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# Summer 2009 Research Symposium Abstract Book

Trinity College

# FIFTH ANNUAL
# SUMMER RESEARCH SYMPOSIUM
# TRINITY COLLEGE

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**PLACENTAL INTERFACES IN VIVIPAROUS SQUAMATES AS REVEALED BY SCANNING ELECTRON MICROSCOPY**
Kristie E. Anderson ‘10
Faculty Sponsors: Daniel Blackburn, Ann Lehman

In viviparous squamates, females sustain their embryos by placentas that provide oxygen, water, and nutrients. We use multiple techniques in studies of placental morphology and find scanning electron microscopy (SEM) particularly useful in revealing surface features at the maternal-fetal interface. In the chorioallantoic placenta of various viviparous squamates, SEM reveals that chorionic and uterine epithelia are attenuated but not eroded, contrary to inferences based on light microscopy. SEM also reveals extensive capillary beds beneath the chorionic and uterine epithelia. The yolk sac omphalopleure shows cellular specializations for absorption in certain thamnophine snakes, and in the lizard *Sceloporus jarrovi* it bears surface ridges of unknown significance. SEM observations support the idea that the two placental types are specialized for distinctly different functions.

**2.**
**HISTOLOGY OF THE CHORIOALLANTOIC PLACENTA OF WATER SNAKE, *NERODIA SIPEDON***
Jessica Chin ‘12
Faculty Sponsor: Daniel Blackburn, Ann Lehman

Using histology methods, we have been able to view how the uterus changes from pre-pregnancy through to post-pregnancy of a water snake known as *Nerodia sipedon*. This species of snake is viviparous, meaning they give birth to live young, and usually mate between April and June and then bear their young between June and November. We compared the three features of the chorioallantoic placenta: the epithelium, glands, and vascularity, to detect changes in the uterus and placenta membranes that occur during gestation. There were notable differences between the pregnant and non-pregnant placenta in all three of these features, such as the chorioallantois and uterus show increased vascularity throughout gestation to facilitate maternal-fetal gas exchange. Also to facilitate increased gas exchange, the maternal and fetal epithelium decreased in epithelial height.

**3.**

## THE EFFECTS OF MUTATED SERRATE LIGANDS ON THE NOTCH SIGNALING PATHWAY IN *DROSOPHILA MELANOGASTER*

Gina V. Filloramo ‘10
Faculty Sponsor: Robert Fleming

The Notch signaling pathway is a highly conserved cell-to-cell signaling system that controls cell fate. In *Drosophila melanogaster,* the transmembrane protein, Serrate (Ser), acts as a ligand capable of binding to and activating the Notch receptor on adjacent cells. Conversely, when Ser and Notch are co-expressed on the same cell surface, Ser has the ability to inhibit the Notch receptor, a phenomenon termed, cis-inhibition. Earlier studies have shown that specific regions of the Ser protein are required for interaction with Notch. The dominant-negative allele of Ser, *Beaded (Bd)* lacks the intracellular domain. While this form of Ser retains the ability to cis-inhibit Notch, it loses the ability to trans-activate. Recently, we have found that an altered form of Ser that lacks the $6^{th}$ EGF-like repeat is no longer capable of cis-inhibition, indicating that this specific EGF-like repeat is required for this property. To understand the properties of the EGF-like repeat deleted form, two genetic constructs were built, both of which were lacking in their intracellular and transmembrane regions. One construct is simply the *Bd* molecule and will serve as an experimental control. The second construct is a combination of the $6^{th}$ EGF-like repeat deletion and the *Bd* form. The goal of the experiment is to determine if the $6^{th}$ EGF-like repeat deletion can override the *Bd* cis-inhibiting form. DNA from each construct was isolated and injected into germ cells to generate transgenic animals in which we will observe Notch and Ser expression in the imaginal wing discs of *D. melanogaster.* We will present our current data with interpretations and models for function aspects of the Ser ligand.

