Student Titles And Abstracts Based On Summer Research 2006

Bilal Alkatout and Nicole Marvin and Kevin Crisp (Advisor). INTERSEGMENTAL INTERNEURONS AND SEROTONIN-FACILITATED SWIMMING IN THE LEECH.

Serotonin (5-HT), released in the leech central nervous system (CNS) when the animal becomes hungry, causes the animal to become more likely to swim. To study 5-HT's effects on swimming, the leech CNS was removed with a segment of skin still attached used to stimulate the animal by touch. The neural correlate of the swimming motion was recorded from the motor neurons that innervate the muscles when the animal is intact. 5-HT was only applied to a small, isolated area of the CNS. This local application had a global effect on the CNS sensitivity to sensory stimulation. This sensitivity is measured by observing the number of stimulus necessary to achieve habituation (2 stimuli without a swim response). 5-HT increased swim responsiveness (number of trials before habituation), but inhibitors of adenylyl cyclase (MDL 12,330A) and protein kinase A (Rp-cAMP) blocked this effect.

Once 5-HT was applied it caused an increase in the connective activity that was traveling from the small 5-HT exposed throughout the CNS. In order to examine this increase in greater detail, we developed a stereotrode recording technique that utilized two extracellular recording sites and a spike sorting program. This technique allowed us to pull out and identify unique units (cells) that could be classified into categories based on characteristics that coincided with the swimming rhythm (swim/swim episodes). Further studies will be able to use this technique to identify units that are activated by 5-HT causing their activity to increase in the leech CNS.

Paul Anderson, Liz Welch and Doug Beussman (Advisor) and Eric Cole (Advisor). IDENTIFICATION OF TETRAHYMENA THERMOPHILA PROTEINS VIA LC-MS AND LC-MS/MS.

Tetrahymena thermophila is a ciliated, unicellular protist that is often used as a model organism in biology labs. Interestingly, it has the ability to undergo asexual and sexual reproduction via a conjugation junction. The goal of this project was to identify as many proteins within the conjugation junction as possible. Using various isolation techniques, proteins were extracted from the conjugation junction of *T. thermophila* and then underwent SDS-PAGE followed by a trypsin digestion. The resulting peptides were injected into an HPLC equipped with a micro-bore C_{18} column, and then analyzed using an electrospray ionization (ESI) ion-trap mass spectrometer. ESI generated an assortment of multiply charged ions. The results from the LC-MS analysis allowed for the identification of potential peptide ions, which were isolated and fragmented via tandem mass spectrometry. The resulting fragment ions were then screened against a *T. thermophila* database containing theoretical proteins based on its genome. So far, this project has resulted in the identification of 25 distinct proteins isolated from the *T. thermophila* conjugation junction. This work has been generously funded by grants from the National Science Foundation (NSF) and Merck AAAS, and is suitable for an undergraduate poster session if available.

Matt Baudino, Dan Edwins, Todd Frederick, Elizabeth Jensen and Olaf Hall-Holt (Advisor). AUTOMATING CORRESPONDENCE AND DISPARITY CALCULATION FOR SEGMENTED STEREO IMAGE PAIRS

An accurate segmentation of a stereo image pair leads to an excellent disparity map of that image. Our partially-automated algorithm has three steps. First, we manually divide the pixel data of each image into geometric regions based on color boundaries. Our user interface for segmentation saves geometric data in a cross-referenced structure (a doubly-connected edge list) that links neighboring shapes. Complex shapes are triangulated into simple polygons for display purposes. Next, a cost function of color and overlap data matches regions between the pair's images. A comparison between the color data of matched regions leads to their horizontal

disparity in pixels. Finally, the disparity for each pixel combine to form a disparity map. The pixel-by-pixel difference between our disparity map and the ground truth map, provided with the image data, is an objective measurement of our claim's accuracy.

Julia Brown and Paul Jackson (Advisor). BRINGING GREEN CHEMISTRY INTO ADVANCED CHEMISTRY LABS.

Ian Campbell, Bob Jacobel (Advisor), Rickard Pettersen (Advisor), and Brian Welch (Advisor). WHY DON'T THEY MATCH? THE EVOLUTION OF FLOW STRIPES AND INTERNAL LAYERS ON KAMB ICE STREAM.

Flowstripes are ubiquitous features indicating fast ice flow on glaciers, ice streams and floating ice shelves. According to model studies by Gudmundsson, Raymond, and Bindschadler (1998) they are an expected consequence whenever velocity at the bed is large compared to shearing

through the ice thickness. Under these conditions, basal undulations are effectively transmitted to the surface where they are advected for long distances downstream. Folding of internal layers depicted in radar profiles is also a common occurrence in ice streams. In the case of Kamb Ice Stream (KIS), "stacks" of internal layers folds on the scale of 1-3 kilometers in wavelength in the cross-flow direction have been traced for over 100 kilometers (Ng and Conway, 2004). The question is what relationship, if any, do these folds have with respect to surface flowstripes?

