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FIRST ANNUAL SUMMER RESEARCH SYMPOSIUM TRINITY COLLEGE

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BIOLOGY

1.

ANALYSIS OF THE PRODUCTION OF THREE CYTOCHROME P450 2D6 POLYMORPHISMS

Shahzad Ahmed 08, Faiza Khan 07, and Lizabeth Nonell 07

Faculty Sponsor: Hebe Guardiola-Diaz

The purpose of this study is to examine three polymorphisms of the Cytochrome P450 2D6 (CYP2D6) enzyme: the wild-type strain, the “M” mutant, and the “9070” mutant. In order to accomplish this, we carried out a series of studies to determine the optimal conditions for the production of CYP2D6 protein using E-coli cells as the expression vector. Western Blot tests and acrylamide gels demonstrated that expression of our protein was optimized at 13°C and at twenty-four hours after induction with IPTG. Using these conditions, we performed a large-scale study and proceeded to lyse our cells and purify our CYP2D6 protein. We succeeded in purifying the 2D6 protein using this process, but there were still other contaminants. In the future, we hope to optimize purification in order to obtain better protein samples and analyze the production of CYP2D6 in each of our strains.

2.

AN ECOLOGICAL AND CHEMICAL EXAMINATION OF GLANDULAR HAIRS IN TWO PIERID BUTTERFLY CATERPILLARS (*PIERIS VIRGINIENSIS* AND *ANTHOCHARIS MIDEA*)

Sarah Arnold 06

Faculty Sponsor: Scott Smedley

Caterpillars of certain pierid butterfly species possess glandular hairs. In *Pieris rapae* and *Pieris napi*, these cuticular structures produce droplets containing mixtures of previously unknown lipids, and in *P. rapae* these compounds serve a defensive role against predatory ants. We have discovered that two additional species possess secretory hairs - *Pieris virginiensis*, a congener of the two previously studied species, and the more distantly related *Anthocharis midea*. We are determining whether the larval secretions of these two species play a defensive role and are characterizing their chemical composition.

3.

ANALYSIS OF TIRE RUBBER LEACHATE WITH A BACTERIAL MUTAGENESIS ASSAY

Sara Benevento 06

Faculty Sponsor: Alison Draper

Rubber particles from automobile tires wear off with use and contribute to water pollution as they leach harmful chemicals into the environment. In an effort to examine the effects of these water-soluble chemicals, *Salmonella typhimurium* was used to assess the mutagenicity of tire rubber leachate. Tire tread particles were leached in hard water for 10 days at room temperature

with constant agitation, filtered through a 0.45 µm nylon membrane and stored at 4°C until use. The leachate was concentrated 10- and 100-fold with a C-18 solid phase extraction column, extracted into hexane, dried under N₂ and reconstituted in DMSO. Bacterial mutagenesis assays using Ames strains TA 1535 and TA 1538 were performed according to Standard Methods. Briefly, bacteria were pre-incubated in nutrient broth for 12 hr at 37°C with shaking. Then, 0.1 ml of test material (in DMSO), 0.5 ml of rat liver S-9 mixture, and 2.5 ml of melted top agar were added. After 20 min additional incubation, the contents were vortexed, poured on minimal agar plates, and incubated at 37°C for 60 hr before being scored. Revertant colonies were counted and scored against negative control plates (DMSO), and diagnostic mutagens analyzed with each experiment served as positive controls. Evidence suggests that tire rubber leachate requires metabolism to induce mutation and may be mutagenic at elevated concentrations. While no mutagenesis was detected with unconcentrated tire rubber leachate, proportional mutagenesis was observed with 10:1 and 100:1 concentration. With a growing number of automobiles on the road there is a marked increase in the amount of tire rubber particles entering the environment: collecting on roadways as dust and eventually being washed into local waterways. Further work will be directed towards identifying the mutagenic chemical(s) in these particles and may suggest the elimination of toxic compounds in future tire production.

4.

MODIFICATION OF *DROSOPHILA* SERRATE- NOTCH INTERACTION BY SPECIFIC INHIBITION OF O-FUCOSYLATION

David Frederick 06

Faculty Sponsor: Robert J. Fleming

This study was undertaken to determine the significance of fucose sugar tags on a specific, highly conserved segment of the *Drosophila* cell surface ligand, Serrate. The Serrate ligand interacts with the Notch receptor, transducing signals that play a critical role in determining the fate of certain cells during development. We hypothesize that inhibited fucosylation of Serrate will result in a loss of function for the Notch receptor. Our target genetic construct contains a single nucleotide modification, which will change a single amino acid in the mutant Serrate and prevent the attachment of fucose to a region known as EGF-like repeat 12. The wild type Serrate gene was inserted into a plasmid and modified using numerous endonuclease digestions, custom polymerase chain reactions, and re-ligations of the genetic fragments. Standard plasmid transformation and cloning techniques were employed using *Escherichia coli* subjected to ampicillin and X-gal markers. Once the construct is complete, it will be inserted into *Drosophila* eggs so that transformant animals can be isolated and morphologically compared to the wild type. We anticipate those studies to be conducted in the coming months.

5.

CAMERA TRAPPING OF VARIOUS SIZED MAMMALS AT THE TRINITY COLLEGE FIELD STATION WITH HEAT AND MOTION SENSOR CAMERA UNITS

Desiree Hernandez 06

Faculty Sponsor: Michael O'Donnell

This summer study was done to observe the distribution and diversity of all mammal size ranges at the Trinity College Field Station via camera trapping using 16 specifically placed heat and motion sensor camera units throughout the 1 km² area of land. It is important to document the animals (and plants) out in the field because it is an area of research used by Trinity College so further research can be done if it is known what exists on the land. It is also safer to be familiar with the kind of environment in which this or any other kind of research is being conducted. Unlike trapping, which requires a great deal of physical work and limits the sizes of the animals able to be captured, camera trapping is the most efficient method of documenting what animals of all size ranges are out in the field. The cameras were set at high environmental sensitivity and set to take pictures every 30 seconds after detecting movement to maximize the chances of photographing the animal at the site. Each camera site contained lures such as shellfish oil, canine lure, bear lure or corn (at deer stations) to attract the animals to the area as a method to capture the animals on camera. The animals captured most on camera were deer, followed by squirrels, the dog (Darla) that lives nearby, raccoons, gray foxes, and fisher. The camera capture rates of these mammals are demonstrated in a table so that the abundance of these animals can be exhibited in a controlled manner.

6.

INVESTIGATION OF AZOL-ANTIFUNGALS AS A NOVEL DRUG THERAPY AGAINST *MYCOBACTERIUM BOVIS*

Michael Kelleher 07

Faculty Sponsor: Lisa-Anne Foster

Mycobacterium tuberculosis is the organism responsible for tuberculosis in humans. Mycobacteria infect their hosts by entering the endosomal pathway of macrophages, yet they avoid lysosomal degradation by remaining in late endosomal vesicles. In these vesicles, the mycobacteria replicate without being detected by the immune system. In recent years, the prevalence of drug-resistant tuberculosis has increased dramatically. Consequently, it is imperative that novel drugs be developed to combat this pathogen. *Mycobacterium bovis* is a closely related species of *M. tuberculosis* that can be used as a model for studying mycobacterial infections. Past research has shown that antifungals may be an effective treatment against mycobacteria, and thus the efficacy of antifungal drugs against *M. bovis* was studied. A dose response experiment was conducted in order to determine the minimum concentration of econazole that prevented mycobacterial growth. It was found that 25uM econazole was the minimum bacteriocidal concentration. However, further studies must be done in order to determine the minimum concentration of econazole that is bacteriocidal with respect to *M. bovis*. Also, a dose response experiment was performed to determine the maximum concentrations of econazole and fluconazole that the macrophages could tolerate. It was determined that these concentrations were 2.5uM for econazole and 20uM for fluconazole. Finally, infection assays

were conducted to determine the effect of antifungals on *M. bovis* infected macrophages. Preliminary findings show that 500nM concentrations of econazole significantly reduced the number of *M. bovis*. This result is extremely promising, and econazole has a great deal of potential as a novel treatment for tuberculosis.