**4.**

## A BIOSYNTHESIS EXPERIMENT TO DETERMINE THE ORIGIN OF A GERMACRENE SESQUITERPENE IN THE PUPAL DEFENSIVE SECRETION OF THE LADYBIRD BEETLE *DELPHASTUS CATALINAE*

Jackie Knapp ‘10
Faculty Sponsor: Scott Smedley

Insects are known to utilize chemicals such as terpenes as pheromones, hormones and defensive secretions. Both the larval and pupal stages of *Delphastus catalinae* (Coleoptera: Coccinellidae) have glandular hairs that secrete a novel germacrene sesquiterpene and polypropanoids, both of which serve a defensive role against predatory ants. The larvae of *D. catalinae* feed on the immature stages of the whitefly *Bemisia tabaci.* A previous study conducted by Patrick McCarthy (Class of 2009) used $^{13}$C-labeled and unlabeled sodium acetate, a possible precursor to sesquiterpenes, to determine whether the germacrene was biosynthesized *de novo* by the beetles or sequestered from the diet. I conducted a biosynthesis experiment in which $^{13}$C- labeled and unlabeled glucose were applied to the whitefly egg diet and presented to later instar *D. catalinae* larvae. The larvae were allowed to pupate and were then sampled for chemical analysis to establish whether glucose was incorporated into the germacrene molecule, thus indicating *de novo* biosynthesis, or whether it was sequestered directly from the diet. Results of the chemical analysis are pending.

**5.**

**THE EFFECT OF COMPOST PILE CONTENT ON INVERTEBRATE INHABITANTS**

Jessica Scordamaglia ‘10
Faculty Sponsor: Scott Smedley

Residential composting has become a popular practice for environmentally conscious households. Composting decreases the amount of biodegradable waste going into landfills. In addition to bacteria, fungi, and other microbes, many macro-organisms are also involved in the decomposition in a compost pile. A survey was conducted to compare invertebrate communities in three compost piles of varying content. The piles included a vegetable products pile, an animal and vegetable products pile, and a control pile with no food scraps, but with the same leaf mulch core and straw cover as the other two piles. The experiment was conducted in a rural/residential area in Andover, Connecticut from June 1 – August 12, 2009. Three invertebrate sampling techniques were utilized. Pitfall traps were used to collect ground-crawling invertebrates along the pile periphery. Adhesive-coated sampling cylinders above the piles were used to collect flying insects. Tullgren funnels were used to collect invertebrates living directly within the piles’ mulch and straw. Primary activities during the summer field season included planning the sampling strategy, collecting and processing samples, and maintaining the piles. During the upcoming academic year, the invertebrates within the samples will be identified, then quantified to compare the communities among the three different compost piles.

**6.**

**BACTERIAL INTERFERENCE: A STUDY OF THE NORMAL FLORA IN THE UPPER RESPIRATORY TRACT**

Andrew Williamson ‘10, Tiffany Damiani ‘12
Faculty Sponsor: Lisa-Anne Foster

Bacteria composing the normal flora of the human upper respiratory tract (URT) serve a variety of roles. One important function is the inhibition of more pathogenic bacteria from colonizing the URT. Identifying the species of bacteria within the normal flora is essential to understating the effect these commensal organisms can have in protecting the human body from infection. This study examines the efficacy, accuracy, and sensitivity of identifying species of bacteria using polymerase chain reaction and restriction fragment length polymorphisms of the 16S rRNA gene. Applying these methods for bacterial detection, we hope to find a correlation between the abundance of specific species of bacteria present and predisposition to illness.

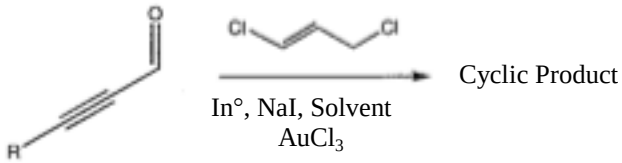
# CHEMISTRY

**7.**

**CYCLIZATION USING INDIUM METAL AND BENIGN CONDITIONS**

Laura Anderson ‘10
Faculty Sponsor: Thomas Mitzel

The uses of more environmentally benign reaction conditions have been of great interest to research in organic chemistry. Currently, chemical conditions to develop important molecules in organic synthesis require inert conditions, and solvents that require special disposal considerations at great cost. Aqueous solvents, coupled with multi-step one-pot reactions lead to greater efficiency and resourcefulness. Previous work in the Mitzel laboratory has established the possibility of a cascade reaction involving an indium promoted Barbier coupling followed by a Cope-rearrangement. This project concentrates on a one-pot cyclization using a gold (III) promoted cascade reaction, which follows an indium-promoted Barbier coupling of a propargyl aldehyde with a dihalide.