We have traced surface flowstripes in Radarsat and MODIS imagery for several hundred kilometers on KIS from the onset of streaming flow into the stagnant trunk. We compare the morphology and evolution of these features at the surface to the internal layer folds in cross-ice stream profiles at five transects along the length of KIS, including those analyzed by Ng and Conway (2004). We find little correspondence between the radar internal layer folds in the cross-flow direction and the flowstripes on the surface directly above. The wavelengths of internal layer folds generally begin with a range of 1-3 km and tend to converge downstream, ending with wavelengths typically less than a kilometer. Flowstripes, though having similar wavelengths (on the order of 1.5 to 3 km at onset), remain roughly subparallel for many kilometers, eventually becoming less distinct as the ice stagnates but retaining their separation. We are thus able to identify examples where flowstripes cross above internal layers.

The amplitude of internal layer folds we have measured decreases towards the surface in a way that suggests they are formed by stresses at the bed in the same way as flowstripes analyzed by Gudmundsson, Raymond, and Bindschadler (1998). This decay in amplitude is consistent with the scale of topography of the folds at the surface, so the issue is, if the flowstripes are the surface expression of the internal folds, why don't they match? We suggest that topographic features on the ice surface are subject to processes that can modify their morphology leading to changes in the pattern of folds relative to the internal layers below. We explore hypotheses about how flowstripes can evolve differently from the folds in internal layers.

Amber Collett, Meg Jensen, Karen Saul, Nick Spanel and Gene Bakko (Advisor). GROWTH AND SURVIVAL RATES IN REFORESTATION USING DIRECT SEEDING METHODS.

St. Olaf College recognizes the importance of native forest restoration and continues to monitor the restored areas to ensure their success. The purpose of this study was to measure the growth and survival rates in reforestation using direct seeding methods in a reforestation plot seeded in 2002. Three sections of this study plot were controlled for unwanted plant species and a fourth was left uncontrolled. Success of each species was determined by measuring growth and survival rates. The growth rates and survival rates were lowest in the most heavily controlled areas.

Tyler Drake and Gary Spessard (Advisor). GREEN CHEMISTRY AND THE SONOGASHIRA COUPLING REACTION.

We present here an environmentally friendly methodology for the Sonogashira coupling reaction with *p*-iodoanisole as the aryl halide and phenylacetylene, 1-hexyne, 2-methyl-3-butyn-2-ol, 1-phenyl-2-propyn-1-ol, 4-ethynyltoluene, or trimethylsilylacetylene as the terminal alkyne. Polyethylene glycol (PEG) is used as the solvent, and the reaction is run in a microwave allowing us to increase the reaction temperature and pressure while decreasing the reaction time greatly.

Rachel Dyer and Anne Walter (Advisor). IDENTIFYING LIPIDS OF THE RED BEET TONOPLAST MEMBRANE.

The tonoplast membrane of the red beet regulates the passage of molecules and ions between the cytosol and the vacuole, which involves regulation of pH and potential energy gradients. Phytoalexins are secondary compounds produced by plants in response to infection by foreign agents. Dihydrowyrone (DHW) is a phytoalexin that causes the collapse of the H^+ gradient across the tonoplast membrane. The vacuolar H^+-ATPase embedded in the tonoplast membrane is not responsible for this gradient collapse. The goal of this research was to identify chemical components of the tonoplast that might with DHW, be responsible for the collapse of the H^+ gradient. I adapted an isolation protocol based on keeping the vacuole intact in hypertonic sorbitol and differential centrifugation. I identified the membrane by its signature enzyme ATPase using a 12% acrylamide gel for SDS-PAGE and determined a preliminary molecular weight profile of 110, 52, 19 and 9 kDa for the tonoplast (52-55 kDa γ-subunit, 16-19 kDa δ-subunit). A vacuolar-specific ATPase assay revealed that the new isolation protocol obtained tonoplast samples free of non-specific phosphatase and mitochondrial ATPase. I extracted the tonoplast lipids by the Bligh-Dyer method and determined a lipid:protein ratio of 20:1. Using two-dimensional thin layer chromatography and electrospray ionization-mass spectrometry, I identified DMPC as a significant component of the tonoplast lipids. Mass spectrometry also revealed that other lipids might be present in lower concentrations. Therefore, further optimization of protocols to identify lipids by ESI-MS is needed, as well as improved protection of lipids during the isolation procedure. Future research also allows for further proof of tonoplast membrane purity and characterization of tonoplast proteins by SDS-PAGE and ESI-MS.

Sonja Ellingson and Jean Porterfield (Advisor). MEGAFUN WITH LEPOMIS MEGALOTIS: INVESTIGATING DISTRIBUTION AND POPULATION GENETICS OF THE LONGEAR SUNFISH.

Lake surveys, mitochondrial sequencing and microsatellite analysis were used to assess the population characteristics and spotty distribution of Minnesota's longear sunfish, *Lepomis megalotis. L. megalotis* is currently considered a species of special concern in Minnesota, and understanding population dynamics are important for management. Sequences from 530 base pairs of the mitochondrial cytochrome *b* gene were obtained from different Minnesota sites and compared with each other and with *L. megalotis* sequences from five other states. Little variation was found between Minnesota populations, suggesting that the cytochrome *b* gene has not had sufficient time to evolve localized genetic differences. Preliminary microsatellite data shows possible unique banding patterns, and further investigation of microsatellite loci will hopefully lend information critical for management of the species in Minnesota waters.

Dan Endean and Jason Engbrecht (Advisor). TRAPPING POSITRONS.