7.

STUDIES ON THE DEVELOPMENT OF THE CORN SNAKE

Siobhan Knight 07

Faculty Sponsor: Daniel Blackburn

We are using Trinity's breeding colony of corn snakes, *Pantherophis guttatus*, to provide basic information about reptile development and egg physiology. During the summer I maintained the eggs and periodically harvested embryos for study. I learned and applied the techniques for light microscopy and scanning electron microscopy and harvested tissues for microscopic study. I also determined the time course of development by examining eggs at different stages. The egg shell was cut open and the embryo was carefully removed and staged according to the Zehr (1962) staging system. The embryos were fixed in 10% formalin for light microscopy. The embryos were processed, embedded in paraffin and sectioned at 7µm using a microtome. The sections, placed on microscope slides, were stained with eosin and hematoxylin. The egg shells from each embryo, containing the chorioallantoic membrane, omphalloallantoic membrane and isolated yolk mass were placed in the Karnovsky's fixative and prepared for scanning electron microscopy. I observed that the female corn snakes lay their eggs 50 – 60 days after mating and the eggs hatch 150 – 160 days later. Based on the Zehr (1962) staging system, the development of the embryos, from conception to hatching, is separated into 37 stages. When the eggs hatched I found the embryos to be at stage 22. At this stage the endolymphatic duct, and the vomeronasal organ in the nasal pit is visible, but no internasal depression can be seen. At the final stage, stage 37, the embryos, which are fully developed with scales and pigment, hatch from the eggs. Based on the information found when the embryos and membranes are examined, I hope to produce a new staging table that more accurately describes the development of the corn snake. I also plan to use scanning EM to study fetal membrane, which sustain the embryo during development.

8.

SOCIAL STIMULATION AND CELL PROLIFERATION IN *APTERNOTUS LEPTORHYNCHUS*

Elizabeth McCarthy 07

Faculty Sponsor: Kent Dunlap

Understanding the relationship between changes in behavior and changes in brain structural plasticity, particularly neurogenesis, could one day aid in the creation of new treatments for brain injuries and neurodegenerative diseases. The neural pathway that controls the chirping behavior of electric fish has been studied extensively and is therefore useful in determining this relationship. It has been found in *Apternotus leptorhynchus*, a type of electric fish, that social stimulation causes an increase in chirping behavior and is also associated with an increase in cell proliferation. In this set of experiments, fish were exposed to social stimulation over different

time intervals to determine how exposure length effected cell proliferation. Fish were matched for weight and electric organ discharge (EOD) and then they were either isolated (one fish per tank) or paired (two fish per tank) for all trials. In one trial, fish were injected with BrdU just one day after matching. There was no difference in BrdU labeling observed between the paired and isolated groups. In another trial, fish were injected with BrdU and then sacrificed 24 days later. Some co-labeling of brain cells with BrdU and Hu was observed in both paired and isolated fish. This indicated that neurogenesis had occurred. Further investigation will be needed to determine if the rates of neurogenesis observed differed between paired and isolated fish.

9.

THE EFFECT OF FLUCONAZOLE ON *M. BOVIS* AND J774 PS+ MACROPHAGES

Amanda Au 07 and Meagan Miller 06

Faculty Sponsor: Hebe Guardiola-Diaz

M. bovis is a model organism for *M. tuberculosis* and therefore is the target of our current antifungal treatment study using fluconazole. Fluconazole is a potential new drug treatment for the tuberculosis mycobacterium. Varying concentrations of the antifungal were tested on *M. bovis* in order to determine a concentration of fluconazole that is detrimental to this mycobacterium. Concentrations ranging from 25 uM to 10 nM of fluconazole were tested on *M. bovis*. Absorbance readings were taken every 12-24 hours over 12 days. Only the controls grew significantly during the 12 day incubation period while the fluconazole tubes stayed at relatively low absorbance readings ranging from -0.009 to 0.023. After 8.58 days of incubation, the liquid cultures were plated and only the controls showed growth. Therefore, Fluconazole was also tested on macrophages at 25 uM, 1.0 uM, 0.75 uM, and 0.5 uM to determine a concentration yielding the best survival rate. The macrophages were grown in the incubator until they were ready to be split into wells and induced with antifungals. They were counted again after 48 hours to determine the number of cells that were dead or alive at each concentration. The control yielded the most live macrophages. Overall, a fluconazole concentration that was detrimental to *M. bovis* but was of little harm to macrophages was not found. The concentrations tested were all effective against *M. bovis* but were also deadly to macrophages.

10.

THE EFFECTS OF EXTENDED PERIODS OF ANOXIA ON *VAUCHERIA* PROPAGULES IN CONNECTICUT RIPARIAN SEDIMENTS

Alison Parpal 08

Faculty Sponsor: Craig Schneider

Species of the yellow green alga *Vaucheria* (Vaucheriaceae, Chrysophyta) are found throughout the world in salt, brackish, and freshwater sediments. This common and resilient genus has demonstrated its ability to survive extreme environmental stresses by depositing hardy, dormant “seed banks” of propagules in the sediment in which it grows. This study investigates the effect of periods of anoxia – a potential environmental stressor – on the germination/survival of *Vaucheria* propagules. Sediment samples used in this study were collected from a streambed in Ashford, Connecticut, where seven species of *Vaucheria* have previously been collected. The

raw samples were mixed and divided into small circular slabs, which were then placed in individual bags and relieved of oxygen in nitrogen-filled desiccating chambers in a dark cold room. One slab was removed from the chamber approximately every thirty days, allowed to cultivate in an incubator under optimal conditions, and observed for germination. Results have shown that at least three species of *Vaucheria*, - *V. aversa*, *V. uncinata* and *V. undulata* - are able to survive at least 150 d. of anoxic dormancy.

11.

CORRELATION OF RAINFALL WITH THE VERTEBRATE DIET OF THE NORTHERN CRESTED CARACARA

Kyle Pias 07

Faculty Sponsor: Joan Morrison

We studied the vertebrate component of the breeding season diet of the Northern crested caracara (*Caracara cheriway*) in south-central Florida, where this species occurs as an isolated population and is threatened by widespread habitat loss. This species' breeding season is closely linked to the rainfall of the region. In this study, the prey items most closely linked to rainfall (fish and amphibians) were examined. The fish species most closely examined was the walking catfish (*Clarius batrachus*) as it represented approximately 72 percent of the caracaras fish diet. The amphibians are represented by sirens and amphiumas (Sirenidae and Amphiumidae). In both cases the numbers of these prey items increased from March to May, corresponding to an increase in rainfall. Also it was found that fish numbers peaked in May, in which the mass spawning of walking catfish across flooded pastures occurs. The change in the diet between nesting stages was also examined. It was found that the overall composition of the diet is significantly different between early nestlings, late nestlings, and fledglings. These findings, combined with previous data correlating rainfall and nest success rates, show how closely the caracaras life history is tied to the wetland cycles in Florida.

12.

SURVEY OF WHITE-TAILED DEER AT THE TCFS

Willis Read-Button 08

Faculty Sponsor: Michael O'Donnell

The monitoring of the white tailed deer population at the Trinity Field Station was conducted in order to assess the deer populations health, which could thereby be used as a rough judgement of the faunal ecosystem as a whole. They will be monitored on the TCFS (Trinity College Field Station) property will be monitored via remote infrared triggered cameras in order to photograph their activity. By baiting specific sites with cracked corn, the deer will be attracted to increase the captured images. Through these images a rough population count will be extrapolated, and timing of antler growth and fawn weaning will also be examined, in order to compare to established values. Through this process, we were able to determine the population, antler growth, and fawn behavior of the White-Tailed Deer at the TCFS, all of which seem to be indicative of a healthy stock and, likely therefore, ecosystem

13.