**8.**

**THE COORDINATION OF TUNGSTEN TO FOUR DIFFERENT HYDROCARBON DIYNE MOLECULES**

Adam Boynton ‘12
Faculty Sponsor: Timothy Curran

Past research by (Curran *et al.*, 2002) showed that it is possible to coordinate one tungsten to two alkynes situated on a peptide strand, forming a cyclicpeptide. But these cyclicpeptides were complicated structures, and the only cyclic complexes yet studied had involved peptides. So the goal of the following project was to study tungsten cyclic coordination in simpler molecules, specifically hydrocarbon diynes. A diyne is any molecule that contains two alkyne groups, and employed in this research were hydrocarbon chains consisting of seven, eight, nine, and ten carbons – 1,6-heptadiyne, 1,7-octadiyne, 1,8-nonadiyne, and 1,9-decadiyne, respectively – with the alkyne groups located at each end of the molecules. The aim was to try and coordinate the two alkyne groups in each molecule to tungsten to form a cyclic complex. The tungsten complex $[W(dmtc)_2(CO)_3]$ was synthesized by reacting previously formed $[W(CO)_5I][Et_4N]$ with $I_2$ and dmtc. The orange $[W(dmtc)_2(CO)_3]$ complex was then reacted with each of the four diyne molecules in a 1:1 molar equivalent in a refluxing solution of degassed methanol. Each of the four reactions yielded a yellow solution, which signified that a tungsten bis(alkyne) complex had formed. TLC analysis of each of these yellow solutions indicated that in all cases more than one

product had formed. Flash chromatography was used to attempt to isolate each of the desired [W(dmtc)$_2$(diyne)] products. The products obtained via flash chromatography were analyzed with HPLC, MS, and $^1$H NMR, which revealed no evidence of any desired product. The MS data suggested that the starting alkynes had decomposed to smaller molecules, but the nature of the decomposition is not known.

**9.**
**TITLE**

Christopher Gromisch '11
Faculty Sponsor: Olivier Nicaise

Chiral chemistry and the manipulation of stereochemistry has become important in the development of chemical drugs and products. Isomers, chemicals of the identical chemical formula but differenting structure, can have radically different properities. Understanding how to manipulate the geometric structure of a certain compound is necessary in chemical work. The ultimate goal of my research was to use a specific configuration of a chiral diol to select for a specific stereochemical product. The desired product, an aromatic, bicyclic alcohol, occurs in a racemic mixture of the two enantiomers (non-superimposable chemical mirror images) under standard conditions. However, by using the chiral diol, which has serves as an intermediate in the reaction, we can create two diastereomers, which do not occur in a racemic mixture. The use of low temperatures (our reaction would theoretically occur at -78$^o$C), favors a specific diastereomer over the other. Before using the chiral diol, it was necessary to receive a high yield of the desired alcohol under the low temperature conditions. Decreasing the reaction temperature decreases the available energy of the system, slowing the reaction rate and affecting the product yield. To compensate for this loss of reactivity, we first synthesized a reactive aromatic compound, a disubstituted benzene ring with a bromine and triflate substituent. We then reacted butyl lithium with di-isopropyl amine to product di-isopropyl amide (LDA) and reacted the LDA with cycloheptanone to produce an enolate. The enolate was reacted under the presence of the benzene compound and butyl lithium to produce the desired product, while kept in an anhydrous environment at -78$^o$C. This beginning reaction was altered by using different stoichiometric amounts of the aromatic compound, the base, butyl lithium, as well as using different bases (LiNCY- lithium dicyclohexyl amine) to reduce the side products. The reactions show that the base used to produce the enolate also forms significant side-product, because the produced benzyne is so reactive. The reactivity of benzyne has led to a highest yield of about 80%, and therefore, a less reactive base will need to be used to produce higher results. Before the desired reaction can occur, the yield of the reaction must be higher.

