. Males were observed to continually court females indicating that older females are more reticent to mate than younger females. Thus female age effects on male fertility are likely to be affected by several aspects of female physiology.

Methylmercury in the St Louis River Basin
Nathan Olson, Gustavus Adolphus College Chemistry
3:10 NHS 105

Mercury and Methylmercury were measured in waters containing elevated levels of sulfate as a result of mining in the St. Louis River Basin. Samples were taken from multiples streams and lakes and in three locations along the St. Louis River. Relationships between the mercury present in the water, dissolved organic carbon and rainfall were also investigated.

Ecological Assessment of the Coneflower Prairie
Mary Patterson, Gustavus Adolphus College Biology
2:00 NHS 305

The Coneflower Prairie is a restoration prairie seeded in 2008 located at Gustavus Adolphus College in St. Peter, MN . An ecological assessment of the prairie was performed to compare the current species composition with what was seeded and to locate areas of poor quality. Transect lines were established and sampled for species composition three times throughout the summer. Based on species composition there are three distinct microhabitats: wet, mesic, and dry. Nineteen native grass species and 60 native forb species were identified. The wet microhabitats had the lowest percent of established species; proper management techniques are recommended to control non-native species in the mesic areas. Overall, the quality of the Coneflower Prairie is good for its size and age and with continual management, the quality of the prairie will continue to increase.

Older females decrease oogenesis in *Drosophila melanogaster*
Penny Poeschl, Gustavus Adolphus College Biology, HHMI Scholar
1:45 NHS 105

Among many animals, the aging process begins early in the reproductive period, thus reproductive physiology may be changing throughout the aging process. *Drosophila melanogaster* is an established model system for studying aging and reproduction because of their small size, ease to care for, and short generation time. Preliminary research indicated that older females had lower fecundity than younger females. To identify the cause of this effect, the number of ovarioles and distribution of developmental stages of egg chambers in old and young females who were either virgin or recently mated were compared. Older females maintain fewer active ovarioles and have a lower rate of oogenesis. The effects of suspended oogenesis are compounded among virgins. Therefore, lower fertility in older females is likely due to at least two factors: fewer active ovarioles and a suspension in oogenesis.

Identifying an mRNA Directly Degraded by the Exosome in *Saccharomyces cerevisiae*
Carl Schiltz, Gustavus Adolphus College Biochemistry/Molecular Biology, HHMI Scholar
2:00 NHS 105

Protein levels in organisms are regulated in part by the changes in abundance of mRNAs available for translation. The levels of mRNAs are determined by the opposing forces of mRNA synthesis and mRNA degradation. In the yeast *Saccharomyces cerevisiae* a protein complex called the exosome is partly responsible for mRNA degradation. Most mRNA species targeted by the exosome are “aberrant” or abnormal; however, the exosome has also been reported to act on at least one mRNA. Previous work has identified the *CTF13* gene as indirectly regulated by the exosome. Using this knowledge, we designed a genetic screen to determine the regulators of *CTF13* with the hope of finding the gene encoding the mRNA that is directly degraded by the exosome. We have successfully identified *SOK2* as a candidate. To test if *SOK2* mRNA is regulated by the exosome, we have begun to analyze the total RNA from wild-type yeast and yeast with impaired exosome function. If *SOK2* mRNA is directly degraded by the exosome, we will then isolate the regions of *SOK2* RNA responsible for exosome recognition. Characterizing the recognition region will allow for the identification of more wild-type mRNA species degraded by the exosome and confirm this novel function of the exosome.

Analyzing the Role of Urban and Isolated Wetlands in Maintaining Watershed Water Quality and Ecosystem Integrity

Emily Seelen, EPA Atlantic Ecology Division

2:40 NHS 105

Isolated wetlands have been of interest after federal court cases regarding their protection under the Clean Water Act of 1972 occurred, specifically *Rapanos vs. United States* in 2006. Waters directly protected under the Act are relatively permanent or continuously flowing bodies of water including oceans, lakes, rivers, etc., as well as water bodies with a significant nexus to navigable water. Isolated wetlands do not easily fit into those categories making legislation on their protection difficult. I completed my research at the Atlantic Ecology Division (AED) of the EPA in Narragansett, RI as a pilot project to a larger study aiming to solidify the relationship isolated wetlands have to other water bodies, to increase the knowledge of these systems and their role in the environment, and to help in their future protection if need be. Research included hydrological analysis of three pre-determined isolated wetlands in Cranston, RI, sample collection and analysis, and investigating historical records of the area. The result of the internship was a starting base for future research on isolated wetlands at the AED of the EPA.