Positrons placed in a standard penning trap can survive for very long times due to coupling of energy from axial motion to cyclotron motion. Contours in the electric field cause this coupling effect to appear in a periodic way based both on the voltages applied along the trap

and the strength of the magnetic field in the trap. By combining these results with other known trapping methods we work to design a trap that is both simplistic and efficient.

David Green and Jason Engbrecht (Advisor). MICELLE RESEARCH USING POSITRONS

Our research explored the characteristics of micelles by using positronium lifetime techniques. Lifetimes of positronium inside and outside the micelles give us information on micellar structure. We have been able to determine aggregation numbers for various micelle concentrations. Future work will involve further analysis of micelle aggregation numbers for additional micelle systems.

Allison Hagen, Bob Jacobel (Advisor), Rickard Pettersen (Advisor), and Brian Welch (Advisor). COMPARISON OF HOLOCENE ICE ACCUMULATION RATES BETWEEN GREENLAND AND WEST ANTARCTICA.

Dated ice stratigraphy provides a basis to model ice accumulation rates in Greenland and Antarctica. Previous research used a one-dimensional flow model to calculate accumulation rates across the interior of Greenland. We present results of similar modeling efforts to calculate accumulation rates for a portion of West Antarctica. Unlike results from Greenland, portions of West Antarctica violate the steady-state assumptions of the model, showing that West Antarctica has a different Holocene climate history than Greenland. This has implications for numerical modeling reconstructions of recent ice flow and for the sensitivity of West Antarctica to future climate change.

David Harris and Gary Spessard (Advisor). OXIDATIONS IN GREEN CHEMISTRY.

Using the principles of green chemistry as guidance, we refined a previously-reported procedure for oxidizing alcohols to carbonyls using hydrogen peroxide (H_2O_2) with Na_2WO_4 catalysis. Secondary alcohols, including those with high melting points, were completely oxidized in 1.5 hours, allowing the entire experiment to be easily completed in a 3-hour laboratory period. This was achieved using only 1 mol % catalyst and 3% H_2O_2. Under the same conditions, most primary alcohols were shown to over-oxidize to their carboxylic acids.

We also refined a previously-reported procedure for the hydroboration of alkenes. We substituted α-pinene for 1-octene as the starting material to enhance the green aspects of the experiment. Not only is α-pinene a natural product, the product of the hydroboration can also be re-used. Students will use the secondary alcohol product in place of (–)-menthol as the starting material for the oxidation experiment during the second semester. Additionally, α-pinene shows optical activity, increasing the teaching opportunities for the experiment.

Anna Johnson and Jumi Hayaki (Advisor). EXPERIENTIAL AVOIDANCE, ALEXITHYMIA, AND ANXIETY SENSITIVITY: CONTRIBUTIONS TO BINGE EATING MOTIVES (A RESEARCH PROPOSAL).

The purpose of this study is to examine the contribution of emotion dysregulation, or difficulties in the modulation of emotional experience, to binge eating motives. Preliminary evidence indicates that certain aspects of emotion dysregulation serve as risk factors for the development of eating disorders; however, the specific mechanisms are not well defined. According to the affect regulation model of binge eating, many bulimic individuals binge eat in order to manage negative affect. This tendency to binge eat in response to unpleasant emotional states may reflect experiential avoidance, or avoidance of unwanted internal experiences. Research also indicates that individuals with eating disorders exhibit high levels of alexithymia, defined as difficulty identifying and describing emotions. Alexithymic individuals may be less capable of regulating their emotions; indeed, alexithymia has been found to predict maladaptive emotional coping. Preliminary research has also demonstrated a positive association between

poor emotion regulation behaviors, such as drinking to manage negative affect, and anxiety sensitivity (AS), the fear of arousal-related sensations. However, the associations among these facets of emotion dysregulation and their unique contribution to binge eating motives are not clear.

This study will examine the contribution of these three facets of emotion dysregulation (namely, experiential avoidance, alexithymia, and AS) to affect regulation binge eating motives. The study hypothesizes that each of these emotional constructs will be positively correlated with each other as well as uniquely predictive of negative reinforcement binge eating motives. The relationships between emotional factors and binge eating motives will be examined in a sample of undergraduate women. Examining this connection will help identify emotional risk factors for the development of eating disorders, as well as targets for clinical intervention.

Kathleen Kephart, Anne Malaktaris, Paul Roback (Advisor), and Dan Hofrenning (Advisor). RELIGION, POLITICS, AND STATISTICS: THREE COCKTAIL PARTY KILLERS A QUANTITATIVE ANALYSIS OF CLERGY MEMBERS' POLITICAL BEHAVIOR

Protestant clergy have been involved with politics throughout our country's history. Our study examines clergy members' political behavior in depth in hopes of ascertaining profiles of politically active clergy. A survey, completed by Protestant clergy in 2000, asks questions about political behavior and attitudes as well as congregational, demographic, theological, and other political information. Our study found the presence of five distinct modes of political behavior among Protestant clergy: campaign action, pulpit political speech, organization, prayer, and non-pulpit political speech. Regression analysis was used to determine significant predictors of political behavior, especially theological and political influences.

John Lamppa, Mike Kuprian, Wolf Merker, Gregory W. Muth (Advisor), and Jeff Schwinefus (Advisor). LOOSENING THE HTR RNA PSEUDOKNOT: THE INFLUENCE OF UREA AND GLYCINE BETAINE ON SECONDARY AND TERTIARY RNA FOLDING.

