UNIVERSITY *of* ST. THOMAS

BUSH FOUNDATION PROGRAM GRANT:
COLLABORATIVE INQUIRY

Inquiry at UST: A Poster Session with the Results of Faculty/Student Collaboration at the University of St. Thomas

Abstracts

Vol. 8
September 28, 2006

Introduction

The abstracts published in this volume reflect the value we at the University of St. Thomas place on faculty/student collaboration.

Students who have recently done collaborative work with a faculty member present that work in these abstracts and at this poster session for purposes of dissemination and scrutiny by their peers, their professors, and the academic public.

The University of St. Thomas expresses its deep gratitude to the Bush Foundation, who funded this event through a three-year Program Grant. The grant seeks to increase the use of inquiry-based teaching methods, so that students experience the real work of the professions, working on real problems often taken from outside the university, in the ways they will be called upon to employ their disciplines after they leave the university.

A second theme of the Bush Program Grant is to increase faculty/student collaboration. We believe that one of the very best ways to teach is to have professors work with students collaboratively. Students see how work is really accomplished in their chosen professions, and professors have the chance to share their work as it is being created.

We hope this event and this volume gives visibility and credibility to the ideas represented in our Bush grant

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September 2006

As president of the University of St. Thomas, I am both pleased and proud to welcome you to the eighth poster session devoted to faculty/student collaboration projects developed as part of our grant from the Bush Foundation, *Focus on Inquiry: Faculty/Student Collaboration at the University of St. Thomas*.

I believe that one of the most effective ways for students to learn is through collaborative inquiry: students and faculty working together on research that can have real-world consequences. This is completely in keeping with our mission as a Catholic university grounded in the liberal arts tradition. We strive to provide a high degree of personal attention in a challenging campus environment that is engaged with the complexities of our urban community and the world beyond.

Collaborative inquiry gives our students the opportunity to experience first-hand how their professors approach research questions in a given discipline. It also gives our faculty a better opportunity to understand how our students think, and helps them develop new ways of looking at research problems. Collaborative inquiry enables our students and faculty to experience their disciplines in action, deepening students' academic experience while simultaneously increasing career competency.

I am very proud of what our students and faculty are doing and I hope the work represented here will illustrate the importance of collaborative inquiry at St. Thomas.

Sincerely,

Reverend Dennis Dease
President

St. Paul, Minnesota
Minneapolis, Minnesota
Owatonna, Minnesota
Rome, Italy

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Melissa Altermatt

SYNTHESIS AND POLYMERIZATION OF A POLYDIACETYLENE LEUKOCYTE ESTERASE ENZYME SENSOR

Faculty Collaborator: Dr. J. Thomas Ippoliti

Leukocyte esterase is an enzyme that is present in the urine of humans with urinary tract infections. Current diagnostic tools for this enzyme are unstable in air and cannot be exposed to air for more than a few minutes. In this project, several different reaction schemes were tried in an attempt to synthesize a leukocyte esterase detector in the form of a polydiacetylene molecule. When polymerized under ultraviolet light, these molecules would have the ability to change color upon contact with the leukocyte esterase enzyme by altering the conformation of their diacetylene backbones. In this research, several new PDA molecules were synthesized and tested for their stability and color changing properties.

Molly Andreason

COMPUTATIONAL MODELING OF GENE NETWORKS

Faculty Collaborator: Dr. Yiannis Kaznessis (University of MN)

Two fundamental questions in biology are how gene expression is regulated as a network and how the regulation leads to specific phenotypes. With the rapid growth of knowledge in gene expression, a new field of synthetic biology has emerged to engineer artificial gene networks that exhibit specific behaviors. The extensive time and cost of experimentally synthesizing these networks *in vivo* motivate the need to computationally model these systems. Modeling the networks also facilitates understanding the underlying relationship between network topologies and their observed phenotypes.

The objective of this study was to model the expression of a four-gene system that would display behavior akin to that of a logic gate. Simulations were run using Hy3S, a suite of stochastic simulation algorithms, using gene networks comprised of the *lac, ara,* and *tet* operons and GFP, with isopropyl ,-D-thiogalactopyranoside (IPTG) and anhydrotetracycline (aTc) as inducers. Results were compared to a similar system that was experimentally synthesized. Preliminary results of our models show consistency with those that have been determined experimentally and provide a solid foundation for future investigations of these gene networks.

Trina M. Arola

SOLID-STATE INTERMOLECULAR INTERACTIONS OF 1,2-BIS(3-IODOPHENYL)AZINE AND ITS ISOMER, 1,2-BIS(3-IODOPHENYLIMINO)ETHANE

Faculty Collaborator: Dr. William H. Ojala

We are working toward preparing new crystalline materials by co-crystallizing molecules we have designated "bridge-flipped isomers," pairs of molecules related by the reversal of a bridge of atoms linking two major parts of each molecule. We are currently examining azines and the isomeric glyoxal Schiff bases, in which the bridge-flipped isomerism is Ar-CH=N-N=CH-Ar' vs. Ar-N=CH-CH=N-Ar' (where Ar = aryl). Because mutual solid-state solubility is greatest for compounds that are isostructural (same molecular packing arrangement), we are using single-crystal X-ray diffraction to identify isostructural bridge-flipped isomeric pairs that would be likely candidates for co-crystallization. Because intermolecular interactions linking molecules into similar chains in the two solid isomers might encourage their isostructuralism, we are focusing on suitably substituted isomers. Because similarity in conformation also may encourage isostructuralism, we are focusing on molecules with potentially similar

conformations (particularly those that may be planar). In this study we have determined the crystal structure of the bridge-flipped azine isomer of a previously published halogen-substituted glyoxal Schiff base known to possess a nearly planar conformation and to engage in intermolecular Lewis-Acid Lewis-Base interactions. We find that these crystal structures differ; halogen-nitrogen contacts in the glyoxal derivative are replaced by halogen-halogen contacts in the azine.

Barjeta Balidemaj

INTERMOLECULAR INTERACTIONS IN BENZYLIDENEANILINE CRYSTALS: A COMPARISON OF A FLUOROBENZYLIDENE-CYANOANILINE TO A CYANOBENZYLIDENE-FLUOROANILINE

Faculty Collaborator: Dr. William H. Ojala

The purpose of this study is to prepare crystalline benzylideneanilines and to determine their crystal structures by X-ray crystallography. An eventual goal is to co-crystallize benzylideneanilines that are "bridge-flipped" isomers of each other, isomers that differ only in the orientation of the –CH=N- bridge between the phenyl rings. We have been examining pairs of bridge-flipped isomers to determine whether they are isostructural, assuming identical molecular packing arrangements in their respective crystals, because these would tend to co-crystallize most readily. Lewis acid-Lewis base contacts between halogen atoms and nitrile groups on the benzylideneaniline molecules might encourage the isomers to pack in similar ways, so we have determined the crystal structures of two halogen/nitrile benzylideneanilines, 4-fluorobenzylidene-2-cyanoaniline and 2-cyanobenzylidene-4-fluoroaniline, to find out whether they are isostructural. We have determined that they are not. In this poster we describe these two different molecular packing arrangements.

Laura Baumgartner

THE INCORPORATION OF ALCOHOL OXIDASE IN ENZYME-LINKED IMMUNOSORBENT ASSAYS

Faculty Collaborator: Dr. Kathy Olson

An enzyme-linked immunosorbent assay, better known as an ELISA, is a test that uses components of the immune system and an enzymatic reaction to determine concentrations of species in solution. Estradiol, the antigen under consideration, is a sex hormone predominately found in women. The amount of estradiol present in a sample can be determined through a competition ELISA that competes unmodified estradiol against AOX-estradiol conjugates. In order to bind alcohol oxidase (AOX) to estradiol, the carboxymethylether form of estradiol is needed. The synthesis is accomplished through an SN2 reaction that uses the phenolic portion of estradiol as the nucleophile and sodium chloroacetate as the substrate. From there, a series of reactions are performed to synthesize an activated form of estradiol that is capable of reacting with the lysine side chains of AOX. In the presence of an appropriate substrate, the AOX reacts to produce a colored product. A low quantifiable product in an ELISA test would correlate to high concentrations of estradiol, meaning the AOX-estradiol conjugates were out-competed by the estradiol. The sensitivity of this newly pioneered ELISA test allows for minute concentrations of estradiol to be detected in any given sample, which is of interest to fertility clinics and in the study of hormonal disorders.

Matt Behrns

LASER BEAM PROFILING (PROJECT 1) AND HEIGHT SENSING AUTOMATION (PROJECT 2)

Faculty Collaborator: Dr. Greg Mowry

Project 1:

Innovative Laser Technologies engineers laser welding and cutting machines for various industries such as aerospace, automotive, and medical. The laser beam profile describes the spatial intensity distribution of the laser. Knowing the beam distribution helps control laser welding and cutting processes. The goal of the project was to develop an *in situ* method of measuring the beam profile with minimum beam perturbation.

Project 2:

Innovative Laser Technologies engineers laser welding and cutting machines for various industries such as aerospace, automotive, and medical. In many cases, customers would like the focus point of the laser to be at the exact location of the working piece. Since the majority of working pieces are not perfectly flat, there must be a control system implemented to control the height of the laser beam head. ILT typically uses linear motors in their systems to control the height of the laser beam head. The goal of the project was to develop a control system to automatically focus the laser beam head on the working piece.

Michael Blissenbach

ANALYSIS OF SEASONAL PROTEIN CHANGES ASSOCIATED WITH PHOTOSYNTHETIC RECOVERY IN WINTER STRESSED CONIFERS

Faculty Collaborator: Dr. Amy Verhoeven

Plants that keep their leaves during winter (evergreens) are subject to low temperatures that reduce their ability to do photosynthesis, but these plants are still exposed to high light levels. This results in an imbalance between light absorption and its utilization via photosynthesis. Evergreens deal with this excess light energy by retaining constantly high levels of the photoprotective xanthophyll cycle pigments zeaxanthin and antheraxanthin in their leaves during winter. There is evidence that seasonal changes in photosynthetic proteins accompany these changes in photoprotective pigments. The purpose of this study was to experimentally manipulate winter stressed leaves by removing branches from evergreens during January and maintaining them in the laboratory for one week. Our goal was to monitor changes in photosynthetic proteins that accompany the recovery in photosynthetic activity and the xanthophyll cycle.