EXAMINING THE IMPORTANCE OF CYP51 IN *MYCOBACTERIUM BOVIS*

Kimberly Riggs 07

Faculty Sponsor: Lisa-Anne Foster

M. tuberculosis is the causative agent of tuberculosis. Tuberculosis infects millions of people throughout the world resulting in nearly 2 million deaths each year. Although an effective treatment regiment consisting of isoniazid and rifampicin is prescribed in most cases, individuals infected with multi drug resistant (MDR) strains remain untreatable. The rise in MDR *Mycobacterium tuberculosis* has spurred research and new treatment methods are in high demand. Analysis of the *M. tuberculosis* genome has aided in the search for new treatment targets. One sequence of particular interest is very similar to the fungal and mammalian CYP51, an enzyme used in sterol biosynthesis. Existing studies on *M. bovis* and *M. smegmatis*, model organisms for the study of *M. tuberculosis*, show that azole anti-fungals inhibit cell growth specifically targeting the cell membrane. In previous studies it's been shown that azole anti-fungals interfere with CYP51. In order to determine whether azole anti-fungals will be a potential treatment, it first must be determined whether or not CYP51 is an essential enzyme. To do this, a deletion mutation must be made. In this study a successful protocol was developed for deletion of *cyp51* from *M.bovis*. Further work on this study includes using the *M. bovis* deletion mutant in an infection assay to determine the essentiality of *cyp51* during infection. Since tuberculosis lives in organisms macrophages, the infection assay will be carried out in J774 macrophages to simulate these conditions.

14.

PCR AMPLIFICATION, CLONING AND CHARACTERIZATION OF NA/K/2CL COTRANSPORTER U22CT-D

Celia Rodriguez 08

Faculty Sponsor: Hebe Guardiola-Diaz

Oligodendrocytes are the cells responsible for myelination of neuronal axons in the Central Nervous System (CNS), contributing to their importance in research. In recent years, the ligand-activated Peroxisome Proliferated-Activated Receptor δ (PPAR δ) has been identified in the nucleus of the oligodendrocyte as a transcription factor. It is involved in the rate at which oligodendrocytes mature, facilitating rapid development of oligodendrocyte precursors. A previous experiment designed to find PPAR δ -regulated genes in oligodendrocytes identified two different genes. In the experiment, adult rat brain cDNA was used as a target during amplification of the DNA strand during PCR. The goal of this research is to generate a full-length cDNA clone for the ion-transporter gene, using a PCR method for DNA amplification, pCR TOPO for cloning, and the Spin MiniPrep technique to ensure uncontaminated results. The long-term purpose of making this DNA constructs is to test its specific role in oligodendrocyte development. In due course, this experiment may lend itself to an investigation in testing the role of the ion cotransporter, enabling the identification of the specific stage or stages in oligodendrocyte development in which the ion-transporter is involved.

15.

LIVE TRAPING OF SMALL MAMMALS USING SHERMAN TRAPS

Elisabeth Treado 06

Faculty Sponsor: Michael O'Donnell

Live trapping of small mammals is a method traditionally used to estimate the population of an area of land, as well as the species diversity. A popular trap used to do this is the Sherman Trap. In this study, bait was placed toward the rear of the traps and the traps were placed approximately 65 feet apart from each other. The bait was a peanut butter, paraffin and oatmeal mix. Approximately 49 traps were used to cover one grid (1km X 1km). The traps were checked every morning, and then rebaited. This was done for 3- 4 consecutive nights. The most common animals trapped were the white-footed mouse (*Peromyscus leucopus*) and the deer mouse (*Peromyscus maniculatus*). There were also some voles and shrews. Some of the results showed conclusive data suggesting an increase in the number of mammals trapped as time went on. The number of recaptured mammals also seemed to increase as time went on suggesting that the same mammals were visiting the traps repeatedly. The species diversity in the highlands compared to the lowlands was very similar. The results obtained may have differed if the traps had been pre-baited prior to trapping the animals.

16.

DIET ANALYSIS FOR THE CRESTED CARACARA USING PELLETS

LingYan Wang 08

Faculty Sponsor: Joan Morrison

The crested caracara (*Caracara cheriway*), is a bird of prey that resides mostly in South and Central America. An isolated population of the species in Florida is classified as threatened due to rapid agricultural and residential growth. These changes in land use may affect the caracara's diet. My project examines the diet of this raptor using pellets that were collected from 87 different nests around the Lake Okeechobee area during 1995 - 1999. Pellets average 4.09 cm in length, 1.99 cm in width and 3.22 g in mass ($n = 50$). Caracara pellets contained both vegetative and animal materials. Ninety-two percent of the pellets contained fire ants (*Solenopsis invicta*). 50% of the pellets contained more than 50% plant materials, mostly grass. The plant materials were quantified by estimating the percentage of plants in the overall matrix. The invertebrate pieces were collected and identified according to their texture, size, shape, and patterns on the elytra and pronotum. The pellets contained 52 different invertebrate types, including spiders, crayfish, and insects. Insects were mostly beetles and some contain toxic chemicals. Most of beetles were in the family Scarabidae, which indicates they were consumed during scavenging by the caracara. The number of invertebrate items found in pellets began to reach a plateau as the sample size increased. The project is ongoing and analysis of more pellets will provide a better understanding of the importance of invertebrates and plants in the caracara's diet. This information about the caracara's diet through pellet analysis may help in preventing the loss of this unique population.

CHEMISTRY

17.

COMPARISON OF METHODS TO SYNTHESIZE 5-5'-DI-TERT-BUTYL-N-(9-FLUORENYLMETHYLOXYCARBONYL)-4-CARBOXYGLUTAMATE

Nicholas Callahan 06

Faculty Sponsor: Richard Prigodich

Solid-phase peptide synthesis is an important source of biologically active peptides. Peptides that include unusual amino acids are expensive to produce due to the high cost of purchasing N-terminal- and side-chain-protected rare amino acids. 4-carboxyglutamic acid is such a rare amino acid. There are two synthetic approaches to synthesizing 4-carboxyglutamic acid in the appropriately protected form for use in solid-phase synthesis. One method activates the hydroxyl side chain of L-serine rendering it as a suitable leaving group for attack of the 3-position with a malonate anion. The other method starts with D-serine. The 1-carboxylate is reduced to an aldehyde then attacked with malonate anion. The hydroxyl group at the 3-position is then oxidized to a carboxylic acid. These two methods were used and this paper presents a comparison of the mechanisms and relative utility of the two approaches.

18.

ANALYTICAL METHOD DEVELOPMENT FOR THE SUPERCRITICAL FLUID EXTRACTION AND QUANTIFICATION OF ROTENONE IN HAIR TO ASSESS OCCUPATIONAL EXPOSURE

Joseph Cavar 06

Faculty Sponsor: Janet Morrison

Rotenone is a naturally occurring compound extracted from the roots of leguminous plants which is incorporated into various botanical pesticide formulations for use in gardens and on food crops. Recent animal studies have suggested a link between long-term exposure to rotenone and the development of symptoms consistent with Parkinson's Disease. The aim of the present study is the development of an analytical method to assess rotenone exposure through hair analysis. Hair provides a relatively non-invasive testing medium for evaluating chronic exposure to toxins, and has been increasingly used as a toxicological specimen to detect chronic illicit drug use due to its wide detection window and the ease and safety associated with sample collection, storage, and transport. A supercritical fluid extraction (SFE) method was developed and optimized for isolation of rotenone. Analyte quantification was performed by reverse phase HPLC with external standard calibration. SFE recovery data is presented for (1) initial spike-recovery experiments designed to optimize SFE conditions of temperature, pressure, fluid composition, and extractant volume and maximize rotenone solubility from an inert matrix; (2) spike-recovery experiments from negative human hair designed to evaluate matrix effects and identify potentially interfering hair coextractables; (3) application of optimized extraction conditions to drug-fortified hair; and, finally (4) analysis of hair obtained from rats subjected to chronic rotenone exposure. Future work will focus on reducing detection limits through the use of LC-MS, with the ultimate goal of assessing exposure in humans who are at especially high risk of environmental contamination through occupational contact.