Human telomerase RNA (hTR) aids in the production and maintenance of telomers by telomerase reverse transcriptase (hTERT). The highly conserved sequence of hTR RNA folds into a compact pseudoknot structure consisting of a G-C rich helix (stem 1), a longer A-U rich helix (stem 2) and two single stranded loops that appear to fold into the minor and major grooves of the respective helices. hTERT requires a stable stem 1 in the pseudoknot for function. Understanding the structure and function of the pseudoknot has an enormous impact on both cancer and AIDS research as both diseases requires a functioning reverse transcriptase. The unfolding of the pseudoknot structure was investigated by thermal denaturation UV absorbance spectroscopy at 40m*m* and 135m*m* NaCl concentrations in the presence and absence of urea and betaine. Addition of urea universally destabilized the pseudoknot structure while betaine, which has been previously reported to stabilize the tertiary structure of proteins, destabilized the helices, but stabilized the tertiary structure. The stoichiometric coefficients for cosolute uptake or exclusion and water release were quantified by analyzing the dependence of the melting temperature of a particular structural unit with water concentration. The addition of NaCl attenuates the interactions of urea and glycine betaine with the newly exposed RNA surface after unfolding.

John Lamppa, Mike Kuprian, Wolf Merker, Gregory W. Muth (Advisor), and Jeff Schwinefus (Advisor). LOOSENING THE HTR RNA PSEUDOKNOT: THE ROLE OF UREA AND GLYCINE BETAINE.

To better understand the structure of the human telomerase RNA (hTR) pseudoknot we isolated various sections, including a hairpin structure that was composed of one stem and one

loop from the overall structure. The hairpin separated from the pseudoknot was exposed to thermal denaturation UV absorbance spectroscopy in 40m*m* and 135m*m* NaCl concentrations both in the presence and absence of urea and glycine betaine. Urea universally destabilized the hairpin structure, whereas glycine betaine appeared to stabilize the tertiary unfolding of the hairpin while destabilizing the helical unfolding. These results confirm the results found in the melting of the overall pseudoknot structure. The studying of the hairpin from the hTR pseudoknot structure is important, because hTR aids in the production and maintenance of telomers by telomerase reverse transcriptase (hTERT). Understanding the structure and function of the pseudoknot has an enormous impact on both cancer and AIDS research as both diseases requires a functioning reverse transcriptase.

Benjamin Landsteiner, William Voorhees, and Dick Brown (Advisor). SLAYING GRENDEL: USING BEOWULF TO SOLVE BIG PROBLEMS.

Landsteiner worked to extend an existing prototype Beowulf computing cluster and to acquire and construct a new high-performance Beowulf cluster; the high-performance cluster was funded by HHMI. The purpose of both clusters is to serve as a resource for scientific computing; the system has been used for a project in Physics, and other projects are currently in progress or anticipated in Biology, Medicine, Statistics, Physics, and Mathematics. The original cluster provides a platform for developing new applications and new cluster configurations, and the high-performance cluster is for production runs of the results from the development cluster.

Voorhees task was to explore options for the cluster system software through background research and prototype implementation, in order to determine a system software configuration that best suits the needs of the St. Olaf clusters, which are managed and programmed by students and serve high-performance computing needs of scientific research projects on campus and beyond. He identified several candidate software strategies, and created small dedicated clusters employing them to test them in our environment. He identified several package distributions of cluster system software, but determined that these either did not fit our circumstances or would lock our clusters to aging software components. Instead, he showed that a locally maintained strategy involving multiple implementations of the key MPI networking software will be feasible, and will provide us with the flexibility our clusters require.

Anna Legard and Jason Engbrecht (Advisor). CALCULATING THE MOMENTUM CROSS-SECTION OF POSITRON VIA GAS SCATTERING ANALYSIS.

Previous summer research has successfully lead us to a better understanding of the rate of thermalization of Positronium in a Helium gas. With our computer analysis fully operational, we sought to calculate the value of the momentum transfer cross-section of Positronium as well as the associated error bar. Our preliminary results indicate a cross-section of 2.3 Å2, while we continue to calculate the error.

Erin Manlove and Brian Borovsky (Advisor). POKING AROUND: A STUDY OF NANOINDENTATION.

Erin Manlove worked to investigate the relationship between molecular structure and friction for ultrathin lubricant films. She performed measurements on high-speed microscopic systems composed of a hexanethiol monolayer adsorbed onto a gold substrate and pressed into contact with a sapphire sphere. Acoustic vibrations provided a reciprocating shear motion at the interface, and frictional forces were monitored during the loading and unloading of the sapphire probe. At lower friction levels, she found that while the friction at a given site is consistent between tests, sequential sites show lower and lower friction. These results suggest the presence of a tribological film (rubbing-induced film) at the interface which controls friction levels. This film may adhere to the tip and be carried to subsequent locations. The components of this film

presumably change as each new site is visited, accounting for the trend towards lower friction. Tribological films at small scale interfaces are a topic of increasing interest among friction researchers, as they may be the most critical element in determining friction and wear. Erin's results therefore contribute to this discussion and are closely tied to emerging applications involving microscopic devices with moving and contacting parts, including high-resolution micromirror displays.

James McKone and Gary Miessler (Advisor). NEW PURSUITS IN GROUP 6 DITHIOLENE CHEMISTRY.

Ligands containing two sulfur atoms, known as dithiolenes, react with group 6 metal complexes of the general formula $[CpM(CO)_3]_2$ (Cp = cyclopentadienyl C_5H_5; M=Mo, W). The resulting structures are useful in simulating the chemical environment at the active sites of some biological enzymes that catalyze oxygen transfer reactions.

In accordance with previous research, the dithiolene ligand *tfd* $[S_2C_2(CF_3)_2]$ was reacted with $[CpW(CO)_3]_2$ under thermal conditions. Several products resulted, which were separated via flash chromatography and analyzed using ^{1}H-NMR and IR spectroscopy, APCI mass spectrometry, and X-ray crystallography.

The tungsten dimer $[CpW(CO)_3]_2$ was also reacted with a new ligand source, *tpd* ($OCS_2C_2S_2CO$) under photochemical conditions in chloroform. The initial product of this reaction was a monomer in which chlorine had replaced the metal-metal bond. The monomer continued to react to form several as yet uncharacterized products. Initial analysis of the products using ^{1}H-NMR and IR spectroscopy and APCI mass spectrometry was promising, with evidence of replacement of CO by the dithiolene ligand.

Charles McEachern, Ben McDonald, and Jim Cederberg (Advisor). THE HYPERFINE SPECTRUM OF KI.

Using St. Olaf's molecular beam electric resonance spectrometer we have done significant work towards mapping the hyperfine spectrum of KI. Sufficient progress has been made that we should be able to improve preexisting measurements by four to five significant figures. Additionally, we have begun to improve upon software written by previous students.

James Morrison and Jean Porterfield (Advisor). TREASURES OF THE DEEP: A STUDY OF THE SCALY PEARL OYSTER PINCTADA LONGISQUAMOSA ON SAN SALVADOR ISLAND.

Tissue samples of *Pinctada longisquamosa*, the Scaly Pearl Oyster, were collected from San Salvador Island to determine whether a history of hurricane-mediated population bottlenecks and substantially differing environmental conditions have resulted in differing levels of genetic variation within and among populations. Sequences for a partial mitochondrial cytochrome *c* oxidase subunit I (COI) were obtained from several individuals from each pond and tested for unique polymorphisms. Only a 0-.32% nucleotide variation recorded between populations was observed compared to a 20-21% difference between related species. Preliminary microsatellite data indicate the possibility of more variation in non-coding sequences (as expected) but given the lack of variation in the mitochondrial sequences it appears that either colonization of San Salvador involved a bottleneck or, as seems likely to be the case, too little time has gone by for accumulation of genetic diversity between ponds.

Matt Moynihan and Amelia Taylor (Advisor). USING INITIAL IDEALS TO PREDICT PHYLOGENETIC TREES.

Andrea Mulhausen, Bob Jacobel (Advisor), Rickard Pettersen (Advisor), and Brian Welch (Advisor). CHANGES IN ICE FLOW ALONG THE SHEAR MARGIN OF KAMB ICE STREAM.

The Kamb Ice Stream Project is a glaciological study in West Antarctica to investigate the causes of the ice stream shut-down about 150 years ago, and whether the ice stream may reactivate in the near future. Our field work utilizes ground-based ice-penetrating radar and GPS; the St. Olaf contribution to the project is principally concerned with deploying deep-penetrating radar to measure and interpret basal reflectivity and internal layering structures. In order to better understand the activity of Kamb Ice Stream before it shut down, we observed the differences between the ice stream and Siple Dome. Understanding the differences in internal stratigraphy and basal reflectivity between these two regions will provide important insight to the history of the ice stream and its surrounding area.

As the boundary between fast-moving and slow-moving ice, shear margins also hold important information about the flow history of an ice stream and the stress and strain around it. In order to increase our understanding of Kamb Ice Stream, we compared the shear margin in two separate locations; one upstream at Lake Camp, the other downstream at Siple Dome.

Kelly Nail, Pao Lor, and Charles Umbanhowar (Advisor). LINKAGES BETWEEN FIRE, CLIMATE, AND VEGETATION: A MULTI-PROXY ANALYSIS OF WESTERN MONGOLIAN SEDIMENT.

The grasslands of western Mongolia are well over 10,000 years old and have been variously affected by climate and fire. Little if any data are available on the history of these grasslands, even for the past 500 years. As part of a broader effort to understand the long term history of these grasslands, several proxies were examined from four western Mongolian lake cores. Microscopic charcoal (a proxy for fire), Loss-on-Ignition (LOI, a descriptor of sediment composition), rock magnetics (a climate proxy), and Carbon:Nitrogen ratios (C:N, proxy for source of organic matter) were analyzed for all four lakes. Results suggest that although fire has been relatively less important throughout the history of the lakes, in recent years fire has virtually disappeared from the Mongolian grasslands. The low C:N ratios also suggest that much of the organic matter present in the lake originated from algal sources. LOI and magnetics results indicate considerable changes in the sedimentation history of the lakes, likely reflecting major changes in climate and landscape pattern use.

Pete Nelson and Shelly Dickinson (Advisor). ETHANOL-INDUCED CONDITIONED PLACE AVERSION IN ADOLESCENT AND ADULT MICE.