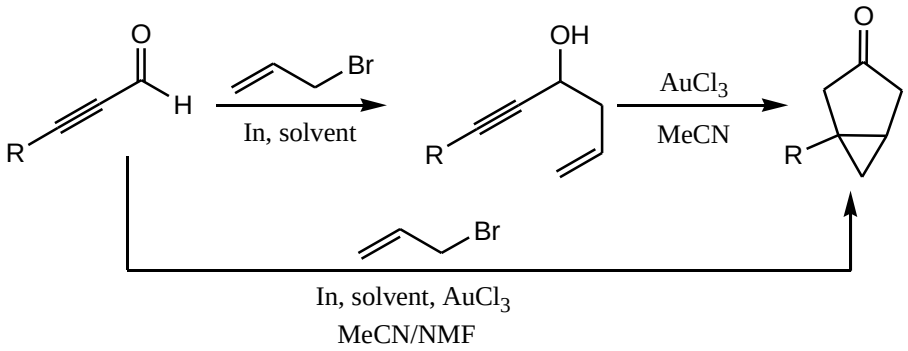
**10.**
**X-RAY PHOTOELECTRON SPECTROSCOPY STUDY OF POTASSIUM IODIDE SOLUTION SURFACES**
John Hasychak III ‘11
Faculty Sponsors: Maria Krisch, Hendrik Bluhm

Many atmospheric aerosols undergo photochemical reactions which have a large effect on atmospheric chemistry. Studies have shown that many tiny liquid droplet aerosols can behave differently than would be expected of bulk liquids undergoing photochemical reactions, possibly due to their large amount of surface area relative to their volume. This study focuses on the photochemistry of potassium iodide on the surface of an aqueous solution and the changes due to increased distance from the liquid-gas interface. A saturated solution of potassium iodide was exposed to an ultraviolet laser in a vacuum. X-ray photoelectron spectroscopy at the Advanced Light Source Synchrotron was used to analyze the contents of the potassium iodide solution at different depths of the surface of the solution, before, during and after UV exposure. Results were expected to show that reactions occur more readily closer to the surface of the liquid. Initial results do not show any depth dependant differences in the potassium iodide photochemical reactions.

**11.**
**MAPPING THE TYPE I COLLAGEN BINDING SITE ON OSTEOCALCIN**
Andrew M. Janiga ‘11, Joseph C.C. Lim ‘12
Faculty Sponsor: Richard Prigodich

Osteocalcin and Collagen are two of the main proteins that play a role in bone structure. It is known that these two proteins bind together. Prior research showed that a peptide derived from the first 14 amino acids of the amino-terminus of osteocalcin will bind to collagen. Preliminary tests with 10, 12, 14, and 16-mer osteocalcin solutions yielded similar results. This study will complete a quantitative analysis of amino terminal peptides of 10, 12, 14 and 16 amino acids in length to determine what portion of the osteocalcin molecule is binding to collagen.

**12.**
**GOLD CATALYZED CYCLIZATION**
Jo-Ann Jee ‘10
Faculty sponsor: Thomas Mitzel




Gold catalysis has attracted much attention in recent years due to the role it plays in cycloisomerization reactions involving alkynes, alkenes and allynes (Hong, 2008). Previous

research in our lab has shown that the two step coupling-cyclization reaction between the phenol propargyl aldehyde and allyl halide system is possible with gold catalysis. The goal is to obtain cyclization with various R-groups under similar conditions. This research focuses on the use of tetramethylsilane (TMS) as the R-group. The results of the attempt at the cascade reaction will be discussed.

**13.**
**USING FTIR SPECTROSCOPY TO DETERMINE SECONDARY STRUCTURES OF HEMOGLOBIN AND LYSOZYME**

Pratheek Kalyanapu '12
Faculty Sponsor: Richard Prigodich

Scientists have used FTIR spectroscopy as a means of studying secondary structure of proteins for quite a while (Griebenow *et al*, 2000). Even though other techniques, such as crystallography, and NMR spectroscopy, can give more detailed structural information than FTIR spectroscopy can the main strength of FTIR is the fact that it is possible to investigate structural changes in a protein under conditions that is not directly non-invasively accessible by other spectroscopic methods (Griebenow *et al,* 2000). A solution of 10 mg/mL bovine hemoglobin in tris buffer was prepared and was placed on to the FTIR and purged for 24 hours and scanned. A solution of 10 mg/mL of Lysozyme in tris buffer was also scanned in a similar way to the hemoglobin.