19.

COUPLING OF PROPARGYL ALDEHYDES WITH α -BROMO ALKENES AND ALKYNES

Jacqueline Corbett 06

Faculty Sponsor: Thomas Mitzel

The formation of carbon-carbon bonds is essential to the synthesis of organic compounds. In this study, propargyl aldehydes were synthesized and indium was used to promote the coupling of propargyl aldehyde moieties with prenyl bromide in various solvents. Furthermore, addition reactions of α -chlorosulfides to carbonyls mediated by indium metal have been studied and shown to exhibit diastereoselectivity. The products of these reactions can be used to synthesize enediynes and epoxydiynes, which are important regions in anti-tumor medication. The purpose of this study was to synthesize α -bromosulfides, which may be more reactive than α -chlorosulfides in addition reactions.

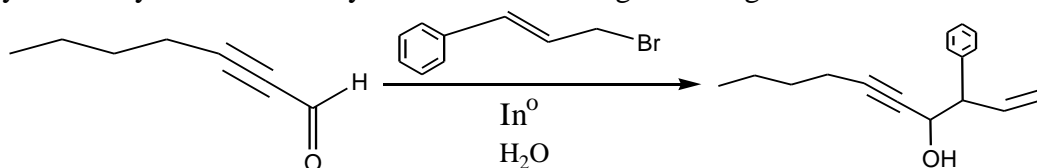
20.

INDIUM PROMOTED COUPLINGS OF HEPT-2-YNAL ALDEHYDE USING CINNAMYL BROMIDE

Kwame Frimpong 08

Faculty Sponsor: Thomas Mitzel

The flow of electrons during synthetic reactions is important in chemistry since that determines the products formed. This summer's research involved indium promoted couplings of hept-2-ynal aldehyde with cinnamyl bromide as the reagent. The general reaction is shown below.



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

21.

BINDING STUDIES OF OSTEOCALCIN TO TYPE I COLLAGEN

Hannah Knipple 07

Faculty Sponsor: Richard Prigodich

Collagen, the fibrous protein in connective tissue, is the most abundant component of the organic matrix of bone tissue. Osteocalcin is a protein found in bone tissue that binds both the collagen organic matrix and the mineral matrix (hydroxyapatite) of bone. Bone mineralization occurs due to the binding of proteins such as osteocalcin and collagen to hydroxyapatite. It is also known that osteocalcin binds to collagen. Peptides of varying length from the osteocalcin N-terminus have been synthesized. A binding study of these peptides and type I collagen is being carried out to map the collagen binding site on osteocalcin. Osteocalcin binds to type I collagen reversibly,

and each collagen molecule has one osteocalcin binding site. The study will measure the decrease in the difference between the absorbance of a blank titrated with collagen and both 12-mer and 16-mer osteocalcin peptide solutions titrated with collagen. After each collagen addition, the collagen-peptide-buffer solution is centrifuged, and the absorbance is read. The binding of osteocalcin to the collagen causes the osteocalcin to pellet with the collagen in the centrifuge. This results in a decrease in the absorbance of the solution relative to that of the blank. This procedure has yielded an overall relative decrease in absorbance consistent with the expected results. More trials must be run to measure a binding constant.

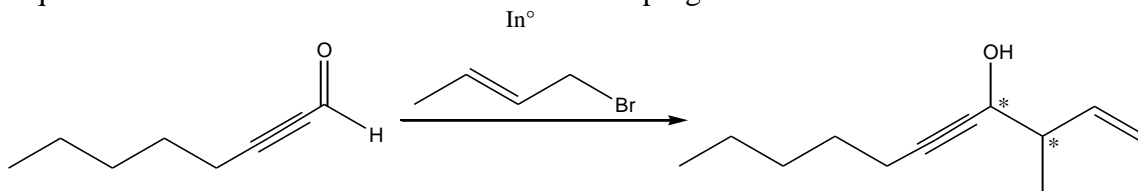
22.

AFFECTS OF TEMPERATURE AND SOLVENT UPON THE INDIUM PROMOTED COUPLING REACTION OF CROTYL BROMIDE AND PROPARGYL ALDEHYDE

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.



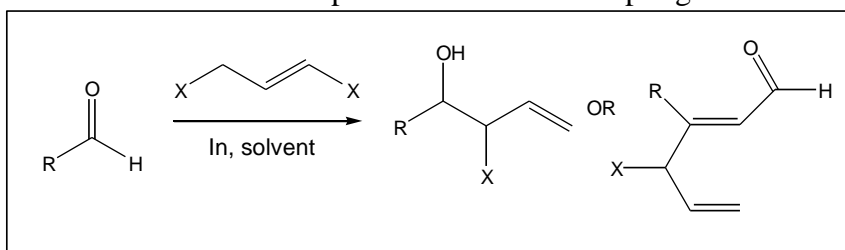
23.

INDIUM PROMOTED COUPLING: THE EFFECTS OF ELECTRON WITHDRAWING GROUPS ON 1,2- AND 1,4-ADDITIONS

Claire Lawlor 06

Faculty Sponsor: Thomas Mitzel

The indium promoted coupling reaction between several allyl-halides and propargyl aldehydes has been investigated. The purpose of this investigation has been to determine whether the mechanism is a 1,2- addition which is then followed by a Cope rearrangement or a 1,4-addition. The effect of an additional halide atom upon the rate of this coupling reaction was also studied.



24.

FORMATION OF BIS-ALKYNE COMPLEX TO TEST PURITY USING HPLC

Jessica Leandre 07

Faculty Sponsor: Timothy Curran

The objective of this research is to determine the possibility that HPLC could be used as a technique that will help recognize the purity of tungsten complexes. Experiments were done to prepare a tungsten complex sample. A dipeptide bearing an alkyne was prepared. This dipeptide was reacted with tungsten in order to form a bis-alkyne complex. The results of this research will be presented.

25.

RATIONAL SYNTHESIS OF POTENTIAL α -HELIX TEMPLATES

Adam Lesser 06

Faculty Sponsor: Timothy Curran

α -Helices are one of three main secondary structures in proteins. Regrettably, these helices are unstable outside of their native protein superstructure. Reliable study of the isolated helices is therefore difficult. A promising alternative is the creation of external, stable, helices by way of helix "templates". By correctly orienting the first few amide carbonyls of a peptide chain, the templates have the potential to form the start of an α -helix. The current research continues ongoing research in this field of study. The proposed helix initiator is a bicyclic dipeptide that constrains the amide carbonyls by placing the amino acid derivatives on a lactam ring. Work has been conducted and is ongoing in the area of constructing 7 and 8 membered lactam initiators. The current research's goal is to find a reliable synthetic method for forming these rings from simple and commercially available precursors.

26.

ANALYSIS OF DOPAMINE AND URIC ACID IN NEURONAL CELL CULTURE MEDIA

Robert Maloof 07 and Lisa Bosy 06

Faculty Sponsor: William Church

We have developed a HPLC/ED method for the detection of dopamine and uric acid in cell culture media samples, and a spectrophotometric method for the quantification of uric acid. Separation of dopamine is performed on 100ul sample assays using ESA MD-TM mobile phase pumped through a ESA MD-150 Analytical, 3.2 mm x 15cm 3 micron analytical column at a flow rate of 1ml/min. Dopamine is quantified using a ESA model 5014B Microdialysis Cell set at a potential of 220mV. Assays of dopamine in HBSS were shown to be linear between a concentration of 1nM and 0.2nM.

Separation of uric acid in HPLC is performed on 20ul sample assays using .01 mM EDTA, 2.2 mM sodium octyl sulfate, and 5.0 mM triethylamine with 15% methanol mobile phase pumped through a Microsorb 100-3uM C18, Varian 100x4.6mm column at a flow rate of .75 ml/min.

Uric acid is quantified using a ESA BAS glassy carbon radial flow electrode. Cell set at a potential of 220mV. Using this method, Assays of uric acid in deionized water were shown to be linear between a concentration of 5uM and 21uM.

The procedure developed for the quantification of uric acid in cell culture media is based on the ability of uric acid to reduce iron(III) to iron(II) in a 1:1 molecular ratio. This method uses 2,4,6-tripyridyl-s-triazine (TPTZ) to form a blue complex with iron(II), allowing iron(II) to be quantified by spectroscopy. The method under development involves reacting the uric acid in a sample with iron(III) in solution, and then measuring the concentration of resulting iron(II) by the change in absorbance after the addition of TPTZ.

The calibrations for all methods have shown to be both repeatable and precise; detection has also shown to be specific for quantification of dopamine/uric acid based upon retention time. Analysis of dopamine and uric in cell media samples from differentiated stem cells has been completed. The spectrophotometric method, while effective for measuring uric acid in certain media, has not yet been proven to be effective for application to cell media.

27.

SAMPLE PREPARATION FOR BINDING STUDIES ON OSTEOCALCIN

Frank Mieles 07

Faculty Sponsor: Richard Prigodich

In order to study the binding of Osteocalcin to collagen, different mer sections of the osteocalcin sequence needed to be synthesized in order to specifically target which amino acid the collagen binds to since it is unknown due to the many positively charged amino acids on the entire protein. The 10-mer, 14-mer, and 16-mer were needed for the binding studies Hannah Knipple was performing.

28.

SYNTHESIS OF SYMMETRIC ALKYNYLPEPTIDES AND COORDINATION TO TUNGSTEN COMPLEXES

Whitney Smith 07

Faculty Sponsor: Timothy Curran

Previous research done in our lab has proven that alkynylpeptides react with the tungsten complex ($W(CO)_3(dmtc)_2$, $dmtc = \text{dimethylthiocarbamate}$). The product of this reaction is a tungsten bis-alkynylpeptide complex. Over the summer I prepared the corresponding mono-alkynylpeptide complexes using symmetrical alkynylpeptides. The results of this work will be presented.

29.

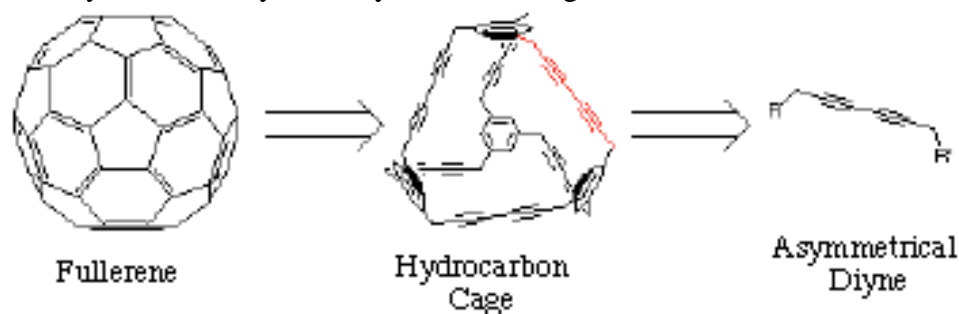
SYNTHESIS OF HYDROCARBON CAGES AS A PRECURSOR TO FULLERENE FORMATION

Katherine Spencer 08 and Michael Johnson 07

Faculty Sponsor: Thomas Mitzel

Fullerenes have the desirable ability to form endohedral complexes with the addition of a “guest” molecule. The size of this guest atom is limited by the size of the individual rings of the fullerene, and a significant amount of energy is required to breach the fullerene shell. The rational synthesis of a hydrocarbon cage as a precursor to Buckminsterfullerene allows for guest molecules to be incorporated into the cage as it forms, thus eliminating much of the size and energy restraints required by traditional methods used in forming such complexes. These hydrocarbon cages may be formed using asymmetrical diyne moieties as shown in Figure 1 below.

Figure 1: Retrosynthetic Analysis of Hydrocarbon Cages



The goal of my research is to continue perfecting the method by which an asymmetrical diyne precursor to the hydrocarbon cage may be formed. Fullerenes have a largely untapped potential in many fields such as industry and medicine and further research in the rational synthesis of fullerenes with or without a guest molecule will lead to breakthroughs and progress in both fields.

30.

ISOLATION OF OSTEOCALCIN FROM BOVINE BONE

Jesse Wanzer 08

Faculty Sponsor: Richard Prigodich

Osteocalcin is a very small protein found in bone tissue. The function of the protein is essentially unknown, but it has been shown that osteocalcin is involved in bone growth and remodeling. The central region of the protein is likely the hydroxyapatite-binding domain due to its abundance of negatively charged residues. The amino terminus contains repeating proline and hydroxyproline residues that are similar to the amino acids in the collagen molecule. This information has given rise to the speculation of preferential binding. However, in order for any further research to continue regarding the binding of osteocalcin and collagen, the osteocalcin had to be isolated from bovine bone samples, using an elaborate fifteen step process.

31.

NUCLEATION OF β -SHEETS WITH A FERROCENE CROSSLINK

David Webster 06

Faculty Sponsor: Timothy Curran

New strategies have been developed to ensure that a peptide will adopt a defined secondary structure. Molecular constraints have been introduced as templates that nucleate α -helices, β -turns, and β -sheets. In this study a 1,1'-ferrocenediacid was used as a constraint to link two peptide strands to create a β -sheet. The ferrocene crosslink has been chosen because the cyclopentadienyl rings are parallel to each other and approximately the same distance apart as the peptide strands in a β -sheet. Two target molecules were synthesized, one dipeptide and one tripeptide ferrocene complex. Early analysis indicates the presence of hydrogen bonding in each case. Further analysis is being done to determine a definite structure.

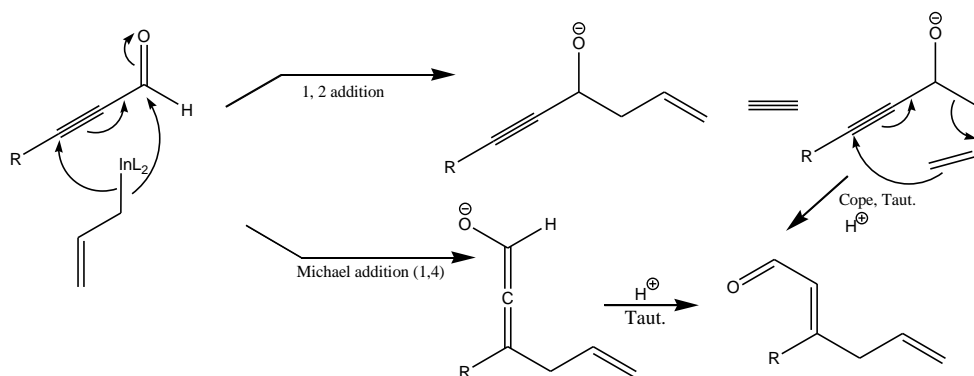
32.

INDIUM PROMOTED COUPLINGS OF PROPARGYL ALDEHYDE MOIETIES WITH 1,2- AND 1,4-REGIOSELECTIVITY

Joseph Wzorek 06

Faculty Sponsor: Thomas Mitzel

The formation and regioselective control of carbon-carbon bonds is a fundamental component of organic synthesis. This control can be directly applied to the formation of useful molecules such as natural product templates. Past research has overwhelmingly shown that indium metal preferentially adds to the 1,2- position of conjugated carbonyl moieties despite the presence of a nucleophilic 1,4- position. Research conducted this past summer examined the ability to produce a 1,4- product through a pathway which involved a 1,2- addition followed by an oxy-Cope rearrangement. This poster will describe the mechanistic pathway towards the formation of the desired 1,4- product. Additionally, a description of the various reaction conditions that were used will be included.



33.

SYNTHESIS OF METALLACYCLIC PEPTIDES BY SIDE-CHAIN TO SIDE-CHAIN COORDINATION

Craig Yennie 06

Faculty Sponsor: Timothy Curran

In previous studies done in our lab we have demonstrated it is possible to create a metallacyclic dilysine dipeptide. This was achieved by synthesizing a dilysine dipeptide in which alkynes groups were added to the lysine side chains. The two alkynes were then couple to a tungsten complex to create the metallacyclic peptide. We found that these metallacyclic peptides can be easily synthesized and exhibit large amounts of conformational flexibility. Mimicking these biological systems can help us understand the way proteins behave in our bodies. We are currently in the progress of creating a metallacyclic dilysine tetrapeptide in which the two lysines occupy the first and fourth positions using a similar synthetic strategy. We would like to know if the metallacyclic tetrapeptide can be synthesized and if the peptide will assume an α -helix conformation.

34.

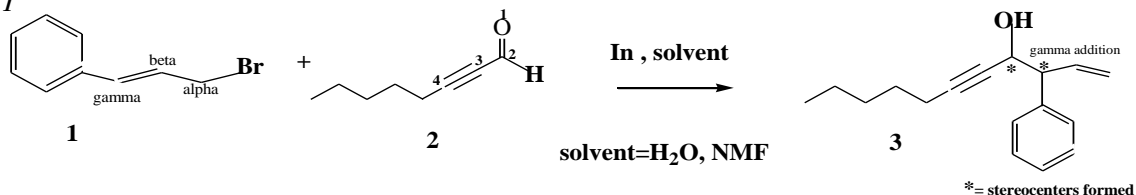
SYNTHESIS OF GAMMA (γ)-HOMOALLYLIC ALCOHOL IN INDIUM-PROMOTED COUPLING REACTIONS OF CINNAMYL BROMIDE AND HEPTYNE ALDEHYDE UNDER VARIOUS SOLVENT AND TEMPERATURE CONDITIONS

Lilia Zhahalyak 06

Faculty Sponsor: Thomas Mitzel

The series of indium promoted allylation of cinnamyl bromide (**1**) to α -heptyne aldehyde (**2**) were run to determine the factors affecting regioselectivity rate and yield of homoallylic alcohol (**3**) formation. The reaction of indium-cinnamyl organometallic complex with sterically non restricted α -aldehyde resulted in two diastereomers at 2:1 ratio in solvent N-methylformamide (NMF) and 1.3/1.6 :1 ratio in deionized water with various yields ranging from 4.5 % to 40% with 100% γ - addition. The rate of allyl-indium reagent formation via single electron transport mechanism (SET) and its stability assumed to be temperature related favoring low temperature conditions in NMF, while either nonchelated or chelated route contributed to the ratio of diastereomers observed in NMF and water.

Scheme 1



EDUCATIONAL STUDIES

35.

DO MAGNET SCHOOLS ATTRACT ALL FAMILIES EQUALLY? A GIS MAPPING ANALYSIS

Naralys Estevez 06

Faculty Sponsor: Jack Dougherty

The great influx of inter-district magnet schools in the metropolitan Hartford region has provided families with a greater number of public school choices, while simultaneously combating racial and socio-economic isolation. However do magnet schools attract all families equally- or do they “cream” students by attracting disproportionate numbers from higher-status demographic groups? Using geographic information system (GIS) spatial analysis, this study explores data from magnet school applications, magnet and neighborhood school enrollments, and Census 2000 to determine whether magnet students are statistically representative of the racial, socio-economic, and school achievement characteristics of the neighborhoods in which they reside. Preliminary findings of applications from the one suburban town, for admission into one elementary magnet school indicate that suburban Non-Whites are more likely to apply to city-suburban magnet schools, than are suburban Whites. These findings suggest that magnet schools are not attracting all families equally and are potentially creaming students by race. It also highlights a need for future investigations on family motivation for applying to magnet schools

36.

SHAPING THE LEARNING CORRIDOR INTERDISTRICT MAGNET SCHOOLS, 1990S TO THE PRESENT

Nivia Nieves 06

Faculty Sponsor: Jack Dougherty

This research focuses on the shaping of magnet school policies and collaboration of various interests groups in the design and implementation of the Learning Corridor, a \$110 million dollar complex of four interdistrict magnet schools in Hartford, Connecticut. Interdistrict magnet schools serve as a key voluntary remedy to the 1996 Sheff v O’Neill school desegregation ruling to reduce racial and socioeconomic isolation in the metropolitan Hartford region. The study explores the original concerns and goals of the Learning Corridor advocates (and opponents), how they gained support from various interest groups during the design phase (1990s-2000), and how they are addressing issues during the implementation (2000-present). The methods include archival documentation and structured oral history interviews with 22 key political figures and 51 interviews with prospective magnet school parents. We found that the Learning Corridor advocates and interest groups collectively succeeded in constructing the Learning Corridor and achieving better racial balance than city or suburban schools. The project was successfully completed although many interest groups’ motivations and concerns differed. We also found that Learning Corridor probably would have happened regardless of the Sheff plaintiff victory, due to Trinity College plans prior to the 1996 ruling. However, the Sheff litigation (1988-present) clearly influenced the Learning Corridor and magnet school policy in Connecticut. It served as a two-edged blade for Hartford’s residents by increasing political and financial support

for magnet schools, and diluting benefits for the immediate neighborhood. This research calls attention to the need to assess the policies and practices of magnet schools and to focus on the challenges of implementing desegregation policy.

37.

FAMILY AND SCHOOL FACTORS INFLUENCING THE RACIAL ACHIEVEMENT GAP IN WEST HARTFORD PUBLIC SCHOOLS

Rebecca Wetzler 06

Faculty Sponsor: David Reuman

This study explores what factors are associated with the racial achievement gap in West Hartford Public Schools. Through careful analysis of standardized test scores for all 2004-2005 West Hartford students, we have been able to determine that three factors associated with race - student mobility, home language, and nursery school - predict the gap at 4th grade. We found that students moving from Hartford to West Hartford had the lowest 4th grade Connecticut Mastery Test (CMT) scores, and students who had been in West Hartford since kindergarten performed at a higher level than all other groups, except students who had moved from out of state. Students who spoke English at home performed at a higher level on the 4th grade CMT Reading and Writing tests. However, on the 4th grade CMT Math test, home language only had a significant effect on White students. Blacks and Hispanics achieved below average whether or not they spoke English at home, and conversely Asians achieved above average irregardless of language spoken at home. Those students coded as participating in nursery school performed at significantly higher levels than other students on the 4th grade CMT. These three factors did not predict which students would close the gap after grade 4. We recommend that future research be designed in order to allow data-driven program development and improvement related to the achievement gap. Future research should also be optimally informative about remedies that will reduce the achievement gap.

38.

RACE, REAL ESTATE, AND RACIAL CHANGE IN BLOOMFIELD SCHOOLS FROM 1960 TO PRESENT

Aleesha Young 07 and Kellie Perkins 05

Faculty Sponsor: Jack Dougherty

My research examines the demographic change in Bloomfield, a town in Connecticut known for its racially mixed population during the 1960's and 1970's. Through qualitative and quantitative approaches, I examined how realtors used block-busting and racial steering to influence racial shifts in the town. This new research goes beyond previous studies because in addition to calculating neighborhood turnover, it investigates several streets in relation to school zone boundaries to answer two questions; How have real estate markets affected racial change in Bloomfield? What relationship do these changes have to its public schools? These questions are particularly significant since racial change in the schools occurred more rapidly than the change town's population. I drew upon archival documents to develop four categories of potential oral history candidates; key historical actors, Bloomfield educators, real estate agents, and residents

living on selected Bloomfield streets. Future steps for this research include, analyzing the oral history interviews and the turnover of selected streets to examine the link, if any between racial changes in neighborhoods and the racial change of Bloomfield schools since the 1960's.

ENGINEERING

39.

5-ELEMENT MODEL OF SYSTEMIC ARTERIAL CIRCULATION IN TIME DOMAIN

Susmita Bhandari 07

Faculty Sponsor: Joseph L. Palladino

A model of the human circulatory system was created using the MATLAB programming language. The core of this system is an analytical model of the heart (Palladino et al., 2005) that treats the heart as a time and volume dependent pressure generator. The heart was coupled to a five-element model of the systemic circulation that was previously studied in the frequency domain (Toy et al, 1985) to describe wave reflection in the pulmonary circulation. This study is the first to apply this arterial model in the time domain. Computed results show that 1) the five-element model is able to serve as a representative arterial load to the heart, 2) computed pressure, volume, and flow curves, as well as system parameters such as stroke volume and ejection fraction, are representative of those measured in humans, and 3) this model is able to separate antegrade (outgoing) from retrograde (reflected) waves from aortic pressure and flow curves. The latter was achieved by devolving the pressure and flow wave forms in the frequency domain via fast Fourier transforms.

40.

AUTOMATION OF FLUID VISCOSITY MEASUREMENTS

Kashif Mohiuddin 08

Faculty Sponsor: Joseph L. Palladino

Viscosity is a measure of a fluid's internal friction and its 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 and strain rate are linearly related, the fluid is said to be Newtonian. Many common fluids (e.g., motor oil, water) are Newtonian. Non-Newtonian fluids include no-drip latex paint, blood, and ketchup. The viscosity of all fluids is highly temperature dependent, and so temperature must be measured as well as shear stress and strain rate.

In this study fluid viscosity was measured with a Brookfield DV-1+ viscometer. Since measurements over a range of temperatures and strain rates is tedious, this project automated data collection using a computer with hardware interface and data acquisition software. A thermistor-based temperature transducer was designed, built, and tested to measure fluid temperature in the range of 0-100 deg C. The voltage output from this sensor and the output of the viscometer were measured using a National Instruments general purpose I/O board to perform analog to digital conversion. LabVIEW software was used to design a graphical interface to this hardware and to display plots of fluid viscosity as functions of temperature.

41.

APNEA MONITOR USING AN 8051-BASED EMBEDDED SYSTEM

Maria Restrepo 06

Faculty Sponsor: Taikang Ning

An 8051-based embedded system was implemented to extract features from respiratory signals classify them, and ultimately detect the presence of apnea. An 8051-based development board was setup to perform calculations involved in biomedical applications. The system used a classificatory algorithm were the Auto Regressive (AR) and zero-crossing models were integrated. In test results, the algorithm performed proper classification of respiratory signals as apnea, normal respiration or respiration with motion. The test results also show that the embedded system is capable to perform the fast calculations necessary for such classification. The embedded system was also capable of indicating the presence of apnea via display.

ENVIRONMENTAL SCIENCE

42.

TOXICITY OF HISTAMINE ANTAGONISTS ON AQUATIC ORGANISMS

Nikki LaBella 06

Faculty Sponsor: Alison Draper

Pharmaceutical contamination of surface water has become an increasing concern due to the potential negative implications for aquatic organisms and human health. The design of once-a-day pharmaceuticals to enhance compliance has resulted in drugs that resist breakdown in wastewater treatment systems and thus, release pharmaceuticals into surface water. Because some of the most commonly prescribed pharmaceuticals are the histamine antagonists, the following drugs were used for toxicity tests: cimetidine, famotidine, nizatidine, ranitidine, astemizole, brompheniramine, diphenhydramine, fexofenadine, hydroxyzine, loratadine, promethazine, and pyrilamine. The toxicity of these drugs was examined on *Selenastrum capricornutum*, *Lemna minor*, *Ceriodaphnia dubia*, *Daphnia magna*, and *Pimephales promelas*, all cultured according to Standard Methods. Exposures were performed using 10 ppm of each drug in the appropriate medium. A two week static assay was performed on *Selenastrum capricornutum* and growth was no different in exposed cultures than in control cultures. In a 96 hr static assay, *Lemna minor* also exhibited little difference in growth when exposed to drugs compared with the control. A 48 hr static assay was conducted on *Ceriodaphnia dubia* and *Daphnia magna* and there was no difference in the mortality rate in treated organisms compared to controls. *Pimephales promelas* underwent a 96 hr static renewal assay in which the drugs also had little effect on the mortality rate. Based on this research, detrimental effects from histamine antagonists at these low, environmentally relevant concentrations are improbable, but environmental effects may be observed with higher concentrations or more susceptible organisms.

43.

MAGNETIC ENHANCEMENT IN LOESSIC SOILS - EFFECTS ON MAGNETIC GRAIN SIZE AND MINERALOGY

Alex Masi 08

Faculty Sponsor: Christoph Geiss

Recently, scientists have discovered that, because magnetic minerals are present in a majority of natural substances, by analyzing the magnetic properties of sediments one can determine changes in climate, such as variations in precipitation, and determine the rate and regional gradients of climatic change. Our work quantifies the presence of hematite, which can appear as a product of weathering, generally reflecting warm climate conditions, or can appear in areas with ample rainfall. In order to detect the presence of hematite, isothermal remnant magnetization, or IRM, will be used. IRM is induced by exposing a sample to a known magnetic field. This magnetic field is produced within a large coil and whatever magnetic materials are present in the sample will have their magnetic moments at least partially aligned by the applied field. Thus far our research has confirmed the presence of hematite in soil samples from Nebraska. The next step in our research is to quantify its presence at various depths soil in the soil profile.

Results from our research will help us to establish hematite concentrations in soils as a paleoclimate indicator and to learn more about the contribution of weakly magnetic minerals, such as hematite, to the magnetic properties of soils.

MATH

44.

AN INVARIANT SEPARATING RATIONAL TANGLES FROM IRRATIONAL TANGLES

Alexis Morley-Lyons 06

Faculty Sponsor: Matthew Horak

A mathematical knot is a closed 1-dimensional “string”, which is embedded into 3-dimensional space. A tangle is a smaller part of a knot which can be surrounded by a circle and have loose ends crossing the circle at four points. A tangle is rational if it can be “untangled” by a finite sequence of twists of the loose ends. Rational tangles form a basis for the classification of knots, and relate to how DNA recombines during replication. We defined invariant properties of tangles in order to classify any given tangle as rational or irrational. The initial conjecture was that the algebraic expression of a rational tangle will never contain either a multiplication of horizontal twists or an addition of vertical twists. Upon investigation of this conjecture, the two properties studied were “chord diagrams” and the “checkerboard shading” of a tangle. While the use of chord diagrams yielded no invariant, checkerboard shading did. For a checkerboard shaded tangle with a graphed directional diagram, we proved that if the graph contains no separating edge, then the tangle is irrational. We proved this conjecture in two parts. The first part shows that if a tangle has a separating edge then it cannot be flyped to a form in which the separating edge does not exist. The second part shows that any rational tangle can be flyped to a form that does have a separating edge. The methods used involved Reidemeister moves, motivated by a prior study of basic topology, an introduction to knot theory, and a brief study of *On the Classification of Rational Tangles* (Kauffman and Lambroloulou, 2004).