Two experiments using DBA/2J male mice were conducted in order to measure the presence of any aversive reaction to ethanol (conditioned place aversion). The first experiment was comprised of 40 adult male mice and the second with 36 male adolescents. After eight conditioning days for experiment one and four conditioning days for experiment two in which either ethanol or saline were paired with a particular contextual stimulus, (either a hole and a grid floor) a final test day was conducted in which the mice were placed on floors that consisted of both a hole portion and a grid portion for 60 minutes. Using photoreceptors, the amount of time spent on either side of the floor was measured and the presence of any conditioned place aversion (CPA) due to ethanol exposure was investigated. In addition to being tested after four conditioning days, mice in experiment two were given four more conditioning days and one more test day. Experiment one revealed a significant level of CPA for the mice exposed to ethanol with the mice exposed only to saline showing no preference. Unlike previous research done under similar conditions, experiment two also revealed CPA for the mice exposed to ethanol after both four and eight conditioning days.

David Osterhouse, Bob Jacobel (Advisor), Rickard Pettersen (Advisor), and Brian Welch (Advisor). THE FLOW OF ICE OVER THE STICKY-SPOT IN THE KAMB ICE STREAM.

There are fast flowing ice streams draining the ice from the West Antarctic Ice Sheet whose activity affect the stability of the Ice Sheet. Understanding the way in which ice flows over and around the "Sticky-spot", an area of nearly stagnant ice in the Kamb Ice Stream is import to understanding why ice streams shut down and restart. With this in mind, we analyzed ice radar data that was collected from this area during field seasons in 2004 and 2005. We calculated the power of the basal reflection which shows that there is quite clearly a less powerful bed reflection over the Sticky-Spot. This could indicate a dry, frozen on bed condition rather than a wet bed condition. Because the ice is frozen on to the bedrock, the stream is forced to flow around it. We compared the internal layers in a series of parallel, crossflow radar profiles and observed that folds in the layers are pushed around the sides the Sticky-Spot rather than over it, confirming that the ice over the Sticky-Spot is stuck and the ice stream is forced to flow around it.

Ashley Poquette, Aly Yarnall, and Gary Muir (Advisor). ABSENCE OF HEAD DIRECTION CELL ACTIVITY IN THE ANESTHETIZED RAT.

Head direction (HD) cells are cells that fire as a function of an animal's head direction in the horizontal plane. They are thought to be an integral component of the spatial navigation system that provides an animal with information about directional heading. They are found in several areas of the brain including the anterior dorsal nucleus of the thalamus (ADN), postsubiculum (PoS) and the lateral mammillary nuclei (LMN) (Taube 2003). Head direction cell activity is not dependent on an animal's location in the environment, but is generated endogenously and can be influenced by external cues. By recording cell activity in the ADN of anesthetized rats, we determined that HD cells are not active under the anesthetics urethane and nembutal. Forty-nine recorded cells showed no HD cell firing properties, with firing being completely unrelated to the animal's head direction.

Megan Rooney, Matt Majerus, and Eric Cole (Advisor). ISOLATION AND CHARACTERIZATION OF THE NUCLEAR EXCHANGE JUNCTION OF *TETRAHYMENA THERMOPHILA*.

Tetrahymena thermophila is a freshwater ciliate that will undergo a process of nuclear exchange known as conjugation when subjected to a nutritionally poor environment. During this process, two cells of compatible mating types fuse plasma membranes to form a nuclear exchange junction. Our research sought to accomplish two things: to improve and elaborate upon a pre-existing protocol for exchange junction isolation, and to explore the protein composition of the exchange junction over the course of its development. Modestly pure exchange junctions were obtained by fixation and sonication of mating pairs followed by a series of centrifugations. Using one-dimensional acrylamide gel electrophoresis, we were able to effectively resolve a diverse range of proteins from the junctions by means of 6% and 12% separating gels. Forty-five protein samples were extracted from the gels and delivered to another research group for mass spectroscopy analysis. At this point, twelve proteins have been identified and include several cytoskeletal components and cellular signaling molecules that may play vital roles in the process of conjugation and the formation of the nuclear exchange junction.

Eric Scholten and Marc Klingshirn (Advisor). APPLYING GREEN CHEMISTRY TO THE FIRST YEAR LABORATORY.

Green chemistry can be generally defined as "environmentally-benign" chemistry. By implementing the principles of green chemistry, we sought to reduce the environmental impact and the overall hazard associated with the first-year chemistry laboratories. Three existing experiments, covering the topics of periodic trends, oxidation-reduction chemistry, and reaction kinetics, were revised. These revisions eliminated the use of toxic barium salts, carcinogenic

chromate ion, the strong oxidizer permanganate, and caustic, concentrated hydrochloric and phosphoric acids. These modifications also allow for an annual 30 L reduction in hazardous waste. Our improvements not only preserve the educational goals of the three experiments, ensuring that future students can receive a strong foundation in general chemistry, but also minimize the experiment's hazard risk and environmental impact.

Pat Shabino and Greg Muth (Advisor). A DRY CAMPUS? AN INVESTIGATION OF PHOSPHORAMIDITE CHEMISTRY.

Sarah Stevens and Doug Beussman (Advisor). DETECTING KETAMINE IN BEVERAGE RESIDUES USING GC-MS AND LC-MS/MS.

In today's society one is confronted with an increasingly large percent of the population that abuses illegal substances. Many of these substances are known to have hallucinogenic effects and some can even cause black outs in large doses. People have been known to take advantage of such effects and drug women in order to facilitate sexual contact, commonly known as date rape. These drugs are often slipped into an unsuspecting victim's drink. One such commonly used drug is ketamine. Several published reports already describe methods for determining the concentration of ketamine in urine, blood serum, and hair. A literature search did not reveal any published accounts discussing the detection of ketamine in drinks however. Since mass spectrometry is a sensitive analytical technique, it should be able to detect small amounts of this drug in beverages and beverage residues.

A method has been developed to determine the presence of ketamine in water, Coca-cola, and New Castle Brown Ale solutions using GC-MS and LC-MS/MS techniques. Samples, based on the lowest dose generally used for a small female in a date rape situation, were made in the three solvents and then poured into a glass. The glass was emptied to simulate consumption of the beverage and then the remaining residue was washed into a vial using nanopure water. A second sample was collected by refilling the glass, pouring out the liquid, and allowing the residue to evaporate over night. The sample was then collected by washing out the glass into a vial using nanopure water the following morning.

GC-MS analysis utilized direct-immersion solid phase microextraction technique (SPME) with a PDMS/DVB fiber and yielded positive identification of ketamine in almost all the samples. LC-MS/MS analysis used electrospray ionization mass spectrometry and direct injection liquid chromatography to detect ketamine in all the samples. LC-MS/MS was deemed the better technique because it required less preparatory work and time since the aqueous sample can be directly injected onto the chromatography column

Honing and perfecting such a technique has large implications for the forensic community. A crime scene investigator could quickly obtain drink residue and test for a drug's presence before lab results from the victim were available. If the victim visited several locations, positive identification of a glass containing the drug in conjunction with a positive test for the drug in the victim's blood or urine could help determine where the spiking of the drink occurred. Forensic science would benefit from having such a technique available to help solve cases involving this date rape drug.

Christin Weierholt Strandli, Ian Campbell, Bob Jacobel (Advisor), Rickard Pettersen (Advisor), and Brian Welch (Advisor). ICE THICKNESS AND VELOCITY STUDIES ON KAMB ICE STREAM.

During the past two Antarctic field seasons we acquired approximately 1600 km of ground-based ice-penetrating radar data on the lower trunk of Kamb Ice Stream (KIS) as part of a larger radar, GPS and modeling study with scientists at the University of California Santa Cruz examining the possibility of ice stream reactivation. We present here a summary of radar results from this work and some preliminary interpretations.

We have produced a map of detailed bed topography over the "Sticky-spot" where ice appears to have become grounded over a large bedrock bump. Radar profiles in a dense grid were measured for ice thickness and the resulting points were gridded into a topographic map using commercial software. We have also used archival data from the University of Wisconsin airborne radar profiles (Rezlaf et al, 1993) to create a larger map placing this in a regional context. We have also acquired GPS positions of survey poles on the ice surface over a two-year interval from measurements made by Cal Tech scientists in 2000-2001. Taking differences between these positions we have plotted velocity vectors of the ice surface superposed on MODIS imagery. The results show flow around the sticky spot where ice has been grounded on the bedrock rise.

David Swanson, Kristin Henry, and Paul Roback (Advisor). ESTIMATING CONCENTRATIONS OF MERCURY AND SELENIUM IN FRANKLIN'S GULL EGGS.

Selenium (Se) and Mercury (Hg) are toxicants that exist both naturally in the environment and as byproducts of industry. Once they reach water sources, they are easily ingested by wildlife, and this poses a number of problems, particularly to birds. If the concentration levels of Hg and Se are high enough in developing bird eggs, they can cause debilitating or fatal birth defects. Scientists measure the concentration of these contaminants in eggs in order to monitor current contaminant levels in the environment and determine what affects they have on wildlife. However, obtaining a standardized measure of contaminant concentrations in these eggs is difficult because wet mass and dry mass are lost throughout the incubation period, increasing the concentration of the toxicants. A variety of contaminant concentration conversion factors are used to correct for this phenomenon. We employed many analysis techniques including bootstrapping, linear regression, and permutation tests, and built a simulation in order to evaluate which conversion factors estimated fresh contaminant concentration best. It was found that the Whole Weight, Content Weight, and Species-Specific conversions were not robust to the assumption of dry weight being lost proportionally to egg weight, while the conversion factor proposed by Hoyt proved to be most accurate in predicting original contaminant concentrations in both our analyses and simulation.

Karen Thiebes and Shelly Dickinson (Advisor). CONDITIONED REWARDING EFFECTS OF ETHANOL IN ADULT AND ADOLESCENT MICE.

The rewarding effects of ethanol were examined in adult and adolescent DBA/2J mice using an unbiased place conditioning design. In each experiment, mice received an intraperitoneal injection of ethanol (2.0 g/kg) or saline immediately before exposure to a distinctive floor stimulus, either hole or grid flooring. Eight five-minute conditioning trials were conducted, four trials with exposure to ethanol and four with saline. A final preference test was conducted where all mice received a saline injection immediately before being placed on a half grid, half hole floor for 30-60 minutes. Adult mice showed significant preference for floors paired with ethanol while adolescents did not show preference. Activity of both adults and adolescents with previous exposure to ethanol on test day was lower than the saline animals, but not significantly. Adolescents exposed to naloxone, an opioid antagonist, did not show a decreased preference for the floor paired with ethanol.

Hannah Thiesen and Jumi Hayaki (Advisor). TOWARD AND UNDERSTANDING OF EMOTION DYSREGULATION IN PSYCHOPATHOLOGY: THE ROLE OF EXPERIENTIAL AVOIDANCE AND SUPPRESSION.

This literature review synthesizes research findings regarding the role of emotion dysregulation in psychopathology. Emotion dysregulation is defined as deficits in an individual's ability to influence emotional experience and/or expression and has recently been implicated in

the development and maintenance of several psychological disorders. This review focuses upon two specific components of emotion dysregulation, namely, experiential avoidance and suppression.

Experiential avoidance is the means by which individuals escape, avoid, or modify unwanted internal experiences. It has been suggested that individuals who experience intense emotions, who cannot understand their emotions, or who are unable effectively to regulate their emotions are motivated to avoid unwanted internal experiences. Experiential avoidance is negatively reinforcing and is especially implicated in Generalized Anxiety Disorder (GAD).

Another component of emotion dysregulation in psychopathology is suppression. Research in the area of suppression focuses on thought suppression and expressive suppression. Thought suppression has also been shown to be an ineffective coping mechanism and has been implicated in a number of psychological disorders. Finally, research on the suppression of emotional expression has found it to be related to increased physiological arousal and cognitive deficits. Overall, research supports the idea that avoidance and suppression are maladaptive responses to negative mood and cognitions. Suggestions for future research are addressed.

Ben Tucker, Matthew Nelson, and Paul Roback (Advisor). ASSESSING INFORMATION LITERACY: TOWARD A STANDARDIZED MEASURE OF ACADEMIC RESEARCH COMPETENCY IN COLLEGE STUDENTS.

We assessed the validity and reliability of the Research Practices Survey and its ability to gauge research competency in St. Olaf students. The instrument measures information literacy according to five categories, or dimensions: experience, attitudes/beliefs, epistemology, knowledge and critical capacity. A sample of 296 incoming first years, 36 spring term first-years, and 80 upper-class students took the survey. Factor analysis and Cronbach's alpha tests confirmed one dimension and its internal consistency, but failed to confirm the remaining four dimensions as valid, separate, and internally consistent constructs. High school academic performance variables were positively associated with two dimensions of research competency in incoming first year students. Comparisons of dimension scores between samples showed that more advanced students generally had higher scores on test dimensions, suggesting that our instrument may be used to gauge improvement in research competency. Suggestions for improving the psychometric properties of the survey are given, and the implications of performance trends are discussed.

Ian C. Vaagenes and Shelly Dickinson (Advisor). TROUBLESHOOTING ELECTROCHEMISTRY AND OPERANT CONDITIONING: LEARNING TO LOVE THE INNER LUDDITE.

The goals of summer research were three-fold. Firstly, to use the time tested methodology of operant conditioning to study the motivational effects of alcohol. Secondly, to use chronoamperometry to measure the *in vivo* efficacy of adolescent vs. adult dopamine transporters, and finally, to utilize conditioned place preference to examine the role of cues in adolescent vs. adult alcohol place conditioning. The first two tasks required setup from the ground up and weeks of troubleshooting. The task of operant conditioning setup necessitated a proficient understanding of the programming language "MedState Notation," and several weeks of mouse "shaping" in order to teach mice the association between "nose poke" and the availability of sugar water as a reward. Finally, the mastery of chronoamperometry was made further complicated by the great number and variety of computer problems encountered and uncontrollable climatical complications, e.g. humidity. Despite initial logistical headaches, the diligent problem solving and setup of the summer has paved the way for hopefully unburdened fall research.

David Vock and Gary Spessard (Advisor). A GREENER METHOD OF MAKING CARBON-CARBON DOUBLE BONDS.

We present an environmentally friendly method of illustrating the formation of carbon-carbon double bonds for an undergraduate lab. The ring closing metathesis of diethyl diallylmalonate was run in the microwave which reduces the time needed to run the reaction and the energy consumed. We have also developed a procedure to use linalool, a natural product, as a starting material.

Allie Wagner, Tim Mitchell, and Kathy Shea (Advisor). TREE GROWTH PATTERNS IN A RESTORED MAPLE-BASSWOOD FOREST.

Tree growth patterns have been observed for 16 years on a maple-basswood forest restoration project at St. Olaf College in southeastern Minnesota. In 1990 tree seedlings were planted in two fields, and data have been collected periodically on height, diameter, mortality, and map location of these trees. More recently, soil samples from these forests were analyzed for nutrients, organic content, moisture, and pH. In the summer of 2006 we updated the measurements for the trees and continued soil analysis for the first time since 2002. The tree growth pattern for each species closely fit an exponential growth model. Overall mortality for the restoration project was 31%, but very few trees have been lost since 2002 indicating mortality has decreased as tree age increases. Nutrient concentration, organic matter, and soil moisture were generally less in the restored fields than in nearby remnant patches of maple-basswood forests. Tree growth patterns are expected to approach a logistic curve model as trees mature and the canopy closes over.