Branches from sun and shade samples of balsam fir *(Abies balsamea),* and sun samples of eastern white pine *(Pinus strobus),* were initially monitored in the field on a cold January morning. Branches were collected and brought into the laboratory where they were allowed to recover for one week. Photosynthetic parameters were monitored throughout recovery. Additionally, thylakoids were isolated periodically during recovery and frozen in liquid nitrogen. Changes in specific light harvesting proteins were analyzed via gel electrophoresis and western blotting of the proteins contained in the thylakoid fractions. The results of this study showed that both species recovered their photosynthetic activity consistently over the course of the week. Additionally, both species displayed increases in the concentrations in nearly all of the light harvesting proteins as the branches recovered. However, one of these proteins, Lhcb2, showed decreases in concentrations as the branches recovered. These results are interesting because they demonstrate that different light harvesting proteins may have different specializations of function, with Lhcb2 perhaps being associated with photoprotection.

Nathaniel C. Brandt

TRANSIENT ABSORPTION SPECTROSCOPY OF PHOTOINDUCED ELECTRON TRANSFER REACTIONS

Faculty Collaborator: Dr. Joseph M. Brom

Photoinduced electron transfer reactions are of high importance in many aspects of chemistry and can be better understood via analysis by transient absorption spectroscopy. An apparatus was constructed for transient absorption spectroscopy by modifying a fluorescence decay apparatus and was optimized and calibrated via observation of the transient decay of triplet-state benzophenone. Following apparatus optimization, the photoinduced electron transfer between 9,10-dicyanoanthracene (DCA) and trans-stilbene (TSB) was observed to verify the ability of the apparatus to study photinduced electron transfer systems. The laser dye 1,3,5,7,8-pentamethylpyrromethene difluoroborate (pyrromethene 546 or PM) was then chosen for analysis due to its suspected ability to undergo a variety of photoinduced electron transfers. Prior to transient absorption spectroscopy, the dye was chemically reduced and oxidized (forming the PM radical anion and radical cation, respectively) in order to determine absorption maxima for each species to aid in the observation of their transient decays.

Maria E. Bye

CHARACTERIZATION OF THE CHEMOTACTIC RESPONSE OF *PSUEDOMONAS PUTIDA* F1 TO THE ENVIRONMENTAL POLLUTANT TOLUENE

Faculty Collaborator: Dr. Jayna L. Ditty

It has long been known that certain bacteria are chemotactic, or are physically attracted, towards different chemicals. Typically, the chemicals that bacteria are attracted to are sources of carbon and energy for the organism. The mechanism that bacteria use to detect compounds in the environment that they wish to consume is by protein receptors located on the surface of the bacteria that can recognize these chemicals. The receptors generate a series of biochemical reactions that lead a bacterium to move towards that chemical. *Pseudomonas putida* F1 is a common environmental bacterium that is chemotactic towards the organic solvent toluene, which is a common environmental contaminant. *P. putida* F1 can also utilize toluene as an energy source. Our hypothesis is that *P. putida* F1 has a specific gene on its chromosome that encodes for the toluene receptor, which allows *P. putida* F1 to detect toluene in the environment and subsequently affect the biochemical changes to make the bacterium swim towards toluene.

The purpose of this work is two-fold: 1) to quantitate the response of *P. putida* F1 to toluene by using quantitative chemotaxis assays and 2) to begin to identify the gene for the toluene receptor. If the gene for the toluene receptor is identified, the specific actions and functions of the toluene receptor protein can be determined. This can then lead to a better understanding of how bacteria respond to toxic chemicals in the environment and may provide improved solutions to the problems involving the biological clean up of specific toxic chemicals in the environment.

Christopher Cleveland

AB INITIO COMPUTATIONAL INVESTIGATION OF THE ELECTROCHEMILUMINESENCE OF 1,3,5,7,8-PENTAMETHYPYRROMETHENE DIFLUOROBORATE

Faculty Collaborator: Dr. Joseph Brom

Sophisticated computational methods for computing quantum mechanical and thermodynamic quantities to a degree of high accuracy have only recently become accessible to the common PC or Mac user. For this reason what was once

only possible from a large computer cluster or super computer is now feasibly accomplished to a high theoretical degree of accuracy with a common workstation. Previously the use of computationally less expensive methods such as molecular modeling and semiempirical methods had been used to compute the molecule properties to a lower degree of accuracy. These archaic methods are suitable for a crude approximation, but to achieve results comparable to experimental values Hartree/Fock and DFT methods must be used in conjunction with a large basis set and diffuse orbitals for anions. The focus of this study was to investigate the electron transfer between the radical cation and radical anion of 1,3,5,7,8-pentamethylpyrromethene difluoroborate (DPM). Specifically, *ab inito* hybrid Hartree-Fock/DFT methods were employed to calculate the gas-phase adiabatic electron affinity, ionization energy of DPM, and optimum geometry.

Michael Cook

MODELING STELLAR NUCLEAR REACTION RATES

Faculty Collaborator: Dr. Josh Nollenberg

We created a computational, thermodynamic model for the Sun. Specifically we used a Polytropic model to simplify our computations. We designed a computational routine to apply various nuclear reaction rates to the simulated stellar environment. This allowed us predict the number of reactions occurring in the star per unit time. By taking the change in stellar composition over time into account, the nuclear production over that lifetime of the star can be found. Since nuclear reaction rates for the Sun have been previously modeled and published, we can compare the accuracy of our model to the accepted values for these reactions. Assuming our model proves reasonably accurate, we can apply it to a more theoretical stellar model. Ultimately we plan to apply a similar model to study population III stars, and predict their nuclear synthesis rates. These stars are hypothesized stars that existed early in the universe, and are composed entirely of H and He. They were responsible for the initial creation of all elements Li and heavier. Better understanding the nucleosynthesis rates of these early stars would extremely useful in understanding the earliest stars and galaxies.

Ben Dauwalter

ENGINEERING OF A LOW-PRICED, LOW-POWER COOLING SYSTEM

Faculty Collaborator: Dr. Camille George

In the developing countries of today's world, there is a need for an alternative to expensive and inefficient air-conditioners which use refrigerant- 134a. For dry and hot climates, an alternative is to use evaporative cooling commonly used in the American Southwest. This project performed experiments on several different pad materials that could be candidates for use in an evaporative cooler to be manufactured in sub Saharan Africa. The research involved learning about and testing: pad materials with low and high fan settings, and water usage. The project found the relationship between pad surface area and air saturation. It also identified two promising alternative pad materials. It was found that two readily available Malian materials, 'fu', a woodchip similar to North American Aspen Chips, and cotton performed quite well.

Joseph W. Dubis

EFFECTS OF PHOTOPERIOD ON THE CIRCADIAN MECHANISM IN CYANOBACTERIA

Faculty Collaborator: Dr. Jayna L. Ditty

Cyanobacteria are unicellular, photosynthetic microorganisms that utilize a circadian clock to efficiently regulate their cellular activities. The mechanism of the circadian clock in the cyanobacterium *Synechococcus elongatus* PCC 7942 has been studied intensively. However, what has received little attention in this field, thus far, has been how the circadian clock communicates with the environment. In particular, very little is known about how the circadian clock in cyanobacteria responds to photoperiod, or the duration of light versus the duration of darkness within a 24-hour day. Photoperiods have been shown to have considerable impacts on circadian clocks in other model systems. Therefore, this project investigated the effect of varied photoperiods on the circadian rhythm of wild-type *S. elongatus.* Wild-type *S. elongatus* cultures were entrained to the photoperiods of 12 hours of light and 12 hours of dark (12L:12D) and 18L:6D for seven days and then allowed to free-run in constant light. Results showed that increasing the duration of light (18L:6D) within a photoperiod has little effect on the free-running period. However, the varied photoperiods result in a phase angle difference of approximately 4 hours. In determining how the phase angle difference manifested itself, sets of wild-type *S. elongatus* were analyzed while being entrained to 18L:6D and 12L:12D photoperiods. It appears that they exhibit biphasic rhythms as they entrain themselves to the environmental light:dark cycles, primarily the lights off cue. This data has been used as a baseline in further experiments underway to determine the relationship between photoperiod and individual circadian clock input genes such as *cikA* and *ldpA*.

Eric Duclos

THE INFLUENCE OF ENVIRONMENTAL SELF-EFFICACY AND KNOWLEDGE ON SUSTAINABLE BEHAVIORS

Faculty Collaborator: Dr. Elise Amel

Little attention has been given to self-efficacy within the environmental literature. This project's purpose is to investigate students' sustainable behaviors and how much self-efficacy and knowledge of environmental issues influences the behaviors. First, student environmental knowledge, self-efficacy regarding sustainable behaviors, and current sustainable behaviors were assessed. Participants then received one e-mail a week for a month containing information on the environment. A participant either received environmental information that had an emphasis of self-efficacy, knowledge, or both (based on random assignment). There was also a control group who did not receive any e-mails. Participants then took a final survey to look for changes in behavior, knowledge, and self-efficacy. Pre-test results indicated that self-efficacy pertaining to a certain activity has a very high variance rate in acting out that activity (in this case, sustainable behaviors). Post-test results show that the changes in all the variables are not significant, but rather approaches significance in the expected direction. These results suggest that self-efficacy should be further researched.

Laura M. Eaton

GEOCHEMICAL CORRELATION OF VOLCANIC ASH IN THE LAKE MEAD AREA NEAR LAS VEGAS NEVADA

Faculty Collaborator: Dr. Melissa Lamb

The western portion of the United States is experiencing tectonic extension, a pulling apart of the Earth's crust. Extension has caused complex geology to develop in this region. A more complete understanding of the current and past movement of this plate is desirable in predicting future movement and preventing destruction due to tectonic activity. Our study is located in the Lake Mead area near Las Vegas, Nevada. Detailed observation and interpretation of the structure and stratigraphy of the rock layers in the region was done. This study focuses on building upon previous chemical correlations of layers of volcanic ash in the area deposited millions of years ago. Following chemical analysis and subsequent statistical correlation, chemically equivalent rock layers have been identified between different layers of strata. Chemical analysis of the ashes was done using a technique called X-ray fluorescence (XRF).

Using these new correlations and stratigraphic controls, as well as data collected in the field area this summer, we have a more complete understanding of the areas tectonic history. The new correlations encompass a broader region, correlating the West, Central, and East fault blocks in our study area which cover approximately 4 miles.

Lauren Edge and Jason Radel

CALCULATING THE MOTION AND CORRELATION DIMENSION OF A CHAOTIC PENDULUM

Faculty Collaborator: Dr. Marty Johnston

Compared to the programs written on previous summers, we decreased the calculation time for the Matlab computer model by a factor of 30. This allowed us to more efficiently compare theoretical and physical pendulums.

One method of comparing the motion of the two systems was an analysis of the Poincare sections produced by each method. Each section is a collection of points on the plane which are sampled at the fundamental frequency of the system. This collection of points in the Poincare section are structured and ordered; the order can be gauged by the correlation dimension of the system. A typical runtime for the dimension analysis program on a 50,000 point section was 12 minutes.

We created "Poincare movies" in two ways. First, a movie can be made by altering the phase of the Poincare section and viewing the results sequentially. This was distinct from the bifurcation movies that we created because it views Poincare permutations of the same pendulum. The second kind, bifurcation Poincare movies, allowed us to look at how altering a given variable altered the motion of the pendulums.

Luke Edholm

CHAOTIC FLOW IN THE LORENZ MODEL

Faculty Collaborator: Dr. Paul Ohmann

The purpose of my physics project this summer was to study chaotic motion in the Lorenz Model. The Lorenz model is a system of differential equations that were derived by meteorologist Edward Lorenz in 1963. Lorenz formulated his equation from the Navier-Stokes equations, which describe fluid flow. Its applications to meteorology and weather forecasting make it extremely valuable in a world that has tsunamis, hurricanes, tornados, and other natural disasters.

While the equations themselves are rather simple, the behavior exhibited by them is extremely rich. Any slight deviation in initial conditions will yield drastically different outcomes. This chaotic behavior is coined by the phrase "The Butterfly Effect,"

In my project this summer, I analyzed hundreds of different graphs corresponding to different initial conditions to explore the underlying patterns of the model. Recognizing these patterns is essential in we are to incorporate physical meaning back into the equations to simulate the weather.

Sean Ewen

MATHEMATICAL MODELING OF POTASSIUM CHANNEL BEHAVIOR

Faculty Collaborators: Dr. Dwight Nelson and Dr. Mikhail Shvartsman

Animal nervous systems can transmit information with incredibly high speed. Information signals must travel quickly through the axon, one of the most important parts of the neuron for long distance communication. The membrane of the axon conducts electrical signals and transmits information along its length through active differences in electrical charge between the outside and inside of the cell membrane. The drop in potential (voltage) is caused by ions entering and leaving the axon through specialized ion channels. One important type of neuronal potential is the action potential and is responsible for the re-amplification of signals as they travel along the axon. The potassium channel allows potassium ions to leave the axon and is responsible for the repolarization phase of the action potential peak to prepare the axon for a new action potential. If the potassium channel fails to open, the membrane potential remains too high and another action potential cannot be induced.

We were able to take a first order differential equation that applies to the change in concentration of open potassium channels over time and create a simplified form to solve for the time it takes potassium channels to become completely open at a specific voltage. The solution was used to find the concentration of open potassium channels at various voltages. Currently, we are working to define and model action potentials as waves using the wave equation. If action potentials could be thought of as waves moving with velocity and wavelength, it appears that a maximum frequency will be reached when each action potential will be followed consecutively by another because action potentials cannot overlap. This maximum frequency is different for various axons and depends on variables such as velocity and size of the action potential.

Sam Friederichs

THE ROLE OF LARVAL FISH IN MAINTAINING HIGH ALGAL ABUNDANCE IN MINNESOTA WETLANDS

Faculty Collaborator: Dr. Kyle Zimmer

Food-web theory predicts that the presence of piscivorous fish that consume minnows should reduce minnow abundance, causing a subsequent increase in zooplankton abundance and a decrease in algal abundance in wetlands through a trophic cascade. However, recent data have indicated no difference in algal abundance between wetlands with and without piscivores, with algal abundance high in both cases. We hypothesized that the few adult minnows remaining in the presence of piscivores produce sufficient numbers of larval offspring to reduce zooplankton abundance, which causes increased algal abundance. Seven wetlands in western Minnesota were sampled for fish communities, zooplankton abundance, and chlorophyll *a* concentrations. Results showed a strong effect of piscivores on abundance of adult planktivores. Although the difference in abundance was just above statistical significance ($p=0.065$), adult planktivores were 245-fold more abundant in wetlands lacking piscivores. Despite this pronounced difference in adult abundance we detected no significant difference in larval planktivore abundance ($p=0.5025$). Larval planktivores appeared to have a strong influence on zooplankton (June $p=0.35$, July $p=0.57$) and chlorophyll *a* concentrations (June $p=0.38$, July $p=0.51$), as we detected no difference in either case between wetlands with and without piscivores. Our results indicate that larval fish may have an unappreciated influence on wetland food webs,

and have the ability to maintain high algal abundance. Thus, the management strategy of introducing piscivores into wetlands to improve water quality may be limited by strong effects associated with larval planktivores.

Amy Gleason

A TELLING DESIGN: HOW ART AND MUSIC GUIDE THE EXPERIENCE OF THE CHAPEL OF ST. THOMAS AQUINAS

Faculty Collaborator: Dr. Shersten Johnson

The interior of the Chapel of St. Thomas Aquinas inspires those who enter with its breathtaking beauty and grandeur, yet many do not grasp the theological implications of the art or remember the beauty of this sacred space upon departure. In order to more deeply enhance the inspirational experience of the building, its art, and its sacred space, I researched and wrote a paper grounded in music theory that connected the parallels between the artwork of the chapel and sacred music of the same time period. I achieve this through the study of its interior artwork (i.e. ceiling paintings and stained-glass windows) and through diligent research of the aesthetic values and music theory of the Italian Renaissance era. Then I located historically and theologically accurate sacred music to connect to the artwork.

Mikkel Haugen, Alyson Lokken and Elizabeth McGarry

MOVEMENT AND COMMUNITY DYNAMICS OF *CHRYSEMYS PICTA* IN AN URBAN POPULATION

Faculty Collaborator: Dr. Anthony Steyermark

The effects of commercial harvesting on the success and vitality of painted turtle *(Chrysemys picta)* populations are still widely unknown. A greater knowledge of population dynamics and intra-species relations and movement patterns will allow county officials and environmentalists to better understand and account for these effects. This investigation analyzes trends within a painted turtle population of a small, non-harvested lake in Shoreview, Minnesota. For three summers, we placed basking traps in twelve locations across the lake chosen for their variation in depth and proximity to land. Individuals were individually marked, and carapace length, plastron length, girth, and mass measurements were taken upon each capture. We estimated population size, sex ratio, and size class distribution, and then analyzed movement and distribution patterns using Geographic Information System (GIS). Preliminary results suggest correlations between gender and movement patterns, and between water depth and population density.

Jonathan Hennek and Jon Athmann

IN PURSUIT OF LUMINESCENT RUTHENIUM COMPOUNDS

Faculty Collaborator: Dr. David Boyd

In an attempt to improve the efficiency of photovoltaic devices, a series of ruthenium bipyridine compounds have been prepared and characterized. The visible light absorbance of these ruthenium compounds can collect and deliver a larger portion of the energy available in the solar spectrum to a photovoltaic device if properly integrated into the device. The compounds studied include several that can be covalently linked to the metal oxide particles as part of the fabrication of the photovoltaic device. The synthesis and characterization of ligands and ruthenium compounds will be described.

Amanda Hixon

FLUORESCENCE QUENCHING OF PYRROMETHENE 546

Faculty Collaborator: Dr. Joseph Brom

Although pyrromethene 546 can be either and electron donor or acceptor, in its excited state it is more prone to be an electron donor. The electron accepting quenchers produced K_{SV} values multiple times higher than the electron donating quenchers. Most of the electron donating quenchers had Stern-Volmer plots that had downward curves.

Pyrromethene 546, when mixed with p-chloranil, is light sensitive. It becomes oxidized and turns pink with a yellow fluorescence. The pyrromethene peak decreases and a new peak is formed at 552 nm. Although p-chloranil has the best linearly fit Stern-Volmer plot, the best quencher is methyl-1,4-benzoquinone with a K_{SV} value of 244 M^{-1}.

Sara Hyatt

THE EFFECT OF RAP1 ON PROGRAMMED CELL DEATH

Faculty Collaborator: Dr. Jennifer Cruise

Previous research has shown that increasing the amount of active Rap1 in MDCK (epithelial) cells causes a decrease in cell proliferation. In contrast, decreasing the amount of active Rap1 causes an increase in cell proliferation. Previous techniques used to study the role of Rap1 in cell proliferation have been unable to demonstrate that changes in cell number are purely due to changes in the rate of proliferation and not due to changes in the rate of programmed cell death (apoptosis). Therefore, we decided to look at the effect of Rap1 on apoptosis. We predict that by increasing the amount of active Rap1 within MDCK cells we will increase the rate of apoptosis whereas by decreasing the amount of active Rap1 we will decrease the rate of apoptosis. Experiments were performed on MDCK cells stably transfected with an active Rap1 gene, a control plasmid, or a dominant-negative Rap 1 gene. In order to induce apoptosis, cells were starved for 0, 24, 48, 72, or 96 hours. The cells were then stained using Annexin V and analyzed via flow cytometry in order to quantify the amount of apoptosis occurring within each population. Our preliminary data supports our prediction that decreasing the amount of active Rap1 within cells decreases the rate of apoptosis in response to starvation conditions. Our data also suggests that increasing the amount of active Rap1 within cells increases the rate of apoptosis in response to starvation conditions; however, this result is less conclusive. We are also currently looking at the effects of Rap1 on anoikis (induction of apoptosis by preventing cell adherence to a substratum).

Matthew Jungwirth

LOW COERCIVITY IN A CO/PT SUPERLATTICE

Faculty Collaborator: Dr. Randall Victora, University of Minnesota, Twin Cities

Recent research in magnetic recording has focused on moving the current bit density of 200 Gb/sq. in. to 1 Tb/sq. in. and beyond. One technique to achieve this is called Heat-Assisted Magnetic Recording (HAMR), which is a hybrid of optical and magnetic recording techniques. A possible media material for use in HAMR is a Co/Pt superlattice, with monolayer interfaces at (001) and particle surfaces (111). Experiments on this material have found a lower coercivity than expected and is required by HAMR. This research focuses on the reason for the low coercivity by deriving analytical equations for the anisotropy density, using the Neel method, and solving them for the entire particle. Derived analytical equations and a computational program yield easy axis anisotropy energies of -0.997 ergs/cm^2 (-1.66 x 10^6 ergs/cm^3) and -0.956 ergs/cm^2 (-1.59 x 10^6 ergs/cm^3), respectively, a difference of 4%. This close agreement between analytical and computational results suggests the theory developed in this paper fully describes the anisotropy energy for a single particle.

John Kingsbury

COMPETITIVENESS OR SELFISHNESS? WHAT VALUES DOES AN INDIVIDUALISTIC CULTURE INSTILL IN CHILDREN?

Faculty Collaborator: Dr. John Tauer

This study examined the effects that the media has on children's values and beliefs. Due to our culture's emphasis on individual achievements, the present study set out to determine how individualistic and collectivistic images in the sports media affect children's values and aspirations. We also assessed the influence that same race vs. different race images have on children.

The 259 participants in this study were white males (ages 9-15) who were enrolled in a youth basketball camp. Participants watched a basketball highlight clip featuring either white or black players performing either individualistic (slam dunks) or collectivistic (passes leading to a basket) basketball skills. Following the clip, participants filled out a questionnaire measuring the importance they placed on various basketball skills and their aspirations about their future basketball careers.

Results of this study supported our first hypothesis in that those who watched slam dunk highlights valued this skill significantly more than those who watched passes. We also found support for our second hypothesis in that those who watched individualistic highlights showed higher competitiveness scores than those who watched collectivistic highlights. However, those who watched collectivistic highlights did not display higher cooperation scores than those who watched individualistic highlights. Our third hypothesis was partially supported in that whites who watched white players passing were more optimistic about their future basketball careers than those who watched blacks, however whites who watched white players slam dunking did not show more optimism.

In sum, our results show that the individualistic images that children see in the media do affect how they think and what they value. As a result, we believe that more exposure to media images that promote unselfishness, and ones that create feelings of optimism would be beneficial for young athletes in our individualistic culture.

Emily Korman

INFLUENZA VIRUS DETECTION USING A CHEMILUMINESCENT POLYMER

Faculty Collaborator: Dr. J. T. Ippoliti

Chemiluminescent polymers are molecules that can bind to other molecules and produce a "glow" that can help detect viruses. In doing so a new chemiluminescent polymer will be synthesized that can detect the influenza virus in a test sample. To start off a sialic acid derivative was made as well as an alcohol that will be attached to the sialic acid and eventually a polymer will be added to help in detection of the influenza virus.

Andrew Korte

ANALYSIS OF TWO FLUOROQUINOLONE ANTIBIOTICS AND THEIR ENVIRONMENTAL PHOTOCHEMICAL DEGRADATION

Faculty Collaborator: Dr. Kristine Wammer

Two fluoroquinolone antibiotics, norfloxacin and ofloxacin, were examined to predict their respective photochemical fates in natural waters. Samples of norfloxacin and ofloxacin solutions in water obtained from Lake Josephine in St. Paul and in deionized water adjusted to a similar pH (~8) were photolyzed under sunlight and analyzed by HPLC to determine concentrations at set time intervals. Photodegradation rates were rapid for both drugs, with a half-life of ~10 minutes for norfloxacin and ~40 minutes for ofloxacin at 50 ìM concentrations and pH 8, with rates dropping

sharply outside the pH range of 8-9. Degradation occurred more quickly in deionized water than natural water, indicating indirect processes likely will not significantly contribute to removal of the drugs in the environment. Rate was also found to be highly dependent upon concentration, with screening effects being seen at concentrations as low as 2 μM in the case of norfloxacin. Using degradation rates for solutions at a range of pH values and measured pKa values, decay constants were calculated for each of three species of norfloxacin allowing for the prediction of decay rate at the range of pHs relevant in natural waters. Two products of norfloxacin photolysis were identified.

Ashley Kramer

ANALYSIS OF VOLATILE COMPOUNDS OF DIAGNOSTIC INTEREST USING A MICRODIALYSIS PROBE EXTRACTION TECHNIQUE

Faculty Collaborator: Dr. Anthony Borgerding

Our lab has had success using microdialysis sampling probes for volatile compound extraction from solutions into the gas phase as opposed to extraction into liquid dialysis, which is more common. In our research volatile compounds were extracted from aqueous solutions through microdialysis probes using gas chromatography with a flame ionization detector (GC/FID). These compounds include acetone and dimethyl sulfide both showing a linear representation over a range of concentration (0.001-0.5% by weight for acetone and 10-200mM for dimethyl sulfide). Recently we have analyzed volatile compounds that are insoluble in water from organic solvent solutions using the microdialysis probes interfaced to a mass spectrometer (MS). We have obtained results for carbon disulfide (dissolved in methanol) over a concentration range of 10-200mM using this method of instrumentation and will also test isoprene and halothane. Our research lab is currently testing our probes on these volatile compounds (which can be found in human breath condensate) for the long-term goal of using microdialysis as an in-vivo method of study in biochemical systems such as different places in the human body.

Marika K. Kuspa

A SOLID-STATE COMPARISON OF TWO "BRIDGE-FLIPPED" BENZYLIDENEANILINES

Faculty Collaborator: Dr. William H. Ojala

The purpose of our research is to crystallize organic compounds (specifically benzylideneanilines) and to determine their crystal structures by X-ray crystallography. The ultimate goal of this project is to determine the structures of a given benzylideneaniline and its "bridge-flipped" isomer (the isomer differing only in the orientation of the -CH=N- group between the phenyl rings) to determine whether the packing arrangements are similar enough (isostructural) to allow the compounds to be co-crystallized. The structure of 4-*(N,N*-dimethylamino)-*N*-(2-fluoro-benzylidene)aniline (I) has been determined. The crystal structure has two molecules in the asymmetric unit in space group $P2_12_12_1$. The bridge-flipped isomer, 4-(((2-fluorophenyl)imino)methyl)-*N,N*-dimethylaniline (II), has been found by previous workers to crystallize in space group $P2_1/c$.

Jennifer Lahr and Matt Des Marais

ABSTRACT FOR MATHEMATICAL MODELS OF CONSUMER PREFERENCES FOR REGIONAL MALLS

Faculty Collaborator: Dr. Arkady Shemyakin

A basic model for predicting consumer preferences has long been in use by marketing analysts. The goal of this project was to either improve the existing model or find that it is sufficient. Surveys were sent to gather data about nine malls in the Twin Cities metro area, and data from these surveys was used to construct a posterior probability model. We suggest the Bayesian model is useful for large malls such as the Mall of America and Southdale, but that the existing Huff model is adequate for smaller malls. The analysis provides a profile of the typical shopper for larger malls that will be useful to marketing analysts.

Katherine Leehy

SYNETHESIS OF PEROXYFLUOR-1 FOR USE IN AN ELISA

Faculty Collaborator: Dr. Katherine Olson

The synthesis of Peroxyfluor-1(PF1) is a two-step reaction that involves multiple refluxes to achieve the final product. In place of these long refluxes the Biotage Initiator Microwave Synthesizer was hypothesized to produce the same results in a very short period of time. This was attempted for both steps but was found only to be successful for the second step. After synthesizing the PF1 it was purified by column chromatography. PF1 can be utilized to make a very sensitive enzyme-linked immunosorbent assay (ELISA). PF1 allows for colored samples to be tested as change in fluorescence is measured, instead of change in color. Alcohol Oxidase (AOX) is an enzyme from Pichia pastoris that has the ability to convert alcohols into hydrogen peroxide. Hydrogen peroxide then converts the PF1 into fluorescein, a highly fluorescent chemical. A competition ELISA can be set up with an analyte, such as estradiol, from the unquantified source and a known amount of the analyte linked to AOX. The change in fluorescence can then be quantified to determine the concentration of the analyte in the unknown sample. Quantifying these unknown samples can be used to test for varied health conditions associated with changes in hormone levels.

Molly Leonard

EVALUATING DETERMINANTS OF CONVOLUTION MATRICES VIA GENERATING FUNCTIONS

Faculty Collaborator: Dr. Yongzhi Yang

This project was motivated by the paper [1], which introduced a novel generating function method to evaluate the upper left corner determinants of a very specific and limited group of infinite dimensional matrices. In this project, we employed a similar approach to evaluating the upper left corner determinants of a much larger and useful group of matrices, which consist of an infinite sequence in the left block and a convolution matrix in the right block. Convolution matrices are found in many applications of mathematics and engineering, making the impacts of this generalization profound. Our research results are able to describe and include all the matrices examined in [1] and [2], as well as any convolution matrix composed of any two sequences. Not only are we able to determine the determinants of a large variety of matrices, but we also have an increased understanding of the structure of the matrix, allowing us to systematically construct a matrix whose determinants are any well-known sequence. With the ability to systematically construct a matrix whose determinants are a certain sequence, we can now easily develop matrices with very interesting properties and have been able to generalize the original matrices whose determinants represent

the Chebyshev polynomials of the first and second kinds. Our generalization of the previous approach to evaluating determinants clearly makes the method more applicable.

[1] Seyoum Getu, "Evaluating Determinants via Generating Functions," *Mathematics Magazine,* 64 (1991), pp. 45 - 53.

[2] Nathan Cahill, John D'Errico, Darren Narayan, and Jack Narayan, "Fibonacci Determinants," *The College Mathematics Journal,* Vol. 33, (2002), pp. 221-225.

Lake Lindstrom

MIDDLE AND HIGH SCHOOL COUNSELORS' PERCEPTIONS OF GLBT YOUTH

Faculty Collaborator: Dr. Lisa K. Waldner

Survey data were statistically analyzed with SPSS software in order to assess the opinions, attitudes, and beliefs of middle and high school counselors regarding GLBT (gay, lesbian, bisexual, transgender) students and their secondary school experiences.

Results demonstrate that attitudes and beliefs vary depending on what area and what type of school in which a counselor works.

Rachel A. Lundeen

PHOTOCHEMICAL BEHAVIOR OF ENROFLOXACIN, A FLUOROQUINOLONE, IN THE AQUEOUS ENVIRONMENT

Faculty Collaborator: Dr. Kristine H. Wammer

The fate and effects of fluoroquinolones (FQs), a type of antibacterial pharmaceutical, within aqueous environments is of growing concern. The significance of environmental studies involving FQs is extremely important since they are being detected in a wide range of field samples. The photolysis of enrofloxacin, an agricultural FQ, was studied in respect to the formation of photoproducts and rate of degradation ($t_{1/2}$ < 12 minutes) under environmentally-relevant conditions. Experiments showed a significant impact of pH on the rate of enrofloxacin degradation. Rate experiments also showed indications of screening at concentrations of enrofloxacin as low as 1 μM. No rate enhancement was seen in experiments using natural water samples, indicating enrofloxacin has no indirect processes affecting photodegradation. A broad suite of photoproducts are observed when enrofloxacin is photolyzed, and bacterial growth studies done within our research group indicated that photolyzed enrofloxacin significantly inhibited growth due to the presence of these photoproducts. Previous work has shown that ciprofloxacin, a different FQ used primarily in human medicine, is a potential photoproduct of enrofloxacin photodegradation. LC-MS data suggests that ciprofloxacin is indeed a minor photoproduct of enrofloxacin in natural waters. Ongoing work is examining to what extent the antibacterial activity of the photoproducts can be attributed to the ciprofloxacin present.

Christian Lytle

JOVIAN PLANET FORMATION IN ~50 AU BINARY STAR SYSTEMS

Faculty Collaborator: Andy Nelson, Los Alamos National Laboratory

The detection of Jovian planets in large-separation binaries (>100 AU) has motivated investigation into the probability of planet formation in approximately 50 AU and smaller systems. We have run smoothed-particle hydrodynamics (SPH) simulations of binary systems with circumstellar disks and compared our results with others in the literature. Cooling based both on a fraction of the orbital period and a fully radiative model are implemented, but neither produce gravitational instabilities of the magnitude required for long term fragmentation of the disks, due

primarily to the strong heating which occurs when the disks are near periapse. These results are in conflict with simulations from the literature that have produced fragmentation in disks with morphologies similar to ours. We propose that the inconsistencies are attributable to numerical deficiencies (low resolution and fixed gravitational softening) and unrealistic initial conditions present in the previous work.

Kyle Marchuk

THERMOCHROMIC POLYMERS: THE EFFECT OF STRUCTURE ON TRANSITION TEMPERATURE

Faculty Collaborator: Dr. J. Thomas Ippoliti

Polydiacetylenes (PDAs) are of interest due to their thermochromic properties. The goal was to synthesize a PDA with certain thermochromic properties that would be feasible to produce in mass quantities. The diacetylene found in Figure 1 was synthesized. The molecule polymerized under UV light and exhibited thermochromic properties. When heated the PDA changed from purple in color to red and then orange.

Jason Q. McClintic

INTRA- AND INTER-GENERATIONAL COLLEGE ATTENDANCE PATTERNS

Faculty Collaborators: Dr. A. Shemyakin and B.F. Tiefenbruck

This project explores intra- and inter-generational change in college attendance patterns. Data from the 1979 and 1997 National Longitudinal Survey of Youth (NLSY) studies will be used. In particular, three major tasks will be undertaken: (1) identify predictors of college attendance for each cohort, (2) investigate changes in the factor profile between cohorts, and (3) attempt to create a model of the college attendance decision. This project builds on the previous literature by examining differences between cohorts and by examining economic and demographic variables. Kendall's tau-b is used to select variables for inclusion in the logistic models of both cohorts' college attendance probabilities. The analysis is carried out using SAS 9.1 and SAS/INSIGHT. Both models are found to be very to extremely concordant with observed behavior.

Katie McGarry

SYNTEHSIS OF A THIADIAZOLE FUNCTIONALIZED ANTIBACTERIAL OXAZOLIDINONE

Faculty Collaborator: Dr. J. Thomas Ippoliti

A six step synthesis (Figure 1) was laid out and followed to produce an oxazolidinone with a p-methoxyphenyl-thiadiazole substituent. Step 1 and 2 (formation of the oxazolidinone ring) were followed as presented, and a new synthesis was explored to produce the oxazolidinone ring in only one step. This new synthesis proved unsuccessful. The original synthesis was followed through step 2 with success.

Alexander J. Micek

SYNTHESIS OF AN ANTIBACTERIAL OXAZOLIDINONE CONTAINING A THIADIAZOLE

Faculty Collaborator: Dr. J. Thomas Ippoliti

Chemical derivatives of the antibiotic Zyvox™ have proven effective in combating gram positive bacterial infections. Here, an attempt was made to combine a thiadiazole with the active region (an oxazolidinone group) of the commercial drug in order to achieve enhanced antibiotic effect. A six-step synthesis beginning with 5-Ethyl-[1,3,4]thiadiazol-2-ylamine was partially completed; step 1 was successfully completed in high yield (up to 75%), and step 2 was completed in lower yield (up to 54%). Further refinement of the purification and reaction schema will be required to obtain step 2 in consistently high yields to facilitate continuation of the reaction pathway.

Matthew J. Moen

NOVEL SYNTHESIS OF (-)-WINE LACTONE IN RACEMIC AND ENANTIOMERICALLY PURE FORM

Faculty Collaborator: Dr. J. Thomas Ippoliti

Two synthetic routes were developed in an attempt to synthesize (-)-Wine lactone in a more efficient and less costly manner. The first route proved to be successful in achieving this goal. Alkylation of the lithium enolate of 3-methyl-2-cyclohexen-1-one was found to be difficult to achieve using various alkylating groups; however, alkylation with ethyl bromoacetate proved successful, giving ethyl-2-(4-methyl-2-oxocyclohex-3-enyl)acetate in high yield: 'Wet' tetrahydrofuran was found to be responsible for enolate quenching in all previous alkylation attempts. Reduction with sodium borohydride in methanol gave ethyl-2-(2-hydroxy-4-methylcyclohex-3-enyl)acetate in adequate amounts. Following isolation, the product was refluxed in 10% sodium hydroxide and acidified using concentrated hydrochloric acid. This gave 3,3a,4,5-tetrahydro-6-methylbenzofuran-2(7aH)-one in high yield. Methylation using lithium diisopropyl amide and iodomethane gave racemic Wine lactone in high yield and relatively pure form. A second synthetic route, which uses starting materials and oxidative methods that are not currently published in the literature, is currently underway. Thus far, the steps of this synthesis have been giving pure products in relatively high yields. Work is also currently being done to convert the racemic Wine lactone route into an enantioselective route. For the initial step, a chiral additive-mediated alkylation was performed using chiral ligands such as (-)-sparteine and quinine. Alkylation has been shown to occur; however, we have not yet determined if the reaction resulted in large enantiomeric excess or a mixture of enantiomers as before. Work is currently being done to complete the remainder of the synthesis.

Paul G. Monson

MARIA MATER ECCLESIAE

Faculty Collaborator: Fr. Micheal Keating

In the nineteenth century, the city of St. Paul, Minnesota, stood as a hopeful beacon for European immigrants seeking a new home where they might preserve their cultural heritage through faith. Five ethnic communities came to dominate the cultural diversity of the new archdiocese. The Irish, French, German, Slavic, and Italian Catholic immigrant communities formed individual parishes, building church structures and communities reflecting their European heritage. Many national parishes in St. Paul and Minneapolis still attest to their ethnic history through architecture, religious art, and cultural contributions. Today we face the challenge to integrate new Catholic

immigrants into the archdiocesan family, especially the Hmong, Vietnamese, Korean, African and Hispanic communities. Moreover, it is imperative that the unique cultural identity of an ethnic community is not sacrificed through mere assimilation. The Twin Cities have maintained a unique preservation of visual, cultural manifestations of the Catholic faith. If, therefore, we are to continue this rich unity of worldviews, we must learn from the faith and fruits of our forbearers. Through a comprehensive research of older ethnic parish architecture, religious art and organization in St. Paul and Minneapolis, I seek to form a sound, applicable vision for incorporating the cultural identity of new Catholic immigrants into the greater context of the archdiocesan faith community.

Tina Nagel

A NATURAL, INEXPENSIVE METHOD TO FILTER ARSENIC IN WATER

Faculty Collaborator: Dr. J. Thomas Ippoliti

Arsenic in drinking water is a significant problem in India and other developing countries, causing multiple types of cancer. Using a corn cob soaked in 50/50 sodium hypochlorite/water solution for one day, rinsed in 5% sodium bicarbonate, and dried, contaminated water can be filtered to meet the international standard for under $5 in non-renewable parts.

Austin Nelson

PARTICLE FLUX PROFILES DURING ELM CONTROL EXPERIMENTS

Faculty Collaborator: Jon G. Watkins, Sandia National Laboratory

The goal of the ITER project that is currently being developed around the world is to prove the scientific and economic feasibility of magnetic confinement fusion as a source of domestic energy production. However, several major obstacles exist in reaching the objectives of the ITER project. One of these problems is the occurrence of semi-periodic magneto-hydrodynamic instabilities known as edge-localized modes (ELMs). ELMs present a significant obstacle in plasma fusion operation in magnetic confinement reactors because they cause impulsive heating of the divertor target plates and inner chamber walls that can potentially be destructive to the reactor walls. At the DIII-D reactor at General Atomics, resonant magnetic perturbations at the plasma edge have been used to reduce or eliminate ELMs in high-confinement mode (H-mode) plasmas. A new array of high spatial resolution Langmuir probes capable of handling large heat fluxes have been installed along the divertor target plates at DIII-D to investigate the effect of resonant magnetic perturbations on the divertor plasma. Profiles of the target plate particle fluxes at the outer strike point have been examined to characterize the edge plasma response under ELM-suppressed conditions. Experimental data has been compared to theoretical predictions, such as strike point splitting. Understanding the effects of magnetic perturbations on ELMing plasmas is vital to the success of fully operational fusion reactors such as ITER.

Anders Ness

MIOCENE EXTENSIONAL TECTONICS AS RECORDED BY THE HORSE SPRING FORMATION, LAKE MEAD AREA, NEVADA: SEDIMENTOLOGY AND ISOTOPE GEOCHEMISTRY OF THE BITTER RIDGE LIMESTONE MEMBER

Faculty Collaborator: Dr. Tom Hickson

The Miocene Horse Spring Formation (HSF) is a sequence of rocks that records the onset and development of the continental extension in the western United States. Detailed sedimentological and geochemical studies on the HSF

should reveal clues about the extensional tectonics of the surrounding area. The Bitter Ridge Limestone (BRL) member of the HSF was formed in a relatively large, long lived, closed lake system. We investigated outcrops of the lower portion of the BRL in two locations in order to understand lateral chemical, physical, and biological properties of the paleolake. The characteristics of the BRL shows evidence of being a shallow lake environment with periods of subaerial exposure. Results from previous mm-scale O- and C- isotope transects suggests a high resolution signal, indicating annual climatic variation and very little post depositional chemical alteration. In addition, we conducted an O- and C-isotope transect by sampling at 2 m intervals over ~200 m of section in the BRL at one locality. These data show statistically significant variation in isotopic ratios that suggest changes in lake chemistry and biological productivity. Furthermore, these data suggest an overall increase in both O- and C-isotopic values. This more systematic trend may be due to climatic changes and a decline in primary productivity in the Bitter Ridge lake basin. Other studies of the $^{40}Ar/^{39}Ar$ geochronology and geochemical fingerprinting of ashes from within the BRL should allow us to correlate sections across large distances between BRL outcrops.

Dana M. Newman

CRYSTAL STRUCTURE AND PACKING ARRANGEMENT COMPARISONS BETWEEN BRIDGE-FLIPPED ISOMERS: *N-(PARA*-BROMOBENZYLIDENE)ANILINE AND *N*-BENZYLIDENE-*PARA*-BROMOANILINE

Faculty Collaborator: Dr. William H. Ojala

Our lab is currently trying to co-crystallize organic bridge-flipped isomers, with hopes that in the future they can be used to synthesize new materials with applications in electronics, pharmaceuticals, circuitry, etc. This presentation is focused on benzylideneaniline bridge-flipped isomers, and more specifically on two compounds: *N-(para*-bromobenzylidene)aniline and *N*-benzylidene-*para*-bromoaniline. Crystal structures and packing arrangements of both compounds have been determined, and it has been found that they do not assume the same packing arrangement as one another; therefore, further computer analysis has been done to try to determine why the two compounds pack differently.

Rex Njoku

TECHNOLOGY AND PHYSIOLOGICAL APPLICATIONS: RELATIONSHIPS BETWEEN BIO-PHYSICAL ECOLOGY, BASIC PHYSIOLOGY FUNCTIONS, BASIC PHYSIOLOGY AND ANIMAL BEHAVIOR USING BIOCOMPUTATIONAL ANALYSES, COMPUTER WEB PROGRAMMING AND INTERPRETATIONS

Faculty Collaborator: Dr. Anthony Steyermark

The study incorporates both fields of computer technology and physiology in order to develop an interactive and educational website to aid science students, professionals and researchers. We noticed that for an active animal to function properly, a huge interplay exists between biophysical ecology, basic physiology functions, biophysical ecology and animal behavior. To pursue this idea, we sought to find relationships that exist in energy, environmental and body calculations of different families, genera and animal species, such as field metabolic rates (FMR), tidal volumes, etc. By knowing how all these factors interplay in an animal's life, we can be able to predict a lot of things about an animal's life just by having a piece of information, such as the animal's metabolism, environmental conditions or behavioral patterns. To make the study easier, efficient and public, we utilized computer programming and web techniques such as: CSS (Cascading Style Sheets), JavaScript, Java, Flash, XHTML, XML, ActiveX and DHTML to develop an interactive educational website, which includes biological calculations and materials that involve various

articles/research dealing with metabolism. Computer softwares used for this research included: Adobe Web Bundle (Dreamweaver MX, Flash 8, Adobe illustrator, Macromedia Fireworks, Adobe Designer, Adobe PhotoShop, etc). The website presently has over 32 or more webpages with advanced calculations, references and highly advanced interactive web videos/materials. This project still continues and we plan to cover more calculations and relationships in future and hopefully come out with a predictive computer science program or software in the near future to aid science physiological simulations and analyses. This accomplishment will be able to give more insight into evolution, extinction, natural selection and adaptations of various animals.

Kiersten Norby and Carl Mickman

MOUSE SCN PER2 GENE EXPRESSION IN VITRO

Assisted by: Jeremy Stubblefield (Biology) and Dan Olsen and Jason Radel (Physics)

Faculty Collaborators: Dr. Dwight Nelson and Dr. Adam Green

The mouse circadian system is driven by internal daily oscillators that appear to be composed of "clock" genes and transcription-translation feedback loops. A major circadian pacemaker is located in the suprachiasmatic nucleus (SCN) of the brain and light-dark (LD) cycles or photoperiod entrain this pacemaker to the external day. In our previous studies we have measured wheel-running activity in mice as an assay of circadian functions, however, in this study we are examining the expression of clock genes to determine whether the neuronal oscillations in the SCN may account for the circadian functions we have quantified at the level of mouse behavior. We are using a strain of C57BL/6J mice that have had a firefly luciferase gene (luc) inserted into the genome producing a simultaneous expression of the mouse clock gene *Period2* (m*Per2)* and the luciferase gene. The luciferase protein then causes the neuron to emit a dim "glow" as *mPer2* is expressed. To measure this glowing we will use customized LabVIEW software to read photon count rates from a low-noise photomultiplier tube (PMT). We are setting up the PMT in a light-tight, temperature controlled incubator along with culture plates containing brain slices or other tissues. This system will allow us to monitor these tissues for luciferase-based light emission over long periods of time *in vitro,* hopefully emitting a glow which oscillates with a 24h time course, indicating the continuing function of the circadian system "in a dish". Once the system is established and detects rhythmicity, we hope to correlate changes in *Per2* oscillators with changes in circadian functions that we have measured at the level of behavior. Finding the links between environmental LD cycles, gene expression and animal behavior will greatly improve our understanding of the central circadian mechanism in mammals.

Maureen E. O'Connor

AN EFFICIENT SYNTHESIS OF A PHOTOCLEAVABLE AMINO ACID: O-NITROPHENYLGLYCINE

Faculty Collaborator: Dr. J. Thomas Ippoliti

Unnatural photocleavable amino acids can be used in the study of complex cellular processes that require the capability to track biomolecules within their natural habitats. One such amino acid is *o*-nitrophenylglycine (Npg), and it can be used to study the cell cycle of the yeast *Saccharomycese cerevisiae.* Npg was initially prepared through the esterification of methyl *o*-nitrophenylacetate, which was then brominated at the benzylic hydrogen. The remaining preparation of Npg was accomplished through a Gabriel synthesis in which potassium phthalimide was reacted with the brominated product, α-bromo-*o*-nitrophenylacetate, followed by acid hydrolysis and purification. Each step was characterized using ^{1}H-NMR Spectroscopy. Reaction reflux times were remarkably reduced through the use of a microwave reactor.

Angela Osmolak and Jordan Crow

SEASONAL CHANGES IN RELATIVE ABUNDANCE AND PHOSPHORYLATION STATUS OF LIGHT HARVESTING AND REACTION CENTER PROTEINS IN *PINUS STROBUS* AND *ABIES BALSAMEA*

Faculty Collaborator: Dr Amy Verhoeven

In evergreens exposed to seasonally cold environments, there is strong evidence that the light harvesting complexes of photosystem II functionally change from energy harvesting to energy dissipating centers. Here we report data from a study examining seasonal changes in relative abundance and phosphorylation status of light harvesting and reaction center proteins in the evergreens *Pinus strobus* (growing in the sun) and *Abies balsamea* (growing in sun and shade environments) in the seasonally very cold climate of Saint Paul, Minnesota. Thylakoids were isolated every two months from January 2005 until January 2006 and western analysis of thylakoid fractions using antibodies to specific light harvesting and reaction center proteins were performed. Antibodies were used to quantify the concentration of the different proteins during each season. Additionally, using the anti-phosphothreonine antibody, protein phosphorylation status was assessed to determine which proteins of PSII showed changes in phosphorylation status under different light and temperature conditions. Results indicate that the majority of the light harvesting complex proteins (Lhcs) decrease in relative abundance during winter (b1, b4, b5, a1, and a4) in sun plants. Interestingly, one of the light harvesting proteins (Lhcb2) does not decrease during winter, and another shows a much smaller decrease (PsbS). Shade plants showed much less seasonal change in protein abundance. Seasonal changes in the phosphorylation pattern of the photosynthetic proteins showed interesting differences in sun and shade needles, and also suggest an increased phosphorylation, during winter, of the low molecular weight PsbH protein. The results are discussed in the context of specific changes in the composition of the light harvesting apparatus as a component of the reconfiguration of the photosynthetic apparatus from light harvesting to dissipating centers during winter.

Vassilena Ouzounova

THE EVOLUTION OF JAPANESE FOREIGN POLICY

Faculty Collaborator: Dr. Robert J. Werner

After the end of WWII, Japan's actions in the world sphere were largely predictable because they followed the U.S.'s policies. However, in the last decade, Japan's foreign policy started to evolve due to internal and external pressure to assume a greater leadership role. Today, Japan is transforming into an active world power that seeks a greater political and military voice in the world. Due to its alliance with the U.S., its proximity to China, and its relationship with Southeast Asian nations, the choices Japan makes in terms of its foreign affairs will have an effect on the world order. I evaluated Japanese foreign policy by synthesizing three main sources: interviews with experts, relevant literature on the subject, and the media. With the aid of these sources, I examined several indicators of the evolution of Japanese foreign policy. Finally, I offered an analysis of what these indicators mean for Japan's future role in world affairs, especially pertaining to its relationship with the United States and China.

Jennifer Payne, Lucas Brand and Amanda Kastelic

THE ROLE OF T CELLS IN SUBSTANCE P MODULATION OF ANTI-TUMOR IMMUNITY IN MICE

Faculty Collaborator: Dr. Jill Manske

In this study, we examined whether immune cells, specifically T cells, that have been exposed to the neuropeptide Substance P (SP) provide tumor protection to animals injected with melanoma cells. In addition, we measured levels of the T cell cytokine Interleukin-2 (IL-2) in SP-treated mice. Previous research in our lab has shown that treatment with SP prior to inoculation with cancer cells results in a decrease in the rate of tumor growth in mice. The current study examines whether purified T cells taken from animals treated with SP can, on their own, enhance tumor immunity. In this study, mice were implanted with mini-osmotic pumps that delivered a continuous supply of either SP or PBS over a 14-day period. During the 14-day period, blood samples were taken from each of the mice for IL-2 analysis. The animals then were sacrificed and their T cells isolated through use of a magnetic separation column. These T cells then were adoptively transferred to recipient mice via tail vein injection. Two days later, the mice were injected subcutaneously with K1735 melanoma cells. Tumor growth was monitored. Initial results showed that mice given T cells from SP-treated mice developed tumors at a slower rate than animals that received T cells from control animals. However, this difference was not statistically significant. We found no increase in serum IL-2 levels in SP treated mice as compared to control animals. Further experiments will determine whether the increase in tumor protection observed in mice receiving SP-treated T cells is real. In addition, the role of T cell cytokines including IL-2 continues to be evaluated. Preliminary results from these studies suggest that SP-stimulated T cells may be able to mediate an increase tumor response in mice.

Amanda Plourde

RAP'S ROLE IN THE PI3K SIGNALLING PATHWAY

Faculty Collaborator: Dr. Jennifer Cruise

Rap is a small G-protein that is closely related to Ras, which has been shown to play a role in human cancers. However, many of the functions of Rap in the cell are unknown. Previous research in our lab has shown that Rap has an effect on proliferation, migration, and the activity of the protein kinases Akt and Jnk. The literature suggests that all of these effects may be linked to the phosphatidyl inositol 3-kinase (PI3K) signaling pathway. Akt activity in particular is usually directly correlated with that of PI3K. To study Rap's role in this pathway, cells were transfected transiently or stably with an active Rap1 gene, a control plasmid, or either a dominant-negative form of Rap1 or a Rap-Gap. Using western blotting of cell lysates, we found that stable overexpression of Rap1 in MDCK epithelial cells caused a decrease in active Akt levels, and inhibiting Rap caused an increase in active Akt. In transiently transfected NIH-3T3 fibroblasts, Rap had the reverse effect on Akt activation. This suggests that Rap's influence over PI3K signaling is cell-type specific, and that Rap's effect on cell proliferation may be through a mechanism independent of Akt. Several other signaling pathways are currently being explored to further characterize the response to active Rap1.

Jason Radel and Lauren Edge

QUANTIFYING CHAOS

Faculty Collaborator: Dr. Martin Johnston

Quantifying the motion of a chaotic pendulum is a project that has been worked on by various students for two years. During the summer I worked on this project with Lauren Edge and Dr. Martin Johnston. My task was to improve on

what students have done in the past and to further develop techniques to compare and quantify the motion of a pendulum. Specifically, I was in charge of the experimental system.

The first major task I accomplished over the summer was to dramatically change the old LabView program used by students. I redid the interface to be more user friendly and also added new features to the program including a correlation dimension analysis, Fast Fourier Transform, and variable torque feedback feature.

The second task I accomplished was to redo the way data was saved and stored. Previous students worked with ASCII file formats; I rewrote programs to save and store files in binary format to greatly reduce storage space and also allowed me to work with much larger quantities of data.

My final major accomplishment over the summer was to write a new LabView program that could very quickly display multiple Poincare plots. These plots could be played sequentially to produce Poincare sections that appeared to move. These "Poincare movies" were very useful in comparing with the theoretical movement of Poincare sections.

Using the new experimental features that I incorporated as well as the theoretical advances done by Lauren, we hope to match experimental Poincare plots and theoretical Poincare plots. When we have matched theoretical predictions with experimental data we will have shown that we understand chaotic motion.

Katherine Robertson

SYNTHESIZING TRAPPED PHOTOCHROMES FOR THE DETECTION OF LEUKOCYTE ESTERASE

Faculty Collaborator: Dr. J.T. Ippoliti

Leukocyte esterase is an enzyme in the urine which indicates a urinary tract infection. The objective of this project is to make a molecule that will change colors if leukocyte esterase is present. This molecule was made, using a new method, by trapping the highly colored open form of an indolinospiropyran with an electrophilic reagent containing an enzyme substrate. Once formed, the molecule was added to a cellulose acetate film which was then tested with leukocyte esterase. The enzyme then cleaves the substrate from the indolinospiropyran converting the dark orange color to a bright pink. Hence, indicating a urinary infection. Although there are different ways to detect a urinary infection, this new method could improve the detection of the enzyme.

Tommy Rodengen

BUILDING FOR THE GEOLOGICAL SCIENCES

Faculty Collaborator: Dr. Kevin Theissen

In two recent projects I combined creative and handyman skills to produce useful tools, a core extruder and a folding working platform, that are utilized in the field for paleoecological and paleoclimatological exploration of lakes. The core extruder is an improvement on a University of Minnesota model resulting in increased stability, shelf room and needed reinforcement. The coring platform was an original idea that has the advantage of portability compared to similar stationary platforms, while keeping the cost of building and materials below any manufactured platform without compromising stability. Furthermore, I have plans to build core-stabilization additions to the coring platform that will result in improved recovery. The planned stabilizer for the coring platform will allow undergraduate researchers to do repeated coring, allowing collection of up to 7m of core in some lakes. Ongoing field and laboratory research actively uses these tools to cut down on time and increase repeatable results. This poster explains the need for these tools, the methods used to create these tools and how they are used to explore past geology.

Brandon Rowekamp

FRACTAL ANALYSIS AND MODELING OF THE STOCK MARKET

Faculty Collaborator: Dr. Cheri Shakiban

The stock market has been a constant topic of interest for both mathematicians and economists. A major question has been how to best model the stock market in an attempt to predict it, or at least to gain a better understanding of it. Traditional analysis has largely relied on the assumption of independent random events.

Rather than view the stock market as a random process, we decided to instead view it as a natural, but immensely complex process. We viewed it as a fractal, which is roughly speaking an infinitely complex object. Examples in nature include coastlines which seem simple when viewed from afar but at closer magnifications reveal new twists and bays.

We tried to apply fractals to the stock market in a variety of ways, including viewing the stock market as a geometric object in continuous space, and as a repeated discrete process. Throughout this process we were guided by the concept of fractal dimension, which is a general measure of how "rough" or "complex" an object is. We considered this to be an important feature of the stock market which any good model should duplicate.

Ultimately we were not able to find one model that would predict the future behavior of the stock market. Our results were limited by the time and computing power that we had at our disposal and thus are inconclusive. However, the analysis we applied in order to test potential models yielded a deal of insight into the complexities of the stock market.

Alicia Sandberg

SINGLE ADOPTIVE MOTHERS: A QUALITATIVE STUDY

Faculty Collaborator: Dr. Jean Giebenhain

Adoption by singles dates back to the early 1900s. Today, single-parent adoptions are allowed throughout the U.S. and in several countries throughout the world. However, many restrictions still exist. In this study, 33 single adoptive mothers were interviewed to investigate their decision to adopt, as well as their pre- and post-adoption experiences, particularly as these relate to their single status. Results indicate that they are satisfied with their lives and role as parents. As a group they are resourceful and persistent. Mothers with teenage and adult children acknowledged difficulties that they viewed as related to adoption, racial issues, and/or possibly the absence of a father. Those with younger children did not cite any such difficulties. A strong support network, while probably the most difficult to maintain during the teenage years, seemed to be especially important during that time. Mothers unanimously saw being the sole decision-maker as a benefit to single-parenting, but that the biggest drawback was not having someone to share the experience, specifically not having someone who is equally responsible for their child and someone to share in the joys and struggles of raising a family. Further studies are needed to add to the body of knowledge on this important topic.

Elizabeth Scherer

MUSCLE ACTIVATION IN CANOE PADDLERS USING BENT AND STRAIGHT SHAFT CANOE PADDLES

Faculty Collaborator: Dr. Bridget A. Duoos

The purpose of this study was to determine if a straight shaft or a 14 degree bent shaft canoe paddle was more efficient in regards to activation of the trapezius, deltoid, biceps, and triceps muscle groups.

Nine college aged males (age= 23.111 yrs ± s.d. 1.364, ht= 69.167" ± s.d. 1.732, wt= 157.61 lbs ± s.d. 18.82, canoe experience= 7.83 yrs ± s.d. 6.25), all recreational canoe paddlers, volunteered to participate in this study.

Maximum voluntary contractions (MVC) of the trapezius, deltoid, biceps, and triceps of the subjects' dominant side were measured twice for each subject using surface electromyography (SEMG). During a third session, each subject sat in the front of a 16 foot Old Town Penobscot canoe and paddled the length of a 25 meter swimming pool, one time using the straight shaft canoe paddle and one time using the bent shaft canoe paddle, the order of which was determined randomly. The subjects paddled at a 116 stroke per minute cadence as sounded by the Matrix MR-500 metronome. Muscle activity was recorded by BioPac Systems Inc. MP30. The third through seventh strokes were analyzed.

The trapezius, deltoid and biceps all showed the bent shaft canoe paddle resulted in less average muscle activation, however, only the trapezius at a significant level ($p = 0.029$ $t = -2.67$). The triceps showed the straight shaft canoe paddle to have a lower average muscle activation, but not at a significant level.

Kirsten Schiefert and Sami Jo White

ROBOTS PLAYING SOFTBALL USING LEGO MINDSTORMS NXT

Faculty Collaborator: Dr. Mark E. Werness

The objective of this project was to design, build, and program robots to play softball. Specifically, we wanted to create a pitcher, catcher, and a batter that would be able to perform the tasks of their positions. Each robot's physical structure and sensors would come from either the older Lego Mindstorms Robotic Invention System 2.0 or the new Lego Mindstorms NXT System released in the summer of 2006. Programming of the robots would be done using either Robolab 2.5 or the NXT software environment both of which are based on LabVIEW. We ended up creating three different pitcher robots with different capabilities to throw the ball, a catcher robot that could catch the ball and throw it back to the pitcher, and a batter robot that could sense the pitched ball coming, hit the ball and run to first base. The main challenges were to design and build the pitcher so that it would consistently throw the ball in the strike zone and to build and program the batter so that it could effectively "see" and hit the pitched ball. Our successful batter was made possible because of the ultrasonic sensor that is included in the NXT sets and our successful pitcher was completed after many iterations of the design, build, and test cycle.

Jenna Schroeder

ANALYSIS OF THE ANTIBACTERIAL ACTIVITY OF TYLOSIN AND ENROFLOXACIN PHOTOPRODUCTS

Faculty Collaborator: Dr. Kristine H. Wammer

Enrofloxacin and tylosin are two antibacterial compounds used primarily for agricultural applications. Both have been found in natural waters at low concentrations. Both drugs are subject to photodegradation when exposed to natural sunlight. While attenuation by sunlight usually mitigates the environmental impacts of antibacterial compounds, problems may arise if the photoproducts themselves introduce additional antibacterial activity. In separate experiments the antibacterial activities of enrofloxacin and tylosin were compared to that of their photoproducts to determine whether the products presented any additional antibacterial activity against Escherichia coli DH5alpha. Enrofloxacin's photoproducts greatly inhibited bacterial growth while tylosin's main photoproduct (resulting from a photoisomerization) did not inhibit bacterial growth at all. These results indicate that photodegradation of tylosin will likely result in elimination of its potential to affect environmental microbial communities whereas assessment of enrofloxacin's potential environmental impacts will likely need to include analysis of its photoproducts.

Luke Schroeder

EFFECTS OF FISH COMMUNITIES ON ABUNDANCE OF AMPHIBIANS AND REPTILES IN SHALLOW LAKES

Faculty Collaborator: Dr. Kyle Zimmer

We examined the effects of variable fish communities on reptiles and amphibians by estimating abundance of tadpoles, salamanders, painted turtles, and fish in 74 shallow lakes in Polk and Grant counties in Minnesota. Fish communities in Minnesota shallow lakes are highly variable. We find four types of fish communities based on presence/absence of fish and fish guilds: fishless (F), planktivores only (P), planktivores+benthivores (PB), and planktivores+benthivores+piscivores (PBP). Past research has shown that fish influence the abundance of amphibians and reptiles; however, influences across the types of fish communities listed above are currently unknown. We classified fish communities in each lake as F, P, PB, or PBP based on the type of fish community present. We then tested for trends in abundance of amphibians and reptiles in both Polk and Grant counties. Results showed that abundance of tadpoles and salamanders in Grant County was significantly higher in F and P lakes compared to PB and PBP lakes. P lakes had a significantly higher abundance of painted turtles compared to PB and PBP lakes, but no difference in abundance compared to F lakes. In contrast, no differences were detected in Polk County. We hypothesize that these differences are due to 3X higher abundance of benthivores in Grant County lakes, suggesting a density-dependent effect of benthivores on amphibians. Additionally, our results show that influences of fish on amphibians may not be restricted to piscivores.

Zach Simmons

A LASER FREQUENCY DOUBLING APPLICATION IN ION TRAPPING

Faculty Collaborator: Dr. Norval Fortson, Dept. of Physics, University of Washington

A optical clock frequency is useful as a time measurement tool but also as an absolute frequency reference. The meta-stable $5D_{3/2}$ transition in Barium (t~83sec) has a very precise frequency as a result of time-energy uncertainty at 2.051 mm and so makes a very good clock. Other ions make good clocks too, and this is valuable because comparing super stable clock frequencies based on different atomic systems allows for the investigation of changes in fundamental constants with respect to time. This is new physics!, suggested by some theories and outside the standard model.

In order to precisely investigate the clock transition in the ion, however, you have to have a very narrow frequency laser. Any laser will have some amount of spread in its frequency as well as long-term drift. In order to stabilize the laser, it is locked via feedback to a transmission line of a Fabry-Perot cavity. A special, vertically mounted, ULE (ultra low expansion) cavity is used as the reference cavity. If the cavity does not change length, then the frequency of a transmission line will not change either. Unfortunately the cavity is designed for 1 mm light (high reflective coatings can be made better at 1 mm). However, this is accessible, provided we frequency double the 2mm laser to 1mm. This is accomplished using a nonlinear optical process and a resonant cavity. This poster documents setting up that doubling cavity to stabilize the laser.

Eric Skarman

MAPPING THE GEOLOGY OF THE BSQ, LAKE MEAD SOUTHERN NEVADA

Faculty Collaborator: Dr. Lisa Lamb

The Lake Mead area in southern Nevada is a very geologically complex area, and there have been many debates over the history of the area's geology. These debates mainly regard the nature and age of faulting in the area. Some geologists think that the area was formed by a series of unrelated faults, others think that it resulted from a system

of connected faults. The UST geology department believed that it was necessary to map the area in further detail in order to answer these questions about the tectonic history of this area. The area that we worked in is called the Bitter Spring Quadrangle (BSQ) and it is only a small part of the southern Nevada region. We chose this area as the geology is very well exposed and understanding the faulting in this area will help us better understand what shaped the entire southern Nevada area.

My work was merely part of a larger study. For the first three weeks I mapped along with five other students in the BSQ. We mapped directly onto either air photos or topo maps. A GPS device was used to find where we were on the map. When we returned to UST, I was in charge of creating a digital map from the data that was collected over the summer. To do this, I made use of a program that is called ArcGIS. Completing this map will allow us to start a structural analysis of the area. Once we have completed that, we will be able to address the debates about the area's geology.

Josh Speros

SYNTHESIS OF A CHEMILUMINESCENT POLYMERIZABLE COMPOUND

Faculty Collaborator: Dr. J.T. Ippoliti

Chemiluminescent compounds are showing an increased importance as a means of detection for biomolecules. A synthetic methodology for the development of the above luminol derivative was found. En route to the synthesis of this new polymerizable derivative a new method of synthesizing the required imide (2) from either the endo or exo isomer of cis-5-norbornene-2,3-dicarboxylic anhydride (1) was found. An efficient means of monobrominating N-methylphthalimide (4) was also discovered. Ultimately, the Buchwald-Hartwig coupling reaction (d) will be utilized in attempt to create this new luminescent compound.

Jeremy J Stubblefield

ENTRAINMENT PHOTOPERIOD MODULATES THE MOUSE CIRCADIAN SYSTEM AND ITS RESPONSIVENESS TO LIGHT

Faculty Collaborator: Dr. Dwight Nelson

Investigations into the mammalian circadian systems have revealed the presence of "clock" gene-protein oscillations that drive rhythms of approximately 24h in both behavior and physiology. These oscillating mechanisms are located in the brain and synchronized or entrained to the environment by light:dark (LD) cycles. Environmental light entrains the circadian system by inducing phase shifts in the circadian oscillator. Our lab has shown that the responsiveness of the mouse circadian system to light (measured using light induced phase shifts) is altered by entrainment to different photoperiods (durations of light and dark). When plotted as a function of the time of day, these phase shifts produce a phase response curve (PRC). In this experiment we tested whether and how different photoperiods may induce changes in the mouse PRC. To test this hypothesis we entrained mice to either LD 16:8 or 8:16 for 4 weeks. Following entrainment, the mice were released into complete darkness (DD) and allowed to freerun for 1wk. On cycle 7 of DD each group of mice (n=12/group) was given a 1h light pulse at a specific phase of the circadian cycle. After 2 additional weeks we assessed the phase reset that each mouse displayed in response to the single light pulse. Mouse behavior was monitored via wheel-running activity throughout the experiment and changes in time of steady-state activity onset were used to quantify phase shift magnitude. We found that LD entrainment to different photoperiods did indeed induce changes in PRC shape, resulting in phase shifts with significantly different magnitudes. The responsiveness of the mouse circadian system is significantly altered by prior entrainment photoperiod. Since this mouse strain does not respond in other ways to short or long photoperiods (e.g. reproduction), the changes are probably do to a more direct effect of daily light duration on the mouse circadian system.

Amanda Thompson and Ross Weinzierl

REVIEW OF MPE AND MATH 101 PREPARATION

Faculty Collaborator: Brenda Tiefenbruck

UST students have a core curriculum requirement of at least one math course. The course of choice for many non-prepared students is MATH 101. This course is offered in no less 25 sections each year thus impacting approximately 700 UST students per year. Preparation for the course is often gauged by results of the Mathematics Placement Exam. Results from the Summer 2005 Freshman Orientation & Registration Mathematics Placement Exams were examined and analyzed for frequency of errors in concepts. Review materials to fill in these specific conceptual gaps were prepared during summer 2006. These researchers created and assembled review materials on the MATH 101 REVIEW UST Community site for use by students and teachers. As students navigate through the MATH 101 semester the review materials can be accessed to assist in reviewing and more adequately preparing for class and success.

Patrick G. Tsai and Randy C. Anderson

STARCH GEL ELECTROPHORESIS AS A TOOL FOR STUDYING GENETIC DIVERSITY AND MATING SYSTEMS IN WILD PLANT POPULATIONS

Faculty collaborator: Dr. Simon K. Emms

Starch gel electrophoresis is a powerful tool for revealing genetic variation within and among individuals in a population. Essentially the technique involves staining metabolically active enzymes after they have been separated in an electrical field in a gel matrix on the basis of size, shape, and charge. Here we describe how the technique works, what it shows about population genetic variation, and how measurement of this variation can be used to understand mating systems and the potential threats to populations caused by habitat fragmentation. We also present some preliminary data showing the application of this technique to our ongoing studies of Prairie Larkspur *Delphinium virescens,* a hermaphroditic angiosperm in the buttercup family (Ranunculaceae) native to savanna and prairie habitats in the Upper Midwest. Using purchased plants to provide us with ready access to leaf material, we have successfully resolved staining patterns for eight different enzymes and shown that genetic variation exists in at least three of them. Investigation of genetic variation in our wild study populations at McKnight Prairie, St. Croix Savanna, and Cedar Creek Natural History Area will begin in 2007.

Matthew Turner

IN SITU SELF-ASSEMBLY OF A G-DNA MOLECULAR SCAFFOLD ON MICA USING A POLYMERIC TEMPLATE

Faculty Collaborator: Dr. Thomas C. Marsh

Research on the structure and function of guanine rich nucleic acids has shown that multiple guanine repeats in a sequence enable these biopolymers to adopt a quadruple helical structure generally known as G-DNA. In the work described here, the DNA oligomer GGGGTTGGGG ($Tet_{1.5}$) is used to create a self-assembling linear supramolecular structure termed a G-wire. The ability to grow G-wires on a substrate could be employed to make connections between nanoscale devices.

Currently, the polymer poly-5-norbornene-2-carboxylic acid (D.P. 4000) with the amine-linked oligonucleotide GGGGTTGGGG at a frequency of 1 oligonucleotide to 10 carboxylic acid groups has been synthesized to serve as a

rigid backbone for the self-assembly of G-wires. Atomic Force Microscopy is used to characterize polymer-templated self-assembly of G-wires on a mica substrate.

Tyler N. Winkelman

POLYLACTIC ACID/POLYSERINE BIODEGRADABLE COPOLYMERS FOR DRUG DELIVERY

Faculty Collaborator: Dr, J. Thomas Ippoliti

Polymers that break down into natural molecules the body can easily process are actively being investigated for their use in biomedical applications. We are interested in synthesizing a copolymer of polylactic acid and polyserine, which breaks down into natural occurring byproducts, lactic acid and serine. While the properties of polylactic acid polymers are well known, the addition of polyserine provides a novel mechanism for functionalizing the biodegradable polymer. An organic catalyst has been synthesized in four steps to catalyze the ring opening copolymerization of protected the serine lactone and lactide. Serine has been successfully coupled with benzylchloroformate to protect the amine in good yields and the serine monomer has been cyclized but in yields less than 5%.

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