Student Titles And Abstracts Based On Summer Research 2005

Paul C. Anderson, Amy L. Wentland, Douglas J. Beussman (Advisor), and Eric S. Cole (Advisor). A PROTEOMIC INVESTIGATION OF *TETRAHYMENA THERMOPHILA* USING LC-MS AND LC-MS/MS.

The proteomics of *Tetrahymena thermophila*, a single-celled protist, are of growing interest in the fields of biology and chemistry. The goal of our summer study was to identify as many proteins within *Tetrahymena's* conjugation junction as possible. Proteins were first isolated from the conjugation junction of *T. thermophila* and subsequently underwent SDS gel electrophoresis. Resulting bands were sent to our lab for analysis, where we conducted in-gel digestion. Proteins were reduced, acetylated and digested using trypsin. Peptides were loaded into a HPLC, separated in a C_{18} column using an acetonitrile/water gradient, and then injected into an electrospray ion trap mass spectrometer. Using the LC-MS we obtained mass-to-charge (*m/z*) ratios of intact peptides, which we entered into Protein Prospector to search an online database containing expected sequences of *Tetrahymena* proteins. We then preformed tandem mass spectrometry (LC-MS/MS) to fragment the peptides and searched the database for their respective sequences. We successfully identified nine distinct proteins from 16 out of 20 bands, and hence expanded our understanding of this organism.

Sarah Anderson, Dane Huber, and Jason Hill (Advisor). THE RATE OF SPONTANEOUS EMBRYONIC MUTATIONS IN *ARABIDOPSIS THALIANA.*

Arabidopsis thaliana has been used extensivly as a model organism for genetic research but little has been done with the natural rate of embryonic lethals. We grew hundreds of lines of plants and scored their seeds to observe the rate of embryonic lethals that occured. As excepted, the natural rate of embryonic lethals is near zero.

Tim Barker and Gary Spessard (Advisor). A GREENER METHOD OF FORMING CARBON CARBON DOUBLE BONDS.

Joel Beard, Christine Gille, Kristin Henry, Sara Krohn, Heather Wiste, Rob Rutherford (Advisor), and Paul Roback(Advisor). OPERON PREDICTION IN *MYCOBACTERIUM TUBERCULOSIS.*

Ian Campbell, Robert Jacobel (Advisor) and Rickard Pettersson (Advisor). DEVELOPMENT OF HIGH-SPEED ACQUISITION SOFTWARE FOR ICE-PENETRATING RADAR

The Center for Geophysical Studies of Ice and Climate (CEGSIC) at St. Olaf College has been utilizing ice-penetrating radar in Antarctica as well as at other sites around the globe in order to study global climate change and the history and dynamics of the world's ice masses. Collecting data in remote locations is a difficult task, requiring a system that is both rugged and reliable because in most cases there will not be a second chance. Recently, CEGSIC acquired a new field computer and digitizing board that will allow us to collect data at significantly faster rates and with a higher signal to noise ratio. I worked with Dr. Rickard Pettersson during the summer of 2005 to write the software to control the radar and collect field data. This poster emphasizes the field requirements and development process of a robust ice-penetrating radar system.

Paul R. Campbell, Allison F. Christensen, Marc A. Klingshirn (Advisor), and Robert M. Hanson (Advisor). GREEN CHEMISTRY: THINKING OUTSIDE THE BOX.

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 1-hexyne or phenylacetylene as the terminal alkyne. Polyethylene glycol (PEG) is used as the solvent, allowing us to increase the reaction temperature and decrease the reaction time greatly.

Peter L. Cathcart and Kim A. Kandl (Advisor). INTERACTIONS OF TWO TRANSLATION ELONGATION FACTORS WITH ACTIN.

There is significant evidence that components of the translational machinery and the actin cytoskeleton interact. For example,eukaryotic elongation factor 1A, eEF1A, binds and bundles actin. Additionally, models suggest that eEF1A interacts in a mutually exclusive fashion with aminoacyl-tRNA, actin, and eEF1B-a. We investigated whether eEF1A interacts preferentially with actin or eEF1B-α under specific conditions. Cosedimentation assays showed that in the presence of GTP and GDP eEF1A bundles actin. In a GDP solution eEF1B-α disrupts the bundling of actin by eEF1A, suggesting that eEF1A preferentially interacts with eEF1B-α. Using actin and eEF1B-a mutants with altered affinities for eEF1A, we further studied the preferential interaction between eEF1A and eEF1B-α. Our future plans include studying interactions in a mixed GDP/GTP solution, and using additional mutants to study these interactions.

Christopher Clark, Larisa Nordstrom, and Jeff Schwinefus (Advisor). UNRAVELING HELIX STABILITY: DEPENDENCE OF COSOLUTE INTERACTIONS AND DNA HYDRATION ON BASE COMPOSITION.

As probes of DNA hydration and helix stability, we have used the neutral organic molecules (cosolutes) ethylene glycol, urea, glycine, sarcosine, and betaine to reduce water concentration and lower the temperature required for DNA helix strand separation (referred to as the DNA melting temperature). To quantify the dependence of DNA helix stability on cosolute concentration and DNA guanine-cytosine (GC) base pair content, we have used a local-bulk domain partition coefficient (K_p). K_p is the ratio of cosolute concentration in a local region near the DNA surface to that in the bulk domain where the free energies of the solution components are not perturbed by the presence of DNA. We find $K_p > 1$ for all cosolutes, indicating favorable interactions with the DNA surface exposed during melting and a reduction in helix stability. Larger K_p values with DNA samples of higher GC content for glycine, sarcosine, and betaine suggest stronger interactions of these cosolutes with GC base pairs. The zwitterions used in this study (glycine, sarcosine, betaine) have strong interactions with salt ions in solution, resulting in partition coefficients that have a strong dependence on cosolute concentration.

Kristin N. Dorn, Gregory W. Muth (Advisor), and Jeff Schwinefus (Advisor). MAKE, MELT, AND MODEL: RNA THERMODYNAMICS.

Beginning with three small but structurally intriguing RNA sequences (a pseudoknot, stemloop, and the stem of the stemloop) this project aimed to improve our current capacity to calculate thermodynamic properties through observation of the of the sequences' behavior when thermally melted. Melting data was collected using a UV-visible spectrophotometer and a differential scanning calorimeter, and primary melting temperatures were extracted through differentiation of UV melt data taken from 20 to 100°C. The primary melting temperature of the pseudoknot, stemloop, and stem were 70.07°C, 96.03°C, and 71.03°C respectively under buffer conditions ranging from 25 to 125 mM NaCl and 5 to 12 mM sodium phosphate at pH 7. As was expected, UV melts of the pseudoknot in the presence of cosolutes showed decreasing melting temperatures as cosolute molality increased. Temperatures decreased linearly in the presences of betaine, while the trend appeared exponential in the presence of urea. Further analysis of pseudoknot UV melt data was performed

using a 2-state folding model, which revealed three transitions occuring during melting (unfolding of the tertiary structure, then stem 2, then stem 1) and melting temperatures were approximated for each transition. Under this model, UV melts with urea showed a uniform lowering of the three melting temperatures, while the three temperatures tended to converge in melts with betaine. Future work includes further investigation of the stemloop and stem using UV melts and modeling, and for all three structures analysis of melt data using more complex models.

Kirsten Eilertson, Haley Hedlin, Mark Holland, Maggie Broner (Advisor), and Julie Legler (Advisor). BROADENING THE USE OF STATISTICAL ANALYSIS IN SECOND LANGUAGE RESEARCH.

Christine Gille and Rob Rutherford (Advisor). OPERON CONFIRMATION IN *MYCOBACTERIUM TUBERCULOSIS.*

*T*he reemergence of human tuberculosis and the development of multiple drug resistant strains has led the World Health Organization to declare tuberculosis a global emergency. Fortunately, with the sequencing of the *M. tuberculosis* genome, genomics and bioinformatics have opened new doors for the development of treatment and therapy. Microarrays have proved particularly useful in visualizing gene expression data and can be used to predict groups of genes that are transcribed together across a variety of different experiments. Reverse Transcription PCR was performed on total RNA from *M. tuberculosis* to test for cotranscription among 30 different sets of such genes. Ten gene pairs were found to be cotranscribed and six pairs were successfully amplified but require further confirmation. An additional five pairs were amplified successfully but with unusual streaks on the gels making the results inconclusive. Amplification was accomplished both for gene pairs with high correlations of coexpression as well as low correlations suggesting that other factors, such as intergenic distance, may be accurate predictors of cotranscription of genes as well.

Josanna Glassberg, Jillian Godfrey, William Richards, Adam Thomas, and Gene Bakko (Advisor). FOREST REGENERATION BY DIRECT TREE SEEDING.

Forest restoration is one important aspect of stewardship on St.Olaf lands. Since 2001 St. Olaf College has been restoring a portion of its rented farmland to hardwood forests. Transect and seeding data from three fields allowed us to analyze the success of direct tree seeding of oak, black walnut, and green ash as a method of forest regeneration. Natural seeding of the fields by box elder trees on the periphery has necessitated control actions that have been somewhat successful. To hinder deer predation, we placed tubes over the oaks in the first field seeding. Germination rates for directly seeded trees are about 20% and survival rates are generally good for oak and black walnut trees when undesirable species are controlled.

Allison Hagen, Brian Welch (Advisor), Robert Jacobel (Advisor), Rickard Pettersson (Advisor). SUB-GLACIAL CONDITIONS OF THE ANTACTIC ICE SHEET OBSERVED WITH GROUND-BASED RADAR

Ice sheets record paleoclimate interactions between the atmosphere, oceans and cryosphere. The relationship between ice volume and sea level is controlled by the rate of ice flow into the oceans, which is in turn controlled by subglacial conditions. The CEGSIC research group uses ice-penetrating radar to study ice flow dynamics and subglacial conditions in West Antarctica. The amplitude of the bed echo is dependent on the dielectric constant of the reflecting material. Since water has a dielectric constant 10 times that of ice and rock, reflections from wet regions should be distinguishable from dry regions. Data from Kamb Ice Stream indicates that this theory holds, however data from cross-continental traverses would suggest that the inland regions of the ice sheet are a patchwork of wet and dry bedrock. We hypothesize that signal strength also depends upon whether the ice-bed interface is exposed bedrock or draped in glacial till.

Steffanie Halberstadt, Kathleen Kephart, Julie Legler (Advisor), and Charles Huff (Advisor). THE ODD COUPLE: STATISTICS AND MORALITY, A QUANTITATIVE ANALYSIS OF MORAL REASONING.

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

Using the principles of green chemistry as guidance, we refined a previously-reported H_2O_2 oxidation technique using (–)- menthol as our test substrate. This is a very useful reaction, especially for the teaching laboratory, as it illustrates oxidation of an alcohol to a ketone and provides a great opportunity to introduce students to a variety of analytical techniques. We were able to completely convert (–)-menthol to (–)-menthone within 1.5 hours, allowing the entire experiment to be easily completed in a 3-hour laboratory period. This was achieved using only 0.5 mol % catalyst and 25 mL of 3% H_2O_2.

Mike Helgen, Kieran Cofell Dwyer, Brian Welch (Advisor) and Robert Jacobel (Advisor). VOLCANOES AND ICE: THE MT. VENIAMINOF FIELD SEASON.

Volcanoes are known throughout the world as places of extreme energy and heat. However, many of the summits of world's volcanoes exist at altitudes that allow glaciers to form. It is the precarious postion of large amounts of ice atop of active volcanoes that produces a receipt for disaster. Water created by melted ice during an eruption can cause mudflows, which have the potential to burry people and buildings. Even minor eruptions can cause significant damage to life and property. This past summer, three of us from St. Olaf College's Center for Geophysics Studies of Ice and Climate worked on a project sponsored by the Alaskan Volcano Observatory to measure the ice volume and likely flow paths of meltwater from atop Mt. Veniaminof, a large Volcano in the Alaskan Peninsula situated below major air traffic routes and near a large salmon fishery. We collected over 125 Km of ice penetrating radar and GPS data in order to determine ice thickness and surface topography of the summit caldera. These data have been analyzed to produce maps of bed topography and hydrological potential to aid in the hazards assessment.

Brandon J. Hill and Gregory W. Muth (Advisor). EXPLORING TRANSCRIPTIONAL REGULATION USING T7RNA POLYMERASE.

Recent advances in DNA expression technology have shown that there exists, primarily in lower life forms, an *in vivo* mechanism by which an effector molecule, often a vitamin or other small molecule, can bind directly to a specific three dimensional site on mRNA, inducing a conformation change, leading to a premature termination of transcription or an inhibition of protein translation. This mechanism, termed a "riboswitch," is advantageous for simpler life forms that cannot afford to waste precious resources on synthesizing molecules that could otherwise be obtained from the environment. In an effort to develop a more quantitative biochemical model, we have examined the proposed upstream thiamine-binding sequence in *E. coli, R. etli* and *B. subtilis*. Using standard viral T7RNAP transcription conditions, we have not observed an increase in transcriptional pausing, indicating that either T7RNAP is immune to this regulatory mechanism or the mechanism lies at the translational level.

Becky Hochstein, Paul Jackson (Advisor), and Mike Swift (Advisor). INDICATORS OF ANTHROPOGENIC CONTAMINATION IN THE CANNON RIVER WATERSHED.

Freshwater mussels, Order Unionoida, are long-lived, benthic organisms which bioaccumulate hydrophobic, anthropogenic (human-produced) chemicals by filtering particles and oxygen from the water. I surveyed mussels below wastewater treatment facility outfalls to see if mussels could survive the discharged chemicals and to find collection sites for chemical extraction specimens. I also developed GC/MS analysis methods for determining phthalate esters (PE's) from mussel tissue using column and solid phase extraction (SPE).

Rebecca Hunt (Mike Swift, Advisor). DAMSELFLY LARVA PREDATION ON CLADOCERANS.

Damselfly larvae are important predators in lakes. I studied the efficiency of *Enallagma hageni* and *Ishnura verticalis* feeding on the cladocerans *Polyphemus, Daphnia, a*nd *Holopedium*. I also measured the functional response of both species. I counted the number of attacks, captures, and ingestions on cladocerans of different sizes and calculated the capture and ingestion efficiencies and handling time. Both damselfly species were most efficient at capturing *Polyphemus* and took the most time ingesting *Daphnia*. *Holopedium* were rarely eaten due to a gelatinous coating. Both species exhibited a Type II functional response; the number eaten increased with density to a maximum of 20-30 prey eaten in one hour. Prey capture and predator functional response help determine the effect of larvae on zooplankton community structure.

Bethany E. Jacobson, Allison Madison, and Donna McMillan (Advisor).STUDIES IN ENVIRONMENTAL PSYCHOLOGY.

Research on psychological well-being has tended to overlook the role that the natural environment can play in one's sense of self and well-being. Contact with the natural environment can positively affect well-being, provoking meaningful, contemplative, and even spiritual experience (Kaplan & Talbot, 1983; Eigner, 2001). The link between the natural environment and spiritual life is also evident in the way that religions attempt to integrate the power and mystery of the natural world into their theology (Eliade, 1959). Our study sought to investigate the relationship of nature and religiosity to well-being.

The Biophilia hypothesis proposes that humans are genetically predisposed to respond strongly to nature-related stimuli (Wilson, 1982). Specifically, Wilson posits that human beings will respond most strongly to savanna-type landscapes (grassy plains with few trees) because they most closely resemble the natural environment in which humans first evolved. Many researchers have attempted to test Wilson's hypothesis (Herzog et al., 2000; other sources). In this study we compiled photographs of savanna, desert, forest, mountain, and ocean scenes and asked participants to evaluate the photographs based on specific criteria in an attempt to create a standardized set of photos for use in a future study testing the Biophilia hypothesis.

The intense responses to nature recognized by the Biophilia hypothesis have largely been studied in terms of strong positive, affiliative responses, leading some researchers to conceptualize biophilia as solely positive. In this study, we compared the effects of reminiscing about positive and negative nature and city related experiences in order to determine if peoples' responses to nature events are more intense both negatively and positively than their responses to similarly valenced city events. We chose to interview elders for this study because of the small number of studies involving the relationship of elders to nature.

Casey Johnson, Joey Paulsen, and Jason Engbrecht (Advisor). MICELLE MEASUREMENTS WITH POSITRON METHODS.

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. Contrary to results by other research groups,[1] our analysis indicates that diffusion of positronium into the micelles does not occur, and a micelle radius could not be measured. However, 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.

[1] G. Duplâtre, M. F. Ferreira Marques, M. da Graça Miguel. J. Phys. Chem. 16608-16612 (1996).

Thomas Kiger, Hännah Thiesen, and Gary Muir (Advisor). APPARATUS FOR RECORDING HEAD-DIRECTION CELLS IN A FREELY-MOVING RAT.

Valerie J. Klema, Anne Walter (Advisor), and Douglass Beussman (Advisor). TONOPLAST MEMBRANE PROPERTIES AND THE EFFECTS OF DIHYDROWYRONE.

Dihydrowyrone (DHW) is a plant toxin known to cause packing in model lipid vesicles. The red beet tonoplast membrane is a particularly interesting membrane of study due to its ability to maintain an internal acidic environment in plant cell central vacuoles. My project involved isolating tonoplast membranes and exploring their characteristic properties as well as DHW's effects on them. To do this, I utilized the fluorescent properties of two molecular probes, laurdan and merocyanine 540 (M540), as a function of both temperature and DHW concentration. Tonoplast lipids were found to create tightly packed unilamellar vesicles which experience further lipid packing with increasing concentrations of DHW.

John Lamppa and Paul Jackson (Advisor). DETECTION OF CONTAMINANTS IN CANNON RIVER WATERSHED THROUGH CAFFEINE TRACERS.

Many anthropogenic (human produced) compounds find their way into our natural water resources everyday. They flow in from farm runoff or pass through waste water treatment facilities (WWTF) undetected. Major sources for these compounds include pharmaceuticals, pesticides and hormones. Some of the chemicals found in these compounds have also shown to be hazardous to human health from other studies. Our mission this summer was to determine if these compounds were in our own Cannon River Watershed (CRW) and if so, what concentration they were present at. Our method for conducting this research consisted of mapping out spots along the CRW where we believed there would be higher concentrations of caffeine. At these locations we collected 1 liter water samples and brought them back to the lab for analysis. Once in the lab these samples were filtered and run through solid phase extraction (SPE). From there the samples were then analyzed with gas chromatography (GC) and mass spectroscopy (MS). The GC/MS made compound identification and concentration possible. With results from this type of analysis we were able to determine the presence of anthropogenic compounds in the CRW and the effectiveness of WWTF's along the CRW. Further research should be done on the affects these compounds have on living organisms and the community should be informed of the findings so that they can help the situation.

Benjamin Landsteiner, Mike Olson, and Rob Rutherford (Advisor). CURRENT COMPARATIVE TABLE 2SOFTWARE FOR AUTOMATING PROTEIN DOMAIN AND SEQUENCE SEARCHES FOR BENCH SCIENTISTS.

Steve Lund and Jason Engbrecht (Advisor). THERMALIZATION RATE OF POSITRONIUM IN HELIUM.

Because of its tiny mass and its gamma rays decay, positronium is a unique analytical tool for examining atomic collisions. We seek to determine the rate of thermalization of positronium formed in helium by using Doppler Broadening Spectroscopy to analyze the gamma rays released from positronium annihilation. There is significant disagreement among research groups as to this rate, and a consensus would provide theorists with a valuable checkpoint as they work to understand the atomic collisions.

Anne Malaktaris, Rachael Sexton, Christiana Taylor, and Bonnie Sherman (Advisor). MONTH-FORMS.

Spatial representations of abstract concepts have been investigated since 1880 when Francis Galton discovered internal spatial structures for organizing numbers, which he called number forms. This study investigates the significance of spatial forms for the months of the year. Of 95 participants interviewed, ten participants with each of the most common forms (counterclockwise (CC), clockwise (C), vertical (V),and horizontal (H)) were selected to participate. These 40 participants responded to paired, forced choice stimuli in each of the four form conditions presented tachistoscopically.

Reaction time (RT) and response accuracy for identification of the months were recorded. Results showed that participants' internal spatial forms interact with the form being processed in terms of RT and accuracy.

Erin Manlove and Brian Borovsky (Advisor). HOW DOES MOLECULAR STRUCTURE AFFECT FRICTION?

Travis C. Mattson and Douglas J. Beussman (Advisor). FORENSIC ANALYSIS OF ECONOMIC POISONS USING SPME AND MASS SPECTROMETRY.

Kelly Nail (Urmila Malvadkar, Advisor). OPTIMAL HARVESTING IN THE PRESENCE OF RANDOM ENVIRONMENTAL EFFECTS.

Using dynamic programming and a modified form of the logistic equation, I attempted to determine the best way to optimize one's yield of fish in the presence of random environmental effects. I also tried to determine under what conditions having a marine reserve would optimize the harvest of fish in areas outside of the reserve. The results of the modeling indicated that there is an optimal total population level that should exist after harvesting. The results also showed that in order to optimize yield, one must typically assume the least favorable conditions and harvest accordingly.

Marla S. Nelson (Mary Caroline Henry, Advisor). STIMULATED FOOD FORAGING BEHAVIOR PATTERNS OF THE BLOWFLY *CALLIPHORA VICINA.*

I conducted experiments to determine similarities between the honeybee's dance and food foraging techniques of the blowfly. Starved *Calliphora vicina* were given various types of food stimuli and their response patterns were observed. My results showed the dance-like behavior of the blowfly was dependent on the type and concentration of food, threshold of each fly, and time lapse. *Calliphora vicina*'s response may be a manifestation of the central excitatory state (CES), an adaptation to help increase probability of survival.

Erika Reid, Eloise Kvam, and David G. L. Van Wylen (Advisor). MYOCARDIAL POSTCONDITIONING IN AGED RATS.

Reperfusion of myocardial tissue following ischemia causes necrosis of parts of the tissue. Postconditioning has been developed as a mechanism of attenuating this reperfusion injury. This study was designed to determine how age, as a comorbidity, impacts the observed effects of postconditioning. A procedure and technique which produces consistent infarct sizes in a rat model was implemented for this study and may be used in future research at St. Olaf. The rats were divided into four groups: young control (n=3), young postconditioned (n=4), aged control (n=4), and aged postconditioned (n=4). Preliminary data of area at risk (percentage of left ventricle) and necrotic tissue (percentage of ischemic tissue) suggest that postconditioning reduces infarct size in both aged and young rats, however, a larger sample size is needed for more accurate statistical analysis.

Chris Rolfes, Erin Mercer, and Jason Engbrecht (Advisor). BI. C. E. P. LABS: BIOLOGICAL CHEMICAL EXPERIMENTS IN PHYSICS LAB.

Introductory physics at St. Olaf College consists of 80% chemistry and biology majors, or pre-health students. The course is specific for non-majors and is appropriate for students needing physics to support work in other disciplines. Thus, there was a great incentive to adapt the previous physics laboratories to accommodate the current student make-up of the course. Six of the twenty labs over the yearlong course were modified with the goal of extending current research trends into the undergraduate laboratory. The revised labs incorporate the physics of *tools* used in chemistry and biology, such as compound microscopes, astronomical telescopes, and PET scanners. Additional labs use physics to explain various chemistry and biology concepts, like the chemical battery.

Lisa Schaus, Doug Beussman (Advisor), and Gary Miessler (Advisor)USING APCI MASS SPECTROMETRY TO CHARACTERIZE MOLYBDENUM AND TUNGSTEN COMPOUNDS.

Lisa Schaus and Gary Miessler (Advisor). SYNTHESIS AND IDENTIFICATION OF TUNGSTEN AND MOLYBDENUM COMPLEXES.

Molybdenum and tungsten are both found in the active sites of enzymes that catalyze reactions involving the direct transfer of oxygen. Although the metal (Mo or W) present in the active site differs, these active sites have similar structures, with the metal bonded to a dithiolene ligand complex, called molybdopterin. A way to compare bonding between the metals and the dithiolene ligand is to synthesize a compound containing both metals as well as a simpler dithiolene ligand, *tfd* ($S_2C_2(CF_3)_2$). Mo-Mo and W-W dimers containing dithiolene ligands readily form, and corresponding Mo-W heterobimetallic dimers should also form. Although such heterobimetallic dimers have not yet been identified, three new homobimetallic compounds that also contain the dithiolene ligand *tfd* have been synthesized and characterized using ^{1}H-NMR, mass spectrometry, and X-ray crystallography. These compounds include [Cp(*tfd*)W(μ-S)$_2$W(=O)Cp], [Cp¢(*tfd*)Mo(μ-S)$_2$Mo(*tfd*)Cp¢], and [Cp¢Mo(=O)(μ-S)$_2$Mo(*tfd*)Cp¢] (Cp = C_5H_5, Cp' = $C_5(CH_3)_4(CH_2CH_3)$).

Patrick Shabino and Gregory Muth (Advisor). IMITATION RNA, CREATING A SECONDARY STRUCTURE ANALOG.

The three dimensional conformation of RNA plays an important role in biologically significant reactions. We have been investigating the use of organic chemistry techniques to imitate and study the function of RNA secondary structure. The methodology of this project is to synthesize a series of novel ribose analogs with defined degrees of bend using 1,2-benzyl alcohol, 1,3-benzyl alcohol and 1,4-benzyl alcohol as the starting material. Our supposition is that these analogs, once functionalized, can then be incorporated into small RNA fragments and their biophysical and biochemical properties can be characterized using NMR, gel-shifts, and various protein binding assays in comparison to native biological molecules. The first step in the reaction scheme is to selectively protect the alcohol with either a t-butyldimethyl silyl (tBDMS) or dimethoxytrityl (DMT) group. Depending on the reaction conditions and choice of protecting group, we saw that the tBDMS group selectively protected the benzylic alcohol and the DMT group selectively protected the phenolic alcohol. These observations were supported by NMR, IR and solubilty analysis. Future work will take advantage of this regioselectivity in the reaction scheme.

Megan Watland (Diane Angell, Advisor). SURVEYING PRAIRIES FOR PRAIRIE VOLES, A SPECIES OF "SPECIAL CONCERN" IN MINNESOTA.

The prairie vole (*Microtus ochrogaster*) was historically common in western and southern Minnesota, but with the loss of prairie habitat, the prairie vole has become rare. The Minnesota Department of Natural Resources considers the prairie vole a "Special Concern" species and recommends that populations be monitored. I conducted a small mammal survey in northeastern Rice and southwestern Goodhue Counties on remnant and reconstructed prairies. Prairie voles seem to be rare since they were only trapped at one of six sites. That site was a high-quality, large remnant prairie. A second large remnant that is being rapidly invaded by trees had only edge and woodland small mammals present. Finally, I found that western harvest mice (*Reithrodontomys megalotis)*, which have been considered uncommon in southern Minnesota, are currently very common.