45.

CLASSIFYING THE GRAPHS OF CUBIC EQUATIONS

Lisa Pham 08

Faculty Sponsor: David Cruz-Uribe

The graphs of quadratic equations can be classified into three forms with six degenerate cases. The three main types of graphs are ellipses, hyperbolas, and parabolas. Cubic equations, however, are more complex and there exists several kinds of graphs to classify. The most well known classification system for cubic curves was developed by Isaac Newton. There were 76 types of cubic curves in his classification system. Since the development of Newton's classification system, other mathematicians came up with more ways to classify cubic curves. Over the summer, we developed a new classification system for the graphs of cubic equations. We analyzed variations of cubic equations using Mathematica, a math program that helped us to understand the graph geometrically. Later we used algebra to confirm the geometric interpretations of a graph. Cubic equations were divided into groups based on the number of asymptotes and the number of open branches a graph had. In the end, we placed all cubic equations into one of four groups. While classifying the graphs of cubic equations, we found the degenerate cases which included a line and parabola, line and ellipse, line and hyperbola and three straight lines. Beyond this summer's research, students can study the relationship of the coefficients of a specific family of cubics. Further study will reveal more about the local properties of a graph. Local properties can tell us many things about the behavior of graph as the coefficients vary including when a graph will pinch off and form a closed detached loop.

NEUROSCIENCE

46.

HIPPOCAMPAL PLASTICITY IS DEPENDENT ON STIMULUS FREQUENCY IN 30 DAY-OLD RATS

Becket Greten-Harrison 07 and Adam J. Pattison 07

Faculty Sponsor: Harry Blaise

There has long been speculation on what exactly is the key to learning. Recently, long-term depression (LTD) and long-term potentiation (LTP), mechanisms of bi-directional activity-dependent synaptic plasticity, have been implicated in learning and memory. It has been shown that there is a frequency dependent transition from LTD to LTP in the perforant pathway/dentate gyrus synapse of rats, which varies as a function of age. Previous research has shown that in adult (90-day old) and immature (15-day old) rats, sustained low-frequency stimulation (LFS) results in the depression of synaptic activity and sustained high-frequency stimulation (HFS) in the excitation of activity. The transition frequency from LTD to LTP is found to be significantly lower in immature rats than in adults. In the present study, we carried this investigation of age-dependent synaptic plasticity further by examining responses in 30 day-old rats to determine how this intermediate age group compares with 15 and 90 day-old animals. This also permits us to assess any changes occurring in synaptic plasticity during the critical period between 15 and 90 days of age. Change in field EPSP (excitatory post-synaptic potential) slope and population spike amplitudes (PSA) from the original baseline readings were used as vectors for measuring changes in the direction and strength of synaptic plasticity in 30 day-old rats in the vigilance

state of quiet waking after sustained stimulation at varying frequencies (900 pulses total). Tetanization of the perforant pathway occurred at frequencies ranging from 1 to 100 Hz. Our findings indicate that the transition from LTD to LTP occurs between 20 and 25 Hz, thus lying intermediate to those of 15 and 90 day-old rats. These results suggest a rapid development of brain systems involved in the establishment and maintenance of bi-directional synaptic plasticity in rats at 30 days of age.

47.

COGNITIVE EFFECTS OF CHRONIC ORGANOPHOSPHATE PESTICIDE EXPOSURE TO MIGRANT FARM WORKERS

Jesse Hansen 06

Faculty Sponsor: Sarah Raskin

Many reports detail the chronic exposure of migrant farm workers to harmful organophosphate pesticides. In this study, a literature review was conducted to explore the documented effects of chronic exposure of agricultural workers to organophosphate pesticides. Due to several risk factors resulting from some workers' socioeconomic status and inability to communicate and understand English, migrant workers are exposed to high levels of pesticides and have a noted incidence of related cognitive deficits. Previous studies have quantified organophosphate pesticide exposure using fluid samples and interview-administered questionnaires. Furthermore, in these studies the administration of neuropsychological tests has revealed a correlation between chronic exposure and certain cognitive deficits in memory, attention and motor skills. These relevant studies were explored to determine where research has been done in the area of pesticide exposure to migrant workers. Additionally, the ultimate goal was to investigate the ways in which researchers have previously quantified pesticide exposure and evaluated potential neuropsychological deficits in order to shape my own research question and protocol for a study that I will conduct during the upcoming academic year. The goal of this pilot study is to explore whether chronic low level organophosphate pesticide exposure in a population of migrant farm workers in Connecticut has resulted in neuropsychological deficits. Pesticide exposure will be quantified by administering a modified exposure questionnaire used by Keifer et al. (1998) to a group of migrant workers at a local ornamental plant nursery. Neuropsychological functioning will be evaluated by administering the Memory for Intentions Screening Test and the World Health Organization Core Test Battery. Future work will include administering the tests to this population and analyzing the relationship between pesticide exposure and neuropsychological dysfunction in farm workers.

48.

INDUCTION OF LTP AND LTD IN ADENOSINE A1 RECEPTOR-DEFICIENT MICE

Natalie Phouyaphone 06

Faculty Sponsors: Harry Blaise and Susan Masino

Adenosine receptors can be found abundantly in the hippocampus, especially the dentate gyrus, an area frequently associated with long-term potentiation (LTP) and depression (LTD). LTP and LTD relate to the increase and decrease in synaptic efficacy, respectively, when responding to a

stimulus. Although the location of the adenosine receptors found in the dentate gyrus can be implicated in LTP and LTD, its exact role in the phenomenon remains ambiguous. Thus, in an effort to narrow down the precise function of these receptors, electrophysiological methods were employed to freely moving mice so that the neurological response known as an evoked response could be recorded. Electrophysiological data recorded in knock-out (KO) mice that genetically lack the adenosine A1R receptors (A1R) were compared to data obtained from heterozygotes and wildtype groups. The population spike amplitude (PSA) and the excitatory postsynaptic potential (EPSP) were recorded from within the dentate gyrus by implanting stimulating and recording microelectrodes in the hippocampal perforant path and dentate gyrus, respectively. When the results of all mice groups were graphed and compared, the KO animals showed more LTP and LTD expression with than wildtype animals, with heterozygotes exhibiting intermediate levels of LTP and LTD. These results indicate that hippocampal plasticity may be modulated by A1R receptors. These findings further support an inhibitory role for adenosine receptors in regulating NMDA activation which is required for both LTP and LTD induction.

49.

URIC ACID ANALYSIS OF VENTRAL MESENCEPHALON AND CELL CULTURE METHODS IN CD-1 MICE

Cristina Wheeler-Castillo 08, Katie Rodgers 07, and Dika Kuljis 07

Faculty Sponsor: William Church

Previous experiments in which levels of uric acid were manipulated in the nigrostriatal system of guinea pigs and anti-oxidant levels were depleted to observe MPTP destruction of dopamine cells raised questions addressed during this summer's research. In Vitro methods were used and refined, initially culturing Hippocampal cells and later using CD-1 embryonic ventral mesencephalon neurons to conduct experiments. Contamination experiments were also conducted with various solutions essential to cell culture in order to identify the source of yeast and other unexpected growths on culture plates. Plates in final allopurinol experiment fluoresced successfully with DCF and neurons were counted. Cell media from CD-1 mouse was analyzed for uric acid levels.