**14.**
**DOES CONFORMATION PROTECT A PEPTIDE FROM CLEAVAGE?**

Michael Lee '10
Faculty Sponsor: Timothy Curran, Bruce Frank Summer Research Fellowship

Amino acids are the building blocks for proteins, and these amino acids can be strung together in long chains, and these chains can take on specific three-dimensional conformations that give a protein its secondary, tertiary, and quaternary structures. Within the protein, one of the secondary structures adopted is the helix. Protease enzymes cleave peptide and protein chains, usually at specific amino acids in the peptide or protein sequence. It is generally believed that proteases will only act on peptides in an extended conformation.

The goal of this study is determine whether a constrained tetrapeptide having a helical conformation is protected from undergoing hydrolysis by the protease chymotrypsin. Previous research by Emma Handy accomplished the synthesis of a tetrapeptide crosslinked by a tether that joins two lysines and a 1, 1'-disubstituted ferrocene, and the helical conformation was confirmed with NMR methods. Current research is focused on the solution-phase crosslinking of the tetrapeptide Lys-Phe-Ala-Lys with 1,1'-ferrocene diacid chloride. Once crosslinked, the ferrocene-tetrapeptide complex will be analyzed using NMR methods to determine if it has a helical conformation. Both the constrained and unconstrained tetrapeptides will be tested using HPLC techniques to see if they undergo cleavage by chymotrypsin, which is known to cleave the Phe-Ala peptide bond.

**15.**

## 1-DIMENSIONAL STACKING OF FERROMAGNETIC NANOPARTICLES IN ANODIC ALUMINA

Jack Love ‘10
Faculty Sponsor: Richard Farrell (UCLA), Sarah Tolbert (UCLA)

When magnetic particles align, there is an anisotropic magnetic coupling effect between the particles, which is desirable for many magnetic device applications. Different templates with cylindrical shapes have been used to confine magnetic particles in order to induce this 1-dimensional coupling. Under anodic conditions, the oxidation of aluminum results in the growth of pores whose size and spacing can be directed by adjusting the anodization conditions, making it an attractive template. While most AAO growth results in pores between 50 and 150 nm in diameter, conditions are used that produced sub-10 nm pores in thin films (50-200nm) of aluminum. Ferromagnetic iron/platinum nanoparticles are then incorporated into these pores. The magnetic properties of the composite films are studied using SQUID magnetometery and magnetic force microscopy. The substrates are studied in three different orientations with respect to the applied magnetic field in order to better understand how the particles align within the pores. The saturation magnetization varied between the different orientations indicating anisotropy in the film. Nanoparticles with a coercive width of 945 Oe showed increases in coercivity of 10-30% when incorporated in the AAO. This increase suggests that the chains of particles are coupling. The films showed normalized remnant magnetization values ranging from 0.15 to 0.4 which are below the expected value of 0.5 for ferromagnetic materials. This suggests that there is anti-ferromagnetic behavior in the system caused by the particles aligning in a zig-zag pattern inside the pores. This work demonstrates a bottom up approach to creating anisotropy in a nanoscale system

**16.**

## METALLACYCLICPEPTIDES DERIVED FROM COORDINATION OF ALKYNYLCYSTEINES TO TUNGSTEN

Thomas McTeague ‘12
Faculty Sponsor: Timothy Curran

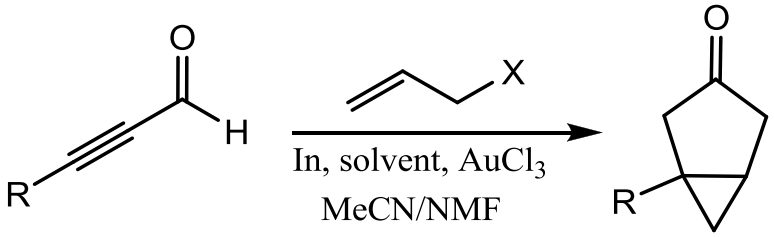
The helix-turn-helix protein conformation, a combination of helix and turn secondary structures, is a DNA binding domain in transcription factors. In particular, protein turns form due to hydrogen bonding between nearby amino acids. This research sought to prepare a short peptide constrained to a turn. The peptide would have two cysteines that had propargyl groups attached to the side chain thiol. The two alkynes would then be crosslinked to a tungsten via reaction with $W(CO)_3(dmtc)_2$. *L*-cysteine hydrochloride hydrate was reacted with propargyl bromide in a solution of sodium ethoxide. The resulting product was dissolved in THF and reacted with $Boc_2O$ and triethylamine in deionized water to obtain Boc-Cys($SCH_2CCH$)-OH. By reacting the Boc-Cys(SCH2CCH)-OH with either anisidine or *N*-hydroxysuccinimide and EDC in methylene chloride at 0°C and allowing to slowly warm to room temperature, a Boc-Cys($SCH_2CCH$)-anisidine and a Boc-Cys($SCH_2CCH$)-OSu were both synthesized respectively. After removing the Boc protecting group from the Boc-Cys($SCH_2CCH$)-anisidine, the deprotected amino acid was then reacted with the previously synthesized Boc-Cys($SCH_2CCH$)-OSu, to form a Boc-

Cys($SCH_2CCH$)-Cys($SCH_2CCH$)--anisidine. This dialkynylpeptide was then reacted with $W(CO)_3(dmtc)_2$ in a refluxing solution of methanol under nitrogen atmosphere until the solution became yellow, and the desired tungsten dialkynylpeptide complex was formed. The resulting product was then purified by flash chromatography using a 1cm column and a 1:1 solution of ethyl acetate:hexanes as the eluant. $^1H$ NMR and mass spectroscopy were then utilized to confirm the structure and identity of the purified product. Studies aimed at discovering whether this molecule adapts a turn are underway.

**17.**

**CYCLIZATION OF AN IMINE USING INDIUM METAL**

Katie Pearson ‘10
Faculty Sponsor: Thomas Mitzel




A main focus of the world today is improving the environment. The use of more environmentally friendly reaction conditions to carry out chemical transformations would aid a great deal in this area. This research focuses on the introduction of different reagents and solvents into reactions to form molecules, that are popular templates in organic synthesis, but are currently formed under “harsh” conditions. Indium metal has been shown to promote C-C bond formations under environmentally benign conditions, including the use of water as an “organic” solvent, with good regio- and stereocontrol. Previous research in the Mitzel laboratory has shown that the use of indium metal has led to not only an oxy-cope rearrangement but also a cyclization of an alcohol product. The cyclization of the alcohol product was done in a two pot reaction where the first step focuses on the coupling of an aldehyde to a allyl halide and the second focuses on the cyclization of the coupled product using indium and gold as a catalysts. The main focus of the research conducted this summer was to complete the cyclization in one pot.

**18.**

**DEVELOPMENT OF A METHOD TO STUDY LIQUID-VAPOR INTERFACE PHOTOCHEMISTRY**

Baltazar Ramos ‘11, John Hasychak III ‘11
Faculty Sponsor: Maria Krisch

Evidence suggests that liquid-vapor interfaces may exhibit different chemical properties than the bulk of the liquid. Understanding these different properties is essential in understanding the chemistry of atmospheric aerosols since they have a large surface area to volume ratio. This study focuses on the marine aerosols that contain the photochemically active organic compounds, such as $CH_2ICl$ $CH_2IBr$ and $CH_2I_2$. These organic compounds were chosen because it is known that halogens affect ozone chemistry. The driving force of this study is to

photochemically react these organic compounds in a KI solution, which is also photochemically active, using a droplet train that imitates aerosols in order to compare interfacial vs. bulk reaction. We discuss construction of the droplet apparatus and different methods tested for analysis of the products, including UV-Vis, fluorescence, and IR spectroscopy.

**19.**

**ACCELERATING EFFECTS OF LEWIS ACID CATALYSTS IN THE FORMATION OF A CYCLIZED PRODUCT**

Linda Tam ‘10
Faculty Sponsor: Thomas Mitