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# Summer 2006 Research Symposium Abstract Book

Trinity College

# SECOND ANNUAL
# SUMMER RESEARCH SYMPOSIUM
# TRINITY COLLEGE

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**1.**

**CYP4X1 INSERTION INTO THE p-GEX VECTOR**

Shahzad Ahmed 08
Faculty Sponsor: Hebe Guardiola-Diaz

The purpose of this study was to insert a CYP4X1 template into the p-GEX vector as part of a larger study to determine CYP4X1's function. In order to accomplish this, a 4X1 expression template was obtained from PCR amplification of the 4X1 gene. This template was then inserted into the TOPO vector and transformed into E. coli from which the vector was amplified. The transformation was inconsistent. Colonies were grown in the presence of a selective antibody (Karamycin) and restriction digests were used to find a correctly transformed colony. This colony was then amplified in a large scale 50 mL culture, digested with NCO1 and NOT1, and the 4X1 template was extracted using a gel extraction kit. 3 ng of 4X1 template DNA were then attempted to be transformed into the p-GEX vector. The 4X1 protein template was successfully inserted into the TOPO vector which produced large amounts of pure 4X1 template DNA. However, insertion of the 4X1 template into the p-GEX vector was unsuccessful. In the future, I hope to successfully insert the 4X1 template into the p-GEX vector.

**2.**

**DETERMINING THE POTENTIAL EFFECTS OF THE AZOLE ANTIFUNGAL DRUG ECONAZOLE ON *MYCOBACTERIUM TUBERCULOSIS***

Lydia Ansen-Wilson 07
Faculty Sponsor: Lisa-Anne Foster

Tuberculosis (TB) is becoming an increasing international health concern as coinfection with HIV continues to rise. The World Health Organization recently estimated that as many as one-third of all AIDS deaths can be attributed to TB. One of the main difficulties in attempting to eradicate TB is the increase in the occurrence of multi-drug resistant strains of *Mycobacterium tuberculosis*, the causative agent of TB. As the overall efficacy of traditional antibiotics declines due to resistance, it becomes vital to search for alternative pharmaceutical therapies. Previous research has shown that the azole antifungal econazole not only successfully inhibits growth of various mycobacterial species but also binds tightly to the tuberculin protein MT CYP51, a cytochrome P450. Recently, however, statistically significant synergy has been observed between 5-25uM econazole and 0.025ug/ml isoniazid, one of the traditional antibiotics used to treat TB, when early log phase cultures of *Mycobacterium bovis* were inoculated with both drugs. It has also been shown that econazole alone most effectively inhibits growth of stationary phase mycobacteria. Thus, azole antifungal drugs likely have the potential to be used to treat both active and latent TB infections. The next step in our work will be to determine whether or not azoles are likely to be effective *in vivo.* Since *M. tuberculosis* is known to have the ability to survive inside macrophages during infection, a protocol for harvesting and infecting mouse macrophages was designed. Macrophages were harvested through peritoneal lavage four to five days after injection of thioglycollate into the peritoneal cavity. Macrophages were then cultured and treated with both econazole and isoniazid to make sure these drugs would not have adverse

effects on the cells. Preliminary results indicate that concentrations of 10-20uM econazole affect the health and viability of the macrophages, though further studies will be necessary to confirm this finding.

**3.**

**THE EFFECT OF LOW FREQUENCY ELECTRICAL STIMULI ON THE PRODUCTION OF ELECTRO COMMUNICATION IN THE WEAKLY ELECTRIC FISH, *APTERONOTUS LEPTORHYNCHUS***

Brett DiBenedictis 07
Faculty Sponsor: Kent Dunlap

The weakly electric fish, *Apteronotus leptorhynchus*, uses a communication modality shared by few animals, and is limited to an aquatic setting (due to the exploitation of a water medium). A. leptorhynchus produces and detects electric fields from the surrounding medium. The animal's reception of electric fields is accomplished by two parallel electrosensory systems, the ampullary system and the tuberous system. The phylogenetically older ampullary system detects low frequencies that are emitted by all animals (eg. heartbeat). Thus they can use the ampullary system to locate other fish. The tuberous system detects high frequency signals that are produced by conspecifics. When communicating, these fish produce brief modulations in their normal frequency, known as "chirps."

Previously, researchers have believed that ampullary receptors do not play an important role in electro communication. I tested this theory by presenting fish with low frequency stimuli and subsequently measured their production of chirps. I first stimulated a fish with a low frequency (30 Hz) and 3-5 minutes later stimulated it again with a high frequency (900-1000 Hz), known to elicit chirping. The low frequency stimuli would activate the ampullary system and the high frequency stimuli would activate the tuberous system. In all cases, fish that were first stimulated with the low frequency chirped significantly more than the controls when later introduced to a high frequency. Controls were stimulated only once with a high frequency. This data suggests that the neural circuitry involved in these two electrosensory systems is intertwined.

**4.**

**GLANDULAR HAIR SECRETIONS OF THREE DISTANTLY RELATED INSECTS: THEIR CHEMICAL COMPOSITION AND ECOLOGICAL ROLE**

Laura E. Eckman 09
Faculty Sponsors: Scott R. Smedley, Thomas Mitzel, Frank C. Schroeder (Cornell University, Department of Chemistry and Chemical Biology)

Glandular hairs, cuticular structures with droplets at the tip, are present in certain insects. Analyses of several of these secretions from butterfly caterpillars and ladybird beetle pupae have led to the discovery of novel chemicals that deter predators. Three distantly related insects for which glandular secretions are poorly understood are larvae and pupae of a ladybird beetle (*Delphastus* sp., Order Coleoptera), caterpillars of the Checkered White butterfly (*Pontia protodice*, Order Lepidoptera), and nymphs of the Hawthorne lace bug (*Corythucha cydoniae*,

Order Heteroptera). Neither the chemical makeup nor the ecological function of the droplets is known for *Delphastus* sp. and *P. protodice*, and the ecological function is not known for *C. cydoniae*, although a previous study resulted in a partial characterization of the chemical composition of this latter species' secretion. For all three species, to determine the chemistry of their droplets, I have collected full body samples of their relevant life stages. The secretions will be analyzed using NMR and other techniques. To determine the ecological role of the droplets, I have planned a series of bioassays with the predatory ant *Crematogaster lineolata*. I have now determined that contact with the lacebug nymphs results in increased cleaning by the ants, but I must perform further bioassays to establish whether this response is caused by the secretion itself. Determination of the chemical make-up and ecological role of the secretions of these three distantly related insects will further our understanding of predatory-prey relationships and insect evolution.

**5.**

**PLACENTAL ANATOMY OF THE SPINY LIZARD *SCELOPORUS JARROVI***

Greg Gavelis 08
Faculty sponsor: Daniel Blackburn

Although most lizards lay eggs, about 20% of the species give birth to their young. Among them is the spiny lizard *Sceloporus jarrovi* from southwestern North America. These lizards are able to retain their eggs full term, a feature made possible by placentas that provide oxygen and water to the embryos during development. We used light microscopy to examine resin-embedded sections of placental membranes to discern the structural basis for placental function. Although placentas of this species have been described as simple by earlier studies, our examination reveals some of the most unusual placental features to be found among reptiles. Specializations include direct contact between fetal and maternal tissues, novel modifications of the yolk sac that persist until birth, and pronounced epithelial outgrowths on both the fetal and maternal faces of the placenta. The striking placental specializations found in *S. jarrovi* suggest that even well-studied species can exhibit dramatic and unexpected specializations, as revealed by microscopy.

**6.**

**CHARACTERIZING THE INVERTEBRATE COMPONENT OF THE DIET OF FLORIDA'S CRESTED CARACARAS**

Isabel Gottlieb 09, Kyle Pias 07
Faculty Sponsor: Joan Morrison

The Crested Caracara (*Caracara cheriway*) is a medium sized raptor that occurs on the grasslands of Mexico and the southern United States ranging from southern Arizona to an isolated population in south-central Florida. What is known about the caracara's diet is largely descriptive (Morrison, 1996) and they are often described as opportunistic carrion eaters (Bent 1938). Recent studies have shown their diet to be much more diverse and consist of much more live prey than previously thought (Morrison and Pias, 2006). We investigated the difference in invertebrate component of the caracara's diet between three groups; 1) breeding birds during the breeding season, 2) non-breeding birds during the breeding season, and 3) non-breeding birds

during the non-breeding season. We analyzed invertebrates found in 141 pellets representing 30 different breeding pairs during the breeding seasons from 1993 to 1997 and 200 pellets collected in 2000 from a communal roost of non-breeding caracaras. Breeding birds consumed members of 22 families and 44 genera and non-breeding birds consumed members of 34 families and 73 genera. The diet of non-breeders was more diverse than the diet of breeders during the breeding season, but diet diversity dropped drastically in the non-breeding season. Most invertebrates found were associated with carrion, dung, or pasture habitat. The high diversity of invertebrates in the non-breeders' diet during the breeding season compared to that of breeding pairs suggests that breeding birds protect the best foraging habitat during the breeding season and may exclude non-breeding birds from the most valuable food sources. The drop in the diversity of the non-breeders during the non-breeding season may be a result of a change in the availability of invertebrates.

**7.**

**MOLECULAR CLONING OF CYTOCHROME P450 cDNAs FROM *MYCOBACTERIUM TUBERCULOSIS***

Olga Corazón Irizarry 09
Faculty Sponsor: Hebe Guardiola-Diaz

Drug-resistant strains of *Mycobacterium tuberculosis* (*M. tuberculosis*), the causative agent of tuberculosis (Tb), have quickly developed, and the infections they cause are increasingly difficult to treat. It is imperative that research continues to find new targets to produce new drug therapies. One of several of 20 cytochrome P450s (CYPs) in *M. tuberculosis* may prove to be a target for treatment of tuberculosis infections. In order to characterize the *M. tuberculosis* CYP complement, I have generated expression constructs for CYP 121, CYP 126, CYP 128 and CYP 140. We are now in a position to study the biochemical properties of these proteins to determine their role in *M. tuberculosis*.

**8.**

**DEVELOPMENT OF THE EMBRYONIC MEMBRANES OF THE CORN SNAKE, *PANTHEROPHIS GUTTATUS***

Siobhan Knight 07
Faculty Sponsor: Daniel Blackburn

I am using Trinity's breeding colony of corn snakes, *Pantherophis guttatus,* to provide basic information about reptile development and egg physiology. During the summer I learned and applied the techniques for scanning electron microscopy (SEM) in order to examine fetal membrane development. I am studying the chorion, allantois and the omphalopleure, as well as looking at the disappearance of the isolated yolk mass. I periodically harvested embryos, removed their membranes, processed them and examined them using SEM. This technique has revealed details of cellular composition of the membranes and given an anatomical basis for physiological exchange between the embryos and the environment.

**9.**

**EFFECT OF GENDER IN SOCIALLY INDUCED CHANGES IN ELECTROCOMMUNICATION AND BRAIN CELL PROLIFERATION IN ELECTRIC FISH**

Elizabeth McCarthy 07
Faculty Sponsor: Kent Dunlap

Previous studies have shown that male-male pairing of electric fish, *Apternotus leptorhynchus*, increases production of aggressive electrocommunicaion signals termed chirps and cell proliferation in the brain. This set of experiments examined the effect of gender on chirp rate and cell proliferation. First male fish were exposed to a simulated male signal and their chirp rates were recorded. Fish were then paired with another male or a female fish for one week, injected with BrdU (a marker of cell proliferation), and then exposed to a simulated male signal again. There was no significant difference between the change in chirp rate after social stimulation compared to before for the two types of pairs ($p = 0.11$). The data was highly suggestive however that the gender of the partner in social stimulation does not influence the degree of socially induced potentiation of chirping to a simulated male signal. No evidence was found for increases in brain cell proliferation stimulated by females. Further study will need to be done to determine the exact relationship between changes in chirping behavior and gender pairing in social stimulation.

**10.**

**THE OPTIMIZATION OF RNA ISOLATION FROM *MYCOBACTERIUM BOVIS* TO DETERMINE THE EXPRESSION OF CYP450 IN LATENT MYCOBACTERIUM TREATED WITH AZOLS**

Sarah Sweatt 07
Faculty Sponsor: Hebe Guardiola-Diaz

Eukaryotic cytochrome P450s (CYPs) are essential in multiple metabolic pathways. Most prokaryotes have no CYPs; however twenty have been identified in *Mycobacterium tuberculosis*, the causative agent of Tuberculosis. The exact functions of CYPs in Mycobacterium tuberculosis are unknown. Stemming from their role in the production of cholesterol, steroids, and other lipids in Prokaryotes, it is thought that the CYPs of Mycobacterium tuberculosis are a novel drug target for treating patients with tuberculosis. The aim of this study was to determine and compare the expression of cyp genes by northern blot analysis. *Mycobacterium bovis* are forced into a latent stage (caused by starvation) and treated with various azols (antifungals shown to bind cyp51) in order to determine the effects of azols on the transcription of cyps in latent mycobacterium. The intricate cell wall structure of the Mycobacterium bovis has proven to be a formidable obstacle in optimizing RNA isolation from Mycobacterium bovis.

**11.**

**THE EFFECTS OF AZOLE ANTI-FUNGALS ON *M. BOVIS* AND *M. SMEGMATIS***

Robert Toscano 07
Faculty Sponsor: Lisa-Anne Foster

Over the past few decades, the number of infections caused by *Mycobacterium tuberculosis* has risen significantly as a result of a deadly combination of mutationally derived drug resistance as well as social and environmental conditions that harbor rapid transmission of the pathogen. For these reasons, there is an increased urgency for the determination of a more efficient mode of targeting the bacteria's virulence. In this study, we attempted to inhibit the function of a cytochrome P450 in *M. bovis* as well as *M. smegmatis,* which has high similarity to that of the CYP51 isoenzyme in M. *tuberculosis.* By targeting this component of the pathogen's genome, we attempted to reduce the sterol levels and consequently inhibit the cells from forming a functional cell membrane. This process involves the ligating a hygromycine- marked allelic exchange substrate, AES, into a shuttle plasmid in order to create a transduced antibiotic resistant bacterial strain. The research was taken a step further by testing the effectiveness of varying concentrations and combinations of an azole anti-fungal, fluconazole, and isoniazid for their ability to bind to CYP51 and subsequently inhibit growth of *M. bovis.* We have found that fluconazole and isoniazid can dramatically inhibit cell growth in culture, leading us to believe that the right concentrations of the two azoles can successfully target the CYP51 isoenzyme and in doing so may act as an effective mode of treatment.

**12.**

**EFFECTS OF THE DELETION OF A HYDROPHOBIC REGION IN SERRATE ON NOTCH ACTIVATION IN DROSOPHILA**

Rumen Vasilev 09, Rachel Reece 09
Faculty Sponsor: Robert Fleming

The Notch signaling pathway is an evolutionarily conserved cell-to-cell communication system that is involved in the differentiation of tissues in a variety of organisms. In Drosophila, the Serrate molecule, a ligand for the Notch system, has been found to regulate Notch activity. Previous work suggested that a deletion of a hydrophobic region and a part of the 5th and 6th EGF-like repeats in the Serrate molecule alters the way Serrate regulates Notch. Serrate can either activate Notch on adjacent cells or inhibit Notch, when both are expressed on the same cells. However, the mutant form no longer inhibits Notch on the same cells. In order to confirm the effects of the deletion of the hydrophobic region, recombinant DNA technology is being used to create a modified Serrate molecule, in which only the entire 6th EGF-like repeat, where the hydrophobic region is located, is removed. In addition, the creation of another construct is underway in which only the hydrophobic region of the Serrate molecule is removed, leaving the 6th EGF–like repeat intact. Since the creation of these constructs is still underway, we expect the results soon. By discovering more about how the Notch signaling pathway works in segregating every tissue type, drugs and treatments can be targeted for diseases caused by defects in Notch signaling.

# CHEMISTRY

**13.**
**COUPLING THE TRIPEPTIDE BOC-LYS(CBZ)-ALA-LYS(CBZ)-NHCH3 TO FERROCENE AND TUNGSTEN**
Neena Chakrabarti 09
Faculty Sponsor: Timothy Curran

The coupling of transition metals with peptides can result in the formation of secondary structures. The ability to predict the formation of these secondary structures and define the shapes of the peptides may aid in the creation of proteins which might bind to DNA and fight terminal illnesses, such as cancer. The goal of my research is to successfully couple ferrocene and tungsten to a tripeptide and analyze the resulting structure of the peptide. For this secondary structure analysis, a lysine derivative Boc-Lys(Cbz)-OSu was used as the starting material. A series of reactions were run in which the amino acid derivatives Boc-Ala-OSu and Boc-Lys(Cbz)-OSu were used to create the tripeptide Boc-Lys(Cbz)-Ala-Lys(Cbz)NHCH3. The most recent reactions involved the coupling of 0.4 g of the tripeptide to ferrocene dichloride and replacing the Cbz groups with alkyne groups on another 0.4 g sample. Although it is predicted that the coupling of this tripeptide with tungsten will result in a gamma turn, this part of the procedure has not been analyzed yet. Future work will be directed toward analyzing the secondary structures of the tripeptide when coupled with ferrocene dichloride and tungsten.

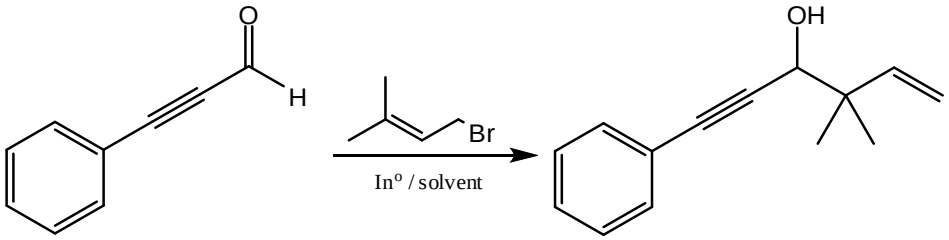
**14.**
**SYNTHESIS AND ANALYSIS OF CA2RUD6 AND EFFECT ON THERMAL DECOMPOSITION BY DOPING WITH TICL3**
Adrian Estepa 07
Faculty Sponsor: Ralph Moyer

Ca2RuD6 was synthesized via a 3 step process of distillation of Ca(s), addition of deuterium using D2(g), and finally addition of Ru(s). Purity of the synthesized compound was analyzed by X-ray diffraction and thermal decomposition was performed under vacuum conditions. X-ray analysis was performed on the decomposed products. TiCl3 was added to the original Ca2RuD6 and a thermal decomposition was performed on the mixture in addition to an X-ray diffraction analysis of the final decomposed products.

**15.**
**INDIUM-PROMOTED COUPLING OF 3-PHENYLPROPIOLALDEHYDE WITH 4-BROMO-2-METHYLBUT-2-ENE**
Kwame Frimpong 08
Faculty Sponsor: Thomas Mitzel

Knowledge of flow of electrons during synthetic reactions is crucial in chemistry as it helps construct models that predict product formation. This study involved indium-promoted coupling of 3-phenylpropiolaldehyde with 4-bromo-2-methylbut-2-ene using a variety of solvents and

reaction conditions. In addition, the kinetics (rates) of the reaction is being studied to determine when the reaction goes to completion. The general reaction is shown below:




This poster will describe the methods used, products obtained and the electronic models derived from the data collected.

**16.**

**SYNTHESIS OF A HELICAL METALLACYCLIC PEPTIDE**

Emmy Handy 08
Faculty Sponsor: Timothy Curran

A metal-ligand interaction can be used to tie two ends of a peptide chain together, yielding a metallacyclic peptide. In this case, a 1,1'-ferrocenedicarboxylic acid link was used to cyclize a tetrapeptide by connecting the first and fourth lysine amino acids via amide bonds. Prior to cyclization, the tetrapeptide was synthesized using solution phase peptide synthesis. $^{1}$HNMR experiments suggest the structure of this metallacylclic peptide to be a $3_{10}$ helix based on the coupling constants for the amide NH protons.

**17.**

**INVESTIGATION OF THE POST-MORTEM DEGRADATION OF COCAINE, METHAMPHETAMINE, MORPHINE, AND PHENCYCLIDINE BY PUTREFACTIVE BACTERIA**

Katharine Harte 08
Faculty Sponsors: Janet Morrison, Robert Powers, PhD (CT State department of Public Safety)

The metabolites of drugs of abuse have mostly been established under pre-mortem conditions, but little is known about the fate of these drugs under post-mortem conditions. Facultative bacteria present in the body during the putrefactive stage of decomposition are known to degrade a variety of organic species. This project hypothesizes that these facultative bacteria metabolize drugs of abuse into as-of-yet unidentified products, which if found would drastically change the current methods of post-mortem toxicology screening. Phase I of this project focused on the development and optimization of liquid-liquid extraction (LLE) methods for the isolation of cocaine, methamphetamine, morphine, and phencyclidine from thiogylcollate growth medium. Following their isolation from the liquid growth medium, the target analytes were derivatized with MSTFA +1% TMS and analyzed by gas chromatography-mass spectrometry (GC/MS) to evaluate sensitivity and recovery.. The LLE/derivatization method used produced inconsistent results among the four analytes tested. Solid phase extraction (SPE), a modified version of the LLE procedure, and alternate derivatization chemistry are currently being explored to improve method sensitivity and reproducibility.

**18.**

**TEMPERATURE AND SOLVENT EFFECTS UPON THE REGIOCHEMISTRY AND RATE OF AN INDIUM PROMOTED COUPLING REACTION**

Kristin Kremer 07
Faculty Sponsor: Thomas Mitzel

The stereoselectivity and reaction pathway of the indium promoted coupling reaction involving crotyl bromide and propargyl aldehyde were studied using different temperatures and solvents. The reaction yielded a high amount of the diastereomer product. Based upon the solvent and temperature conditions used, the reaction may have proceeded as a 1,2 or a 1,4 Michael Addition. Water and NMF were the solvents used. At room temperature the reaction rate in both solvents was the same, but when run at 0° in NMF, the rate of the reaction increased. Data acquired from the GC-MS was used to follow the progress of the reaction.

**19.**

**DEFINED CONFORMATION IN A DIPEPTIDE INDUCED BY CROSS-LINKING TWO LYSINES WITH 1,1'-FERROCENEDIACID CHLORIDE**

Andrew Rosenau 07
Faculty Sponsor: Timothy Curran

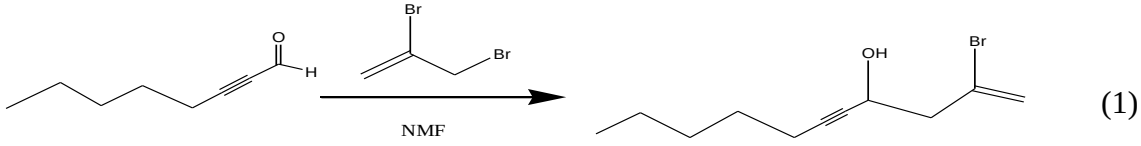
Conformational changes of peptide chains are a growing interest in synthetic chemistry. Being able to predict and/or manipulate different peptide chains has many beneficial applications in drug design and disease treatment. Two lysine derivatives were reacted to form a dilysine, this dipeptide was then reacted with 1,1’-ferrocenediacid chloride to form a metallacyclicpeptide. The cyclic ferrocenyl dipeptide was purified using flash chromatography and identified using ES-MS, $^{1}$HNMR, HPLC, and melting point analysis. The overall yield of the synthesis was low (24%) due to the last step in the synthesis; 1,1’-ferrocenediacid chloride is a very reactive compound and many side reactions occur in which 1,1’-ferrocenediacid chloride will react with more than one dilysine residue. Using DMSO titration a hydrogen bond was found to occur between the ferrocene carbonyl and the amide proton linking the two lysines causing a slight bend in the dipeptide chain. Further studies are being carried out to find out what effects changing the starting peptides will have on the conformational changes and whether there are conditions under which the hydrogen bond can be broken.

**20.**

**THE SYNTHESIS OF 3-(2-BROMOALLYL)OCT-2-ENAL VIA INDIUM COUPLING REACTION AND COPE REARRANGEMENT.**

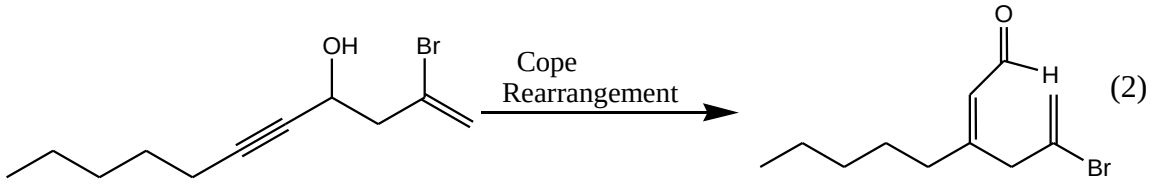
Laert Rusha 08
Faculty Sponsor: Thomas Mitzel

The goal of this project was to synthesize organic compounds that would serve as templates for antitumor drugs. We set out to create 3-(2-bromoallyl)oct-2-enal. In a 25 mL round-bottom flask we mixed 1 mmol oct-2-ynal with 1.5 mmol 2,3- dribromopropene and 1.1 mmol of indium powder in NMF solvent (as seen in reaction scheme 1) and stir vigorously with a stir bar. The reaction was monitored with TLC plates every hour to see when new products formed.




Oct-2-ynal 2-bromoundec-1-en-5-yn-4-ol (1)

We hypothesized that the indium would first react with the 2,3-dibromopropene, inserting itself in the molecule and forming a 3 ligand complex. The indium complex would then react with the carbonyl group of the oct-2-ynal via a conjugate addition. The intermediate molecule would then be protonated resulting in 2-bromoundec-1-en-5-yn-4-ol (1). We were hoping that the resulting alcohol would go one step further via a cope rearrangement to form the desired product, 3-(2-bromoallyl)oct-2-enal.




2-bromoundec-1-en-5-yn-4-ol (*Z*)-3-(2-bromoallyl)oct-2-enal (2)

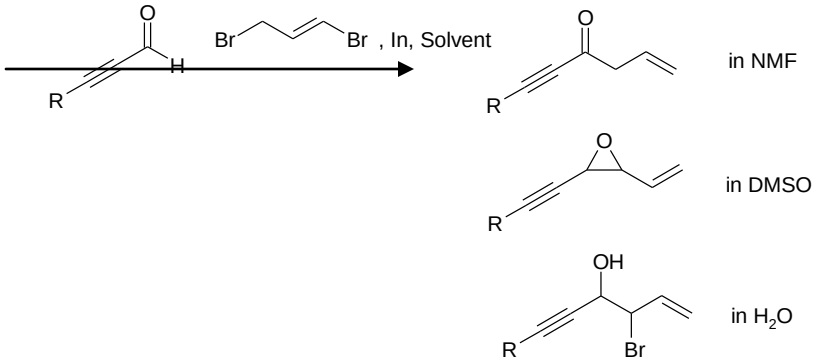
We were not able to get the alcohol product or the desired molecule to form. Reaction 1 was run under different conditions to see if perhaps it was something about the conditions that were impeding it. The reaction was run in NMF and water solvent. It was also run at room temperature for 6 hours, 12 hours, 18 hours, 24 hours, 80 hours but still with no success. The products that formed were a mixture of starting material and other unknowns. From the abundance on the GC graph, it was clear that the starting material, the 2,3-dibromopropene and the oct-2-ynal, were by far the most prevalent. Other products that formed we were not able to identify because their concentrations were too small.

**21.**

**CONTROL OF PRODUCT FORMATION IN INDIUM PROMOTED COUPLINGS USING DIFFERENT SOLVENTS**

Timothy Scarella 08
Faculty Sponsor: Thomas Mitzel

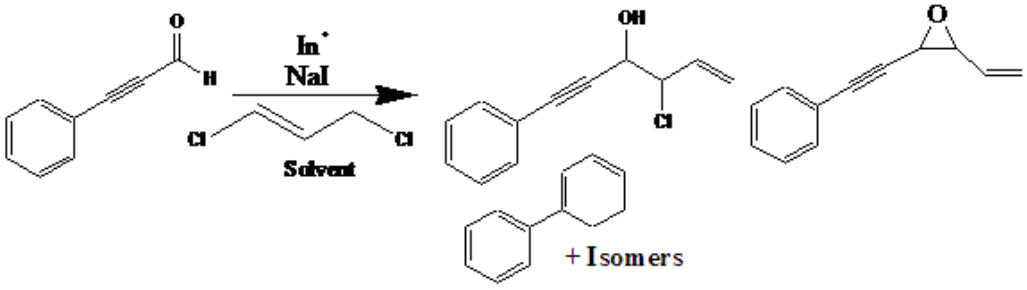
The control of product formation is of great importance in organic synthesis. This poster will detail the efforts made towards controlling product formation in indium-promoted couplings, primarily using changes in solvent.




**22.**

**CASCADE REACTIONS USING BARBIER COUPLING CONDITIONS**

Rebecca Suflas 08
Faculty Sponsor: Thomas Mitzel




The stereoselectivity of indium promoted coupling reactions involving 1,3-dichloropropene and 3-phenylpropionaldehyde was studied. The reaction was carried out using several different solvents and was run under different conditions to determine how these changes would affect the product of the reaction. Each of the conditions yielded slightly different products and concentration of those products. Solvents used in this reaction were DMSO, NMF, THF, $H_2O$, and a 1:1 solution of DMSO/$H_2O$. Sonication was also used to speed up reaction rates and determine if additional products would form. When sonicated, Barbier conditions were used and a bicyclic structure was then obtained.

**23.**
**COMPARISON OF SYMMETRIC AND ASYMMETRIC TUNGSTEN MONO-ALKYNYLAMINO ACID COMPLEXES**
Whitney Smith 07, Peter Hendrickson 09
Faculty Sponsor: Timothy Curran

Previous research done in our lab has proven that alkynylpeptides react with the tungsten complex (W(CO)3(dmtc)2, dmtc= dimethylthiocarbamate). The product of this reaction is a tungsten bis-alkynylpeptide complex. This summer the corresponding mono-alkynylamino acid complexes were prepared using both symmetrical and asymmetrical alkynylamino acids. It was found that the NMR spectra of the asymmetric alkynylamino acids and the symmetric alkynylamino acids were nearly identical. The results and implications of this work will be presented.

# COMPUTER SCIENCE

**24.**
**CONNJUR: TOWARDS A FREE OPEN SOURCE SOFTWARE APPLICATION TO SUPPORT THE BIOMOLECULAR ANALYSIS USING NMR SPECTROSCOPY**
Brian Sinnott 07
Faculty Sponsor: Heidi Ellis

Currently, experiments to determine the structure of macromolecules using Nuclear Magnetic Resonance (NMR) involve the use of a spectrometer that produces raw spectral data and a series of software tools to analyze the data. These software tools operate on different platforms and use a variety of different input and output file formats, creating a complex experiment environment and resulting in the potential for lost data. The CONNecticut Joint University Research (CONNJUR) group has created a software application capable of combining a variety of tools that can be used transparently during the determination of the structure of a molecule using NMR spectroscopy. The CONNJUR software is supported by a MySQL database which stores experimental data, including a history of the steps taken in an experiment. The research undertaken during the summer encompassed three areas. The group intends to make the CONNJUR software free/open source. Therefore, the first research effort was to investigate the available licenses and to determine the optimal license for the CONNJUR software. Open software would allow all members of the NMR community to provide valuable input to CONNJUR's code. The CONNJUR code was commented and a user manual started to support understanding by contributors to CONNJUR as part of this effort. The second venue of research was determining the optimal way to allow data to be displayed within a graphical user interface. A program was developed that would take a group of objects, retrieve the data in the objects and display the data in a table, regardless of the type of the objects. Lastly, the usability of CONNJUR's interface was addressed adding by scroll bars, tooltips, and help buttons.

# EDUCATIONAL STUDIES

**25.**
**A POLITICAL HISTORY OF SCHOOL FINANCE REFORM IN THE METROPOLITAN HARTFORD REGION, 1945-2005**
Elisabeth Pennington 07
Faculty Sponsor: Jack Dougherty

Over the past 50 years, states have been fighting continuous battles over local property taxes and school finance equity. Since the 1970s, the state school funding systems of 19 states have been declared unconstitutional causing them to reassess school finance legislation. We lack a clear understanding of how the politics of school finance have evolved since the post-WWII era, especially the struggle between cities and suburbs. This historical analysis focuses on Connecticut and explores the question: how did legislators act on school finance bills and what factors influenced them from 1945 to the present? Both qualitative and quantitative data have been compiled from 1945 to the present including Connecticut General Assembly education committee hearings, economic regression analysis of legislative roll call votes, and longitudinal school funding data. Findings reveal that while funding education through property taxes has been continually contested since 1945, how funds are allocated has changed throughout time. State funding to subsidize local education in the years preceding World War II focused on the needs of rural school districts to upgrade their education systems but after the 1965 legislative reapportionment and the 1975 Horton v Meskill judicial intervention, urban districts such as Hartford received considerably more funds.

**26.**
**A VISUAL GUIDE TO SHEFF VS. O'NEILL SCHOOL DESEGREGATION**
Jesse Wanzer 08
Faculty Sponsors: Jack Dougherty, David Tatem

How much has the racial composition of schools changed during the past decade of school desegregation in metropolitan Hartford? In 1989, Elizabeth Horton Sheff and other parents filed a lawsuit on behalf of their children against then-Governor William O'Neill in 1989, claiming that Connecticut's school system of separate city and suburban school districts led to racially segregated schools. In 1996 the state Supreme Court ruled in favor of the Sheff plaintiffs, but did not specify a goal, solution, or timetable. By June 2007, the settlement calls for at least 30 percent of the public school minority students residing in Hartford to be educated in racially desegregated schools, primarily through interdistrict magnets and "Open Choice" city-suburban transfers.

Our study investigated whether this voluntary desegregation plan is likely to meet the 30 percent goal by next year. To measure the progress toward this goal, we obtained raw student enrollment data from the Connecticut Department of Education and calculated the percentage of Hartford minority students who were enrolled in magnet schools and suburban districts that met the Sheff settlement standards. Our most significant finding was most Hartford students in magnet schools in 2005-06 were ineligible to be counted under Sheff because the proportion of minority students

exceeded that standard defined in the settlement (currently 73%), or because they were in grades that had not yet been phased in to the new magnet school. Five of the twenty-two magnet schools did not meet the requirement this past year, and more will be in jeopardy when the grace period ends at the beginning of the school's third year of operation. Presently, we stand less than halfway (14%) toward meeting the 30% Sheff settlement goal by June 2007, and it appears that progress will remain stagnant.

# ENGINEERING

**27.**
**TRACKING THE MOVING BOUNDARY OF STREAMED IMAGES USING LEVEL SETS**
Susmita Bhandari 07
Faculty Sponsor: Taikang Ning

Level set method is a numerical technique that can track evolving interfaces by means of solving a variety of partial differential equations. It has been implemented in many applications in image processing, computer graphics, robotics, computational geometry and mathematics among others. Its use in image processing for segmentation and tracking has been an active area of research in recent years. However, the execution of level set algorithms has been found to be computation intensive and time consuming. In this research, we consider using this method in image processing to implement a system that can track evolving boundaries of a target object. The system will have a pipelined and parallel structure implemented on a Field Programmable Gate Array (FPGA) with which we hope to significantly reduce the execution time. The approach to this problem is through a hardware/software co-design involving both algorithm development and hardware implementation. We are currently in the process of creating a complete model of the algorithm in Mathwork's Simulink environment. Future work will entail implementing the model into FPGA environment and setting up an image data streaming system using a progressive scan camera.

**28.**
**STUDY OF NEURON MODELS USING THE GENERAL NEURAL SIMULATION SYSTEM**
Mahmudul Chowdhury 08, Adam Fine 08
Faculty Sponsor: Harry Blaise

Neurons can be represented as electric circuits consisting of resistors and capacitors(RC). Neural networks were simplified as a compartmental model in order to study the electronic representations of neurons. Each compartment is an RC circuit. The action potential of various compartments was examined when the soma of the neuron was injected with a current. The General Neural Simulation System(GENESIS) was used in order to inject current to simulate the neuron. A systematic procedure was used in order to proceed through the simulation, one compartment was simulated; followed by more compartments, each step making the neuron more complex. There were two components to the simulation, the neuron and injection current.

A pulse of electric current was passed through the soma which triggered an action potential allowing sodium and calcium channels of the soma to open. The soma and dendrite compartments were according to the Hodgkin and Huxley model. In that a model, the two components include charging the membrane capacitance and the movement of specific type of ions across the membrane. The ionic current itself is divided into a sodium current and potassium current. The length and diameter of each compartment used in the model were 30micro meters each. The sodium equilibrium potential was set at 0.045V and the potassium potential was -0.082V. The simulation clock was always set at 0 and the injection current used was 0.3nA. The graph produced from such a model shows the membrane voltage during action potential.

**29.**
**COMPUTER-BASED FLUID VISCOSITY INSTRUMENT**
Kashif Mohiuddin 08
Faculty Sponsor: Joseph Palladino

Viscosity is a fluid property that is a measure of the fluid's internal friction and resistance to flow. Viscosity relates how hard one pushes on a fluid (shear stress) to how fast it flows (strain rate). If the shear stress in linearly related to the strain rate, the fluid is said to be Newtonian; such as motor oil, and water. Non-Newtonian fluids include no-drip latex paint, blood and ketchup. Non-Newtonian fluids were the focus of this study. The viscosity of fluids is highly dependant on the temperature, and therefore temperature must be measured along with shear stress and strain rate when studying the viscosity of a fluid.

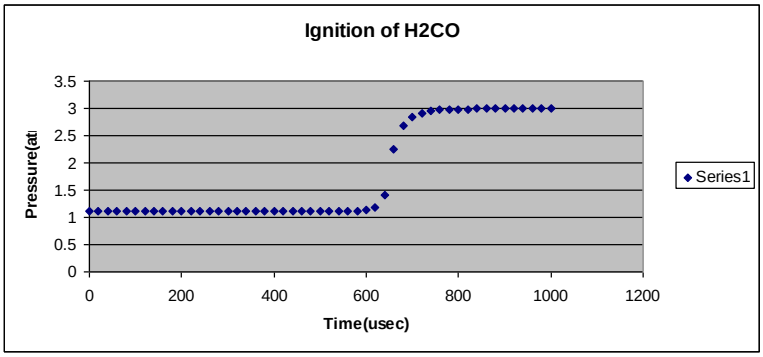
The measurement of viscosity over a range of temperatures gets to be very tedious, and so a system was designed to automate the data logging process. A Brookfield DV-I+ viscometer was used in conjunction with a custom designed thermistor based temperature transducer to measure the required quantities. The transducer was built and calibrated to measure temperatures in the range of 0 – 100 deg C. The range of measurement was later reduced to 60 deg C, due to measurement uncertainty of the viscometer in low temperature ranges. Output voltages from the viscometer and temperature transducer were interfaced with a lab computer using a National Instruments (NI) general purpose I/O board to perform analog to digital conversion. NI LabVIEW software was used to develop a GUI based user-interface to control the system and display plots of viscosity as a function of temperature.

**30.**
**SHOCK TUBE RESEARCH**
Scott Mussmann 09
Faculty Sponsor: John Mertens

Intro: This research project focuses on two objectives: designing a shock tube and doing computational work involving gas chemistry to model combustion reactions. A shock tube is a device that heats gases up nearly instantaneously to a controlled temperature using supersonic shockwaves.

Methods: CAD programs and previous design plans were used to design a shock tube to be constructed. More specifically, an apparatus was designed to allow gases to enter and exit the shock tube with minimal leakage. Parts for the apparatus were ordered and design plans were made for future machining. The time of ignition of a reaction – the time at which the pressure increases dramatically – was calculated with Chemkin, a differential equation solver. The ignition times of Syngas combustion in air were modeled for high-pressure low-temperature conditions.

Sample Results: The shock tube was successfully designed and design diagrams can be seen on other parts of this poster. The figure below shows a typical ignition calculation for Syngas, a mixture of $H_2$ and CO produced from coal. The calculated time of ignition below is 630μsec.




Discussion and broader implications: Syngas can be a clean and domestically available source of energy in the future. Design of detailed models of its combustion process will aid future design of Syngas power plants.

**31.**

**CMU CAMERA FOR AUTONOMOUS ROBOT NAVIGATION**

Kumud Nepal 09
Faculty Sponsor: David Ahlgren

Autonomous robots require feedback from their environments in order to perform certain actions. One of these feedback mechanisms is the CMU camera, named after Carnegie Mellon University that made it. A CMUcam is an advanced optical device used for registering and processing of images of surroundings. The precision and flexibility of the CMU camera's options have made it a viable alternative for replacing the currently and generally used SHARP sensors, which rely on transmission and reception of IR beams for obstacle avoidance and navigation by autonomous robots. The CMU cam captures actual images and processes the images based on pixel system in terms of the different channels of colors it is subjected to. This processing helps in registering different textures, surroundings and environments that a robot might have to go through in the course of autonomous navigation. To attain the goal of actually using the camera for future purposes with Trinity College robots, this camera was thoroughly studied. It was connected to a HandyBoard, a small computer made by MIT and was tried communicating with the computer via a programming language called Interactive C. Several unknown pin connections and lack of knowledge for appropriate connections for required purposes, however, hindered the research objective to some extent. Nonetheless, despite the failure with two cameras, the research is still going on. The cameras that didn't work have been sent back to the

manufacturing company for repair and new cameras are being ordered and are being studied upon. Future work will be directed towards making successful connection to a computer to make communication to and from the camera possible, so that proper and goal oriented software can be written and instrumented for robotic tasks desired.

**32.**
**MATHEMATICAL MODELING OF HEART MUSCLE DYNAMICS**
David Pietrocola 08
Faculty Sponsor: Joseph Palladino

Complex anatomical systems such as heart muscle require an iterative design approach to develop new equations of motion to describe these physiological systems. In this study, MATLAB-based kinematic and kinetic equations of motion were developed from previous work. Using guidance from a lumped model of heart dynamics developed by the faculty advisor, a compact model of heart muscle contraction that retains the dynamics of this large-scale model with only a handful of equations was possible. This approach was shown capable of describing isometric and isotonic contractions. This work strongly suggests that what we called "the ejection effect" for the ejecting heart, an initial enhancement of the heart's ability to eject blood early in systole and a subsequent depression, are based on muscle dynamics at the fiber (cellular) level. This approach consequently links organ system function (heart) to its underlying cellular basis. Future work will apply this model to describe a system of muscle forces.

**33.**
**FORMATION OF SURFACE BUCKLED STRUCTURES AND INFLUENCE ON ADHESION**
Erica Smith 08
Faculty Sponsors: Thomas Mitzel, Alfred Crosby, PhD (University of Massachusetts)

Nature offers many examples of how topographical patterns can affect interfacial interactions. To synthetically generate such patterned surfaces without using topography, we demonstrate that surface buckles form on soft polymers using osmotic stress as a compressive force. As in nature, the adhesion properties of a surface change as the surface roughness changes. Patterns were generated on a polymer network of an n-butyl acrylate monomer solution (98%wt) crosslinked with ethylene glycol dimethacrylate (2%wt) and commercial photoinitators to polymerize the network. After generating stable buckles on the poly(n-butyl acrylate) (pnBA) surface, the work of adhesion was measured using a Contact Adhesion Test. The adhesion properties of the surface can be tuned by changing the thickness of the soft polymer, consequently changing the wavelength of the pattern produced. The total work of adhesion done on the smooth pnBA is 1.09 J/m2 and for a wrinkled surface is 6.97 J/m2. This method is a simple way to effectively tune the adhesive properties of a surface.

# ENVIRONMENTAL SCIENCE

**34.**

**ASPECTS OF THE DIET OF THE NORTHERN CRESTED CARACARA IN FLORIDA**

Kyle Pias 07
Faculty Sponsor: Joan Morrison

We investigated diet of the northern Crested Caracara (*Caracara cheriway*) in Florida as a measure for assessing its foraging ecology, information required in recovery planning for this species, which occurs as an isolated population in the south-central peninsula. Prey remains collected at active nests suggest that carrion comprises only about 33% of food brought to nests. Patterns in consumption of vertebrate prey reflect seasonal precipitation patterns and indicate the importance of wetlands for foraging, at least during the breeding season. Invertebrate communities assessed from pellets collected at active nests and under a communal roost (representing non-breeding individuals) indicate high use of dung and carrion-feeding insects, with an unexpectedly high number of chemically protected insects ingested. Pellets collected from nesting caracaras contained higher proportions of carrion-feeding and chemically protected insects but overall, representatives of fewer insect families and fewer insects per pellet. In contrast, pellets collected from non-breeders at the communal roost contained representatives of more insect families and more than twice as many insects per pellet. These data suggest further hypotheses for testing that involve differences between territorial adults and non-breeding individuals in access to and use of a variety of food resources and high quality foraging habitats.

# NEUROSCIENCE

**35.**

**SIMULATED DRIVING AND BRAIN IMAGING: COMBINING BEHAVIOR, BRAIN ACTIVITY, AND VIRTUAL REALITY**

Kara Carvalho 07
Faculty Sponsors: Dan Lloyd, Vince Calhoun, PhD (Institute of Living)

Virtual reality in the form of simulated driving is a useful tool for studying brain imaging. Various clinical questions can be addressed, including the role of alcohol as a modulator of brain function. In the past, a study of the neural correlates of alcohol intoxication through the use of a simulated driving paradigm has been used to identify areas affected by alcohol intoxication. Analysis was performed using independent component analysis (ICA) to isolate systematically nonoverlapping 'networks' and their time courses. Specific brain circuits were found to be modulated by alcohol, and relationships between average behavior, brain function, and alcohol blood levels were examined. We now move beyond the comparison of average behavior and demonstrate the utility of recording real-time driving behavior through a new study utilizing a programmable simulated driving paradigm developed at our center. Nine driving epochs taken from 26 subjects were analyzed. Findings reveal nine components, selected through ICA analysis correlated with various aspects of behavior. Additional components and significant findings are further outlined to provide new and important information about the neural correlates of driving.