Characterization of Column Contribution to Selectivity using the Hydrophobic Subtraction Model

Eric Talus, Gustavus Adolphus College Chemistry

2:40 NHS 305

The Hydrophobic Subtraction Model of selectivity for reversed-phase columns uses five column characteristics, hydrophobicity, steric hindrance, hydrogen-bond acidity, hydrogen-bond basicity, and ion interactions to characterize column's contribution to selectivity. Linear regression of experimental retention data for 16 probe compounds against known selectivity parameters for these compounds yields numerical values for the five column characteristics described above. These characteristics can in turn be used to compare column selectivities, looking for either similarities or differences between columns. A database kept by the United States Pharmocopeial is available to compare columns that have been characterized by the Hydrophobis Subtraction Model. In this presentation we will summarize the findings of our most recent efforts to characterize 40 new columns released on the commercial market with the last year.

Nucleophilic Reactions of Potassium Phthaloylphosphide

Tuan Tran, Gustavus Adolphus College Chemistry

4:45 NHS 105

Solid potassium phthaloylphosphide [*o*-$C_6H_4(C{=}O)_2PK$, abbreviated henceforth as KPhth] was prepared by reaction of diethyl phthalate, phosphine, and potassium *t*-butoxide in a Schlenk vessel designed for gas/liquid reactions. The product was then isolated by Schlenk filtration and stored under nitrogen. The phosphorus atom in KPhth is nucleophilic, and reacts readily in traditional S_N2 reactions. In this study, KPhth was first reacted with various alkylating agents, including one fluorous ponytail iodide, to provide the P-alkylated products. A second study, reactions of KPhth and $KPPh_2$ with thiazyl trifluoride (NSF_3) was also pursued. Expectations were that the phosphide nucleophiles would displace fluoride from NSF_3 to provide P-substituted derivatives such as NSF_2Phth. Preliminary ^{19}F and ^{31}P NMR analysis seems to

indicate, however, that NSF_3 acts as an oxidative fluorinating agent rather than as a simple electrophile. Experimental details and spectroscopic analyses from both studies will be discussed.

Differentiating calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD) stones using quantitative morphological information from clinical CT images
James Trevathan, Mayo Clinic CT Clinical Innovations Center
5:00 NHS 201

To differentiate calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD) kidney stones using clinical CT images. Under an IRB-approved protocol, image data of 19 stones (10 COM and 9 COD) were retrieved from a cohort of 80 patients who underwent clinical CT exams for kidney stone composition analysis. All the selected stones in patient images were larger than about 5 mm. CT images were processed using an in-house software, which quantified stone surface morphology with curvature based calculations. A shape index was generated as a quantitative metric to differentiate COM vs. COD stones. The morphological difference between COM and COD stones was detectable in clinical images for stones larger than 5 mm and in micro-CT images. The shape index is a highly promising method, which can separate COM and COD stones with reasonable accuracy.

The Reduction of Riverine Silica Transport due to Invasive Riparian Vegetation
Zach Wagner, Gustavus Adolphus College Geology
2:55 NHS 105

Although silica is a very common element, it is a limiting nutrient for some microorganisms due to only small amounts of it being dissolved in aquatic systems. Rivers are important in the transport of silica from weathered rocks on continents to the ocean. This study focuses on the invasive grass *Phragmites australis,* a riparian plant that sequesters dissolved silica. Using sediment cores, river surveys, and plant surveys, we are working on quantifying the amount of silica that *Phragmites australis* sequesters due to biogenic silica burial and changes in channel morphology. This study has important implications for aquatic and marine ecosystems as well as the carbon cycle.

Determination of Methylmercury-Dissolved Organic Matter Binding Constants by Competitive Ligand Exchange-Solid Phase Extraction
Michael Walker, Gustavus Adolphus College Chemistry
3:25 NHS 105

A competitive ligand exchange-solid phase extraction (CLE-SPE) method has been employed to measure binding 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, thiolactic acid was utilized as the competing ligand. Similarly, 1-dodecanethiol was used to measure the binding constant to the hydrophilic portion. Preliminary results suggest binding constants on the order of log $K_{MeHgDOM}$ = 14-18.

Separation and Characterization of γ-Glutamylcysteine Ligase
Beth Wiese, Gustavus Adolphus College Biochemistry/Molecular Biology
3:10 NHS 305

γ-Glutamylcysteine ligase (γ-GCL) is the enzyme which 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. Previous work in the Kelly lab suggests that *E. coli* γ-GCL transitions from a monomeric to a dimeric form over time. My summer research objective was to separate and characterize the monomeric and dimeric forms of *E. coli* γ-GCL. Purified protein was separated using size exclusion chromatography, and then separated samples were analyzed using kinetics, fluorescence, and gel electrophoresis experiments to determine kinetic efficiency, stability, and molecular weight. Protein separation resulted in three distinct forms of γ-GCL, two distinct monomers and one dimer form indicated by analysis of the native protein gels. The dimeric form was less kinetically efficient than at least one monomer. A difference in protein stability and migration on native gels suggests that the monomers are structurally distinct. Future work will focus upon the transition between the monomeric and dimeric forms and include further data collection and characterization of each distinct form.

Characterization of Carbon-Modified Silicas for Analytical Liquid Chromatography
Paul Young, Gustavus Adolphus College Chemistry
2:55 NHS 305

A carbon-modified porous silica material has been developed for use in analytical separations regarding High Performance Liquid Chromatography as well as for a solid-phase extraction media. The carbon-silica material is unique in comparison to current commercially available carbon-based stationary phases in the sense that it exhibits appreciable mass transfer characteristics as well as stability at higher pressures. In contrast to commercially available carbon-based stationary phases, carbon on silica provides more reasonable retention for normally highly retained compounds, provides greater selectivity for various classes of stereoisomers, and is much more thermodynamically and chemically stable. The carbon on silica provides ?tunable? retention by varying the carbon load of the underlying, inert Type B porous silica substrate. This project focuses on the characterization of a series of materials that cover a wide range of carbon loading, including: surface area and pore volume measurements, retention of non-polar and polar compounds, as well as selectivity.

Poster Abstracts (Poster session from 3:40-4:25 in the NHS Atrium)

Methylmercury Concentrations and Dissolved Organic Carbon/Methylmercury Relationships in Waters Receiving Excess Sulfate

Amy Christiansen, Gustavus Adolphus College Chemistry

Mercury is an element that is found naturally in the environment, but humans have increased its deposition and chemical appearance through intentional use in products and burning of coal. Mercury is a neurotoxin, and exposure to it can cause health and developmental problems in both humans and other wildlife. Methylmercury, an organic form of mercury, is of the most concern to humans, as it accumulates in biota and eventually makes its way up the food chain in greater and greater concentrations. The purpose of this study was to evaluate concentrations of MeHg in waters receiving excess sulfate from mining operations and to analyze dissolved organic carbon (DOC)/MeHg relationships. Samples were taken from the surface and the bottom waters of lakes throughout the mining-affected St. Louis River Watershed in northern MN. These samples were then tested for methylmercury (MeHg) and total mercury (THg) in the lab at Gustavus using an ICP-MS and a Merx Hg analyzer. Other labs tested for anions, cations, DOC, and sulfur isotopes. Biota samples were also taken from the St. Louis River Watershed to be tested for MeHg content.

Identifying Rare Genetic Variants in Familial Waldenström Macroglobulinemia

Dawn Comstock, Gustavus Adolphus College Biology

Waldenström Macroglobulinemia (WM) is a rare form of non-Hodgkin lymphoma that shows familial aggregation. The Genetic Epidemiology Branch of the Division of Cancer Epidemiology and Genetics has accrued pedigrees from families with multiple cases of WM. This study focuses on three such families of WM, with 3-5 cases of WM per family and several other members also diagnosed with monoclonal gammopathy of undetermined significance, non-Hodgkin lymphoma, and diffuse large B-cell lymphoma. From these pedigree, our goal was to identify germline mutations in genes causing susceptibility to WM and related conditions using Next-Generation Sequencing and Copy Number Analysis. By identifying mutations shared by patients, we then prioritized them for follow-up based on rarity in the general population, possible effect of substitution, conservation and chromosomal location. Several interesting variants were identified and heterogeneity was shown between families, further analyses and studies are needed to better understand the effect of mutations, as well as technical validation and functional analysis of high priority variants.

Lexical Development in Toddlers

Madison Heckel, Gustavus Adolphus College Psychology/Center for Developmental Science

Words in children's vocabularies are all intertwined and connected, such that hearing a word will activate words similar both in sound and in meaning. For example, hearing the word "dog" activates other 'd' words such as "doll," "door" and "duck," as well as words related to dog, such as "cat" and "woof". However, since children have a small vocabulary, they frequently hear words they don't know. How do these words that don't have meaning yet affect, if at all, the activation of words in a child's vocabulary? In order to study this question, 3-5 year old children of the St. Peter, MN area were asked to listen to a set of nonsense words that followed specific sound patterns (e.g., a lot of the words began with the letter "b"),

and were then asked to help a puppet choose which common objects to share with friends. Some of these objects began with the same letters that occurred frequently in the nonsense words (e.g., ball). It was hypothesized that if children's vocabularies were influenced by the sound patterns of the nonsense words, then their object choices would systematically vary based on the nonwords that they heard.

Bellowing of American Bison and Variance in Tongue Position
Michelle Hulke, Gustavus Adolphus College Biology, HHMI Scholar

Over the course of six weeks, mature bulls from a herd of American bison (*Bison bison)* were observed, recording their bellowing patterns as they correlated to tongue positions. Six alternate hypotheses were tested, with two of these matching significant data. ANOVA tests showed that the temperature during bellowing events with the tongue fully extended were significantly hotter compared to other tongue positions, suggesting that bulls might use their tongue to increase evaporation and cool themselves off. Alternately, the number of bellowing events, length of bellowing events, and percentage of bellowing events utilizing a fully-extended tongue were all found to have a direct correlation to bull rank, supporting the hypothesis that bulls of higher rank will bellow with an extended tongue more frequently. Bulls were also observed to bellow with their tongue fully or mostly extended when facing a bull of lower rank, while keeping their tongue mostly retracted when facing a bull of higher rank. Both findings are valuable to understanding how bison and other ungulates will respond to changes within the environment and how we should guide our conservation efforts.

Understanding the Kinetochore Complex in Saccharomyces Cerevisiae
Kory Kolis, Gustavus Adolphus College Biochemistry/Molecular Biology, HHMI Scholar

We would like to gain a better understanding of the function of the four essential yeast kinetochore proteins (Cbf2, Cep3, Skp1, and Ctf13) specifically relating to maintaining high fidelity of chromosome transmission during cell division. The centromere is the region of DNA where these proteins bind to form a kinetochore complex, a complex which is essential in chromosome transmission. From earlier studies we know that a temperature sensitive mutation causing a deficiency in Ctf13p protein function causes a drop in chromosome transmission fidelity. We have previously shown that CBF2, CEP3, or SKP1 in high dosage will suppress the temperature-sensitivity caused by the loss of Ctf13p function. We have three specific aims: 1) to test the effectiveness of the dosage suppressors at covering the chromosome transmission defect of the ctf13 gene, 2) to test for a genetic interaction of ctf13 and skp1, and 3) to measure the levels of kinetochore assembly supported by dosage suppressors.

Correlation Between iBALT formation and the Expression Levels of IL-17A, IL-23, and CXCL13 During Influenza A Virus (IAV), Group A Streptococcal (GAS), and IAV+GAS Infections
Laura Leland, University of Iowa Interdisciplinary SURP

Co-infection with bacteria, including group A *Streptococcus* (GAS), is known to be a significant burden on human health during pandemic influenza A virus (IAV) outbreaks. However, how co-infection alters immunity remains understudied. The inducible bronchus-associated lymphoid tissue (iBALT) is thought to be important in local immune responses to virus infections of the lung as well as autoimmune diseases, yet the complete mechanism of iBALT induction remains unclear. While infection with IAV alone is sufficient to induce BALT formation, our work has shown iBALT formation to be inhibited by GAS during

GAS+IAV co-infections. Importantly, studies focused on understanding the immune system mechanisms during streptococcal infections, co-infection, and iBALT formation and maintenance hold the potential to allow focused alteration of immunity during pandemic IAV infections as well as during seasonal respiratory infections. Here we have utilized these infection models to attempt to identify cytokines and chemokines that are important to iBALT formation. Specifically, we have focused upon CXCL13, a known inducer of B cell follicle organization, and IL-17A and IL-23, which are both important in inflammatory pathways that can lead to iBALT formation. Our results suggest that expression of CXCL13, IL-17A, and IL-23 is not altered by GAS+IAV co-infection compared to IAV infection alone, and indicate that alterations in other factors such as CCL19, CCL21, or dendritic cell recruitment may be responsible for the lesion in iBALT formation during co-infection.

Discovery of Possible RNA Biomarkers in Ovarian Cancer
Evan Odean, University of Minnesota Duluth Medical School

Detection of ovarian cancer is difficult and current biomarkers are unreliable. Micro RNAs (miRNAs) are a promising type of RNAs whose abundance may be helpful in detecting cancer. In this study we used deep-sequencing data to identify short RNA molecules in ovarian cancer and qRT-PCR to confirm their presence in numerous ovarian samples. Through these means we identified a previously undiscovered human miRNA, miR-2476, that may interfere with translation of the PCGF2 gene, a known tumor suppressor.

Qualitative and quantitative assessment of taphonomic patterns in modern algae and cyanobacteria: implications for identifying Precambrian microfossils
Tara Selly, Gustavus Adolphus College Geology

Precambrian microfossils are notoriously difficult to assign to major taxonomic groups. At present, no single set of characters can be used to identify the earliest eukaryotes or to securely place silicified microfossils or compressed acritarchs into domain-level clades. Cell size, cell wall ultrastructure, ornamentation, and biogeochemical characteristics are used separately or in combination to evaluate the systematics of these microfossils. In addition to morphological characteristics, it is plausible that taphonomic characters might also lend insight into the nature of these fossils. In particular, rate and mode of early post-mortem decomposition might be expected to have a taxonomic as well as environmental component, thereby influencing how organisms are represented in the fossil record.

Understanding characteristic taphonomic pattern in diverse groups can aid in recognizing eukaryotes in the Precambrian fossil record. Previous work has evaluated decomposition of algae and cyanobacteria separately; this project aims to make a direct comparison between photosynthetic prokaryotes and eukaryotes and to establish a framework by which other groups (e.g., fungi, animals) can be evaluated. In this research, we report decomposition patterns through qualitative description of trends (e.g., differential decomposition) and through quantitative analysis of decomposition. We describe observed taphonomic trajectories and compare cyanobacterial and algal patterns. Preliminary results indicated that there are characteristic differences between major groups. Based on these initial findings, taphonomic characters may be useful, when combined with traditional taxonomic characters, in inferring phylogenetic placement of Precambrian microfossils.

Differential Life History Investment in American Bison -- Within season changes in offspring sex ratio
Mary Joy Sun, Gustavus Adolphus College Biology, HHMI Scholar

My hypothesis is that one of the ways bison cows maximize their reproductive fitness is by biasing births towards male offspring early in the season and female offspring later in the season. This would give the sex that benefits more from large body size (the males) longer time to develop before the onset of winter and food scarcity. To test this idea, a population of around 300 bison on Samuel H. Ordway, Jr. Memorial Preserve in Leola, South Dakota is studied during summer of 2012. Five other field researches and I gathered daily observation data from a truck. Every cow is identified either by tags or natural markings and her calf's size and sex is clearly recorded. Cow and calf pairing is mostly done during nursing to reduce error. The result shows large old male calf percentage is higher than large old female calf percentage, whereas tiny newborn male calf percentage is less than female. Statistically, the difference is not significant, there are no within season changes in offspring sex ration in American bison. The hypothesis is not supported possibly due to limited collection of data. Future studies are encouraged.

Differentiating calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD) stones using quantitative morphological information from clinical CT images
James Trevathan, Mayo Clinic CT Clinical Innovations Center

To differentiate calcium oxalate monohydrate (COM) and calcium oxalate dihydrate (COD) kidney stones using clinical CT images. Under an IRB-approved protocol, image data of 19 stones (10 COM and 9 COD) were retrieved from a cohort of 80 patients who underwent clinical CT exams for kidney stone composition analysis. All the selected stones in patient images were larger than about 5 mm. CT images were processed using an in-house software, which quantified stone surface morphology with curvature based calculations. A shape index was generated as a quantitative metric to differentiate COM vs. COD stones. The morphological difference between COM and COD stones was detectable in clinical images for stones larger than 5 mm and in micro-CT images. The shape index is a highly promising method, which can separate COM and COD stones with reasonable accuracy.

Spectroscopic Characterization of Cr^{3+}-Pyrazole Coordination Complexes
Guillermo Turcios, Gustavus Adolphus College Chemistry

The goal of the experiment was to characterize aqueous chromium(III)-pyrazole complexes. This was accomplished by collecting UV-visible spectra (375 nm -800 nm) of solutions with varying concentrations of $CrCl_3$, pyrazole ($C_3H_4N_2$), and NaCl (added to vary the ionic strength). The data were then statistically treated to determine the number of observed complexes and their respective molar absorptivity profiles over the scanned range. Preliminary results indicate that the Cr(pyr), $Cr(pyr)_2$, and $Cr(pyr)_3$ complexes are observed, and that their free energies of formation are -189 kJ/mol, -120 kJ/mol, and -8.9 kJ/mol, respectively.