**36.**

**EFFECTS OF LOW CARBOHYDRATE DIET ON ADENOSINE RECEPTOR ACTIVITY IN THE HIPPOCAMPUS**

Jason Gockel 07
Faculty Sponsor: Susan Masino

The therapeutic effects of a low carbohydrate (ketogenic) diet such as the South Beach or Atkins in treating seizure activity in intractable epilepsy have been known for almost a century. However, the mechanisms underlying the diet's effectiveness have yet to be determined. Recent studies of the regulation of adenosine suggest that a ketogenic diet may regulate adenosine. Because adenosine is an important inhibitory neuromodulator, we designed an experiment to test for an interaction between the ketogenic diet and adenosine homeostasis. Newly weaned Sprague-Dawley rats were placed on either a basal control diet or on a ketogenic diet for a minimum of three weeks. After 3-5 weeks on diet, we performed electrophysiological recording from the hippocampus of animals fed either control or ketogenic diets. We tested the endogenous influence of adenosine by applying DPCPX, an adenosine A1 receptor antagonist. Results from electrophysiological recordings suggest a greater endogenous inhibition due to adenosine in the ketogenic fed rats. These fingings support the hypothesis that a ketogenic diet alters the levels of adenosine and possibly receptor concentrations within the hippocampus.

**37.**

**MATERNAL SEPARATION INFLUENCES EMOTIONAL MEMORY IN RATS**

Kaitlin Haines 09, Urey Chow 09
Faculty Sponsor: Harry Blaise

Neonatal isolation, a known emotional stressor, has been shown to impact memory processes by altering levels of synaptic plasticity in the hippocampus. Synaptic plasticity, which is measured by the changes in neuronal activity, is defined as bidirectional, incurring long term potentiation (LTP) in the positive direction and long term depression (LTD) in the negative direction. LTP can be defined as an increase in neuronal activity and synaptic strength, whereas LTD can be referred to as a decrease in synaptic strength. The basolateral amygdala (BLA) and dentate gyrus (DG) are two structures in the brain that have been linked to both emotion and learning and memory. Their interactions are thought to represent the neural mechanisms linking emotion to memory. In order to assess the effects of neonatal isolation on bidirectional synaptic plasticity in the BLA, neonates, ages 2 through 9 days, were separated from their mothers in white noise chambers for one hour each day and then permitted to mature under standard conditions. Between 70-120 days of ages, animals underwent surgery to implant stimulating, recording, and ground electrodes in the BLA, dentate gyrus, and contralateral parietal cortex, respectively. After a 3-5 day recovery period, the animals were stimulated with either a 100-pulse, 5-Hz burst stimulation to induce LTP, or a 900-pulse, 1-Hz sustained stimulation to induce LTD. Preliminary results indicate that there is an increase in synaptic strength of isolated compared to non-isolated animals, suggesting that neonatal isolation increases LTP in the BLA and DG. Results for LTD are inconclusive, thus far.

**38.**

**BI-DIRECTIONAL SYNAPTIC PLASTICITY IN THE HIPPOCAMPUS OF FREELY BEHAVING A1R DEFICIENT MICE**

Robert Hill 07
Faculty Sponsor: Harry Blaise

Adenosine A1 receptors (A1R)'s are inhibitory on the central nervous system (CNS) when activated by endogenous adenosine. This inhibition results in neuroprotection for many areas of the CNS. The presence of an A1R antagonist has been shown to increase levels of long term potentiation (LTP) and long term depression (LTD) due to its inhibitory effect on the normally inhibitory receptors. Three groups of genetically modified A1R mice were used in this study: control, heterozygous, and wild type, to examine the effects of A1R density on bidirectional synaptic plasticity in freely behaving mice. Adult male and female mice were anesthetized using ip-administered sodium pentobarbital (55mg/kg) and then chronically implanted with stimulating and recording electrodes in the perforant pathway of the entorhinal cortex and the dentate gyrus of the hippocampus respectively. After a one week recovery, animals were given a sustained train of 900 pulses while in a state of quiet waking that were administered at varying frequencies to induce either LTP or LTP. Excitatory post synaptic potential (EPSP) and population spike amplitude (PSA) values were recorded from these animals and used to determine a percent change from baseline for each time point. Analysis of the data was fairly consistent with past findings and the data collected at 15Hz suggests that this frequency could be the crossover point from LTD to LTP. This crossover point shows the dependence of A1R density and its saturation point resulting in either LTD or LTP. It also shows how these forms of synaptic plasticity are co-regulated. In order to come to any acceptable conclusions more data needs to be recorded. Thus far the results have been consistent with past findings that A1R deficient mice exhibit the highest levels of LTP and LTD compared to heterozygous and control mice.

**39.**

**LONG-TERM PLASTICITY IN THE POLYSYNAPTIC DENTATE GYRUS-ENTORHINAL CORTEX PATHWAY IN FREELY BEHAVING RATS**

Hannah Knipple 07
Faculty Sponsor: Harry Blaise

It has long been known that the hippocampal formation is crucial for information encoding and for both short- and long-term memory consolidation. Neurophysiological phenomena such as long-term potentiation (LTP) and depression (LTD) have been extensively studied in the entorhinal cortex-dentate gyrus synapse—the first branch of the so-called hippocampal trisynaptic circuit. Sensory information enters the hippocampal formation from the neocortex primarily via the entorhinal cortex which synapses onto the dentate gyrus subfield of the hippocampus via the perforant pathway. This information is then passed on from the dentate to the pyramidal neurons of area CA3 via the mossy fibers, and from there to the pyramidal neurons of area CA1 via the Schaffer collateral axon terminals. However, many studies have indicated that memory is not actually stored in the hippocampus, but is processed and encoded there in the short term before being relayed back up to the entorhinal cortex and subsequently to the neocortex for storage. If this is the case, then the multi-synaptic connection from the dentate

gyrus to the entorhinal cortex should be capable of reliably supporting induction of long-term plasticity. To assess this hypothesis, we conducted studies in freely behaving adult Sprague-Dawley rats which were chronically implanted with a bipolar twisted-pair stimulating electrode (stainless-steel) in the dentate gyrus and a monopolar single-strand wire electrode (tungsten) in the entorhinal cortex. Field potentials were recorded in the entorhinal cortex in response to biphasic current pulses applied to the dentate neurons. LTP induction was also achieved via application of theta burst stimulation (TBS) and subsequent single-pulse evoked field potentials were characterized to determine whether LTP can be reliably induced in this synapse. Results indicate that the synapses in the entorhinal cortex-dentate gyrus connection can reliably support LTP. These results suggest that information encoding and memory consolidation and storage in the brain may be achieved through long-term neuroplastic alterations in the multi-synaptic connection from the hippocampus to the entorhinal cortex. These results provide further insight on hippocampal function in both information encoding and memory consolidation in the brain.

**40.**

**DIFFERENT APPROACHES TO MEASURING PROSPECTIVE MEMORY**

Maggie Moult 07, Hanna Ghaleb 07
Faculty Sponsor: Sarah Raskin

Prospective memory, or memory for intentions, is the memory for future events, in contrast with retrospective memory. Research has only recently begun to investigate how to assess prospective memory and its function in everyday life. Differing tests from separate fields have attempted to measure prospective memory. The Einstein test, developed by cognitive psychologists Gilles O. Einstein et al. and the Memory for Intentions Screening Test (MIST) developed by neuropsychologists Sarah Raskin and Carol A. Buckheit were the two tests compared in the present study. Both tests were administered to the same 8 college-aged students in order to determine whether or not the scores from both tests would correlate and therefore measure prospective memory in a similar way. After a statistical analysis of the students' scores, no significant relationship between the two tests was found, suggesting that the tests may be measuring different aspects of memory. In the future, further research may lead to a more comprehensive test to evaluate prospective memory.

**41.**

**THE EFFECT OF A LOW CARBOHYDRATE DIET ON ADENOSINE IN THE BRAIN**

Laura Pomeroy 09
Faculty Sponsor: Susan Masino

The ketogenic (low carbohydrate) diet can be effective in reducing or eliminating seizures, especially those in children with epilepsy. Unlike anticonvulsant drugs, the ketogenic diet has very few side effects. However, because of its high-fat and low-carbohydrate content, the ketogenic diet is not very palatable and is difficult to maintain.

At this time, the mechanism underlying the anticonvulsant effect of the ketogenic diet is unknown. However, it is possible that the neuromodulator adenosine may play a part in the

ketogenic diet. This hypothesis is supported by adenosine's role as an endogenous anticonvulsant that exists in the extracellular space and regulates local neuronal excitability in the brain. Furthermore, a ketogenic diet can decrease extracellular pH, and a decrease in pH increases extracellular adenosine and decreases excitability. Taken together, these two findings imply the existence of a relationship between the ketogenic diet and adenosine.

To test this hypothesis, male Sprague-Dawley rats were randomly chosen at weaning (approximately 21 days) from sibling cohorts and assigned to one of two possible treatment groups. The experimental group was fed a low carbohydrate ketogenic diet and the control group was fed a matched control diet for a minimum of three weeks and up to four weeks. Preliminary electrophysiological recordings of hippocampal slices from control versus ketogenic animals show that ketogenic slices show a reduced response when extracellular adenosine is applied. One possibility is that additional extracellular adenosine is inhibiting synaptic activity and acting as an anticonvulsant, and thus blunting the effect of exogenous adenosine applied in these experiments. At this time, these results support the hypothesis that a ketogenic diet regulates the influence of adenosine on brain excitability, and may offer new therapeutic avenues for the treatment of epilepsy.

# PHYSICS

**42.**

**STUDY OF THE CLIMATIC INFLUENCE ON THE LOESSIC SOILS IN THE MIDWESTERN UNITED STATES**

Saroj Aryal 09
Faculty Sponsor: Christoph Geiss

Soil formation is controlled by five major factors: climate, time, vegetation, topography, and parent material. In our research we studied the effects of the se factors on the magnetic characteristics of the soil. Most of our sites in Nebraska and some parts of Iowa and Minnesota have almost the same age and developed under similar topographic conditions. Also, most of our sites developed in late-Pleistocene or Holocene loess ranging from SE Minnesota through SW Nebraska and Kansas, so they have the same parent material. For our study we measured magnetic susceptibility, ARM, IRM, hysteresis loops and Curie temperatures. In addition, have also studied several non-magnetic components such as the determination of the soil mineral content, soil color and textural changes.

The parameters were measured against the depth of the soil. The soil in the upper horizons seems to have higher concentrations of magnetic minerals as shown by the measurements of Magnetic Susceptibility, ARM, IRM and ARM/IRM. It was also observed that these changes in magnetic properties are dependent upon the climatic conditions under which the soil forms. The average ARM, IRM, ARM/IRM and Magnetic Susceptibility were somewhat proportional to the mean annual precipitation.

**43.**

## RAMAN SPECTROSCOPY OF CARBON MATERIALS

Matthew Bermudez 09
Faculty Sponsors: Barbara Walden, Ann Lehman

Raman Spectroscopy uses visible light to excite a sample material. The material will scatter some light back at different wavelengths than the incident light. The change in wavelength of the light corresponds to a change in the vibrational energy of the material. Many materials have a characteristic set of vibrational modes. Modes have certain wavelengths at which they will emit a Raman signal. Raman Spectroscopy was used to examine four carbon samples. Pure carbon forms many allotropes, all with unique sets of properties, scales of crystalline structures, and proportions of chemical bonds. Comparing the Raman spectra of the carbon samples reveals how the structure and proportions of sp2 and sp3 bonds affect the vibrational modes of the allotropes.

**44.**

## A FASTER, CHEAPER CIRCUIT FOR DETECTION OF COINCIDENT PHOTONS

Sagar Bhandari 09, Nabil Imam 08, Valentina Zhelyaskova 08, Doug Goodman 06
Faculty Sponsors: David Branning, David Ahlgren, Mark Beck (Whitman College)

Our experiment involves the creation and detection of coincident photon pairs. In our lab, a Single Photon Counting Module (SPCM) is used to detect each photon. Each SPCM sends an electronic pulse corresponding to an incident photon. As we are concerned with the photons arriving simultaneously at two detectors, the pulses from the detectors should be checked for simultaneity. Traditionally, the pulses from each detector (named start and stop) are sent to a Time to Amplitude Converter (TAC) that converts the delay time between those two pulses into a voltage. This voltage is then analyzed by a Single Channel Analyzer which sends a new pulse every time the voltage from the TAC falls within a certain range (this voltage range corresponds to a time window set manually on the SCA module). And therefore, each of these new pulses corresponds to a coincidence count. However, this method of counting coincidences turns out to be inefficient since a lot of coincidence counts are missed due to the long conversion time of the TAC and it is expensive too. It was realized that simple "AND" gates (contained in cheap integrated circuits) that have a much shorter conversion time could be used to check for coincidence. The initial design of this new Coincidence Counting Circuit was proposed by Professor Mark Beck at Whitman College which was later improved upon by Professor David Ahlgren, Professor David Branning, Sagar Bhandari'09 and Nabil Imam '08 at Trinity College. The prototype circuit board was fabricated by PCB Express and completed in the Trinity College Engineering Department. It was tested in the lab and significant improvement in the coincidence counting rate was observed. In fact, at high counting rates the new coincidence counting circuit was twice as efficient as the traditional TAC/SCA method.

**45.**
**QUANTUM OPTICS**
Nabil Imam 08
Faculty Sponsor: David Branning

The goal of our research is to test the supposedly intrinsic randomness of quantum theory. When a photon is incident on a BBO crystal, a quantum mechanical process called parametric downconversion causes the crystal to emit a pair of photons. The process of parametric downconversion is thought to be random. The photons coming out of the crystal will be detected and a comprehensive statistical random number test will be carried out on the data to see whether or not the downconversion process is truly random. A second test will also be carried out to investigate the randomness associated with the quantum bits themselves. The two photons coming out of the crystal will be passed through a polarizer which will cause the photon to make a choice between two directions of polorisation, vertical or horizontal. Quantum theory's prediction is that this choice is random. By running similar statistical tests on the data, the randomness of this process will be investigated. These tests will have significance in current cryptography research since the research is based on the assumption that the entire procedures mentioned above are truly random. If our data indicates non-randomness, it is possible that a hidden source of bias is present in the optics or electronics which can be exploited by hackers. If that is the case, our illumination of the problem will help cryptographers avoid such biases

# PSYCHOLOGY

**46.**
**INVESTIGATING THE EFFECTS OF COGNITIVE STIMULATION ON MODERATE/SEVERE ALZHEIMER'S PATIENTS**
Samara Strauss 07
Faculty Sponsors: Susan Masino, Patti Said, MA (Director, New England Cognitive Center)

Alzheimer's Disease is a neurodegenerative disorder manifested through symptoms such as memory loss, inability to plan and engage in abstract thought, a lost interest and ability for appropriate social interaction, depression, agitation, or complete lack of emotion, and in the most severe cases, an inability to care for oneself. The exact cause of the disorder is unknown, but current research has shown that Alzheimer's patients generally have a genetic predisposition which facilitates plaque and protein buildup and neurofibrillary tangles (Mayo Clinic on Alzheimer's Disease).
Despite many drugs that slow some symptoms of the disorder, there is currently no cure for Alzheimer's disease. However, recent studies have shown the positive effects of cognitive intervention, including Cognitive Stimulation Therapy (CST), in slowing the cognitive decline. In the present study, researchers investigated the effects of cognitive stimulation on six moderate to severe Alzheimer's patients. All participants were pre and post tested with the Mini Mental State Exam (MMSE), Quality of Life-Alzheimer's Disease Scale, and Holden Communication Scale prior to and following the test period. Paired t-tests showed a significant rise and difference in all scores for participants receiving 12 weeks of CST. This preliminary research suggests that there is a significant benefit to maintaining cognitive stimulation in Alzheimer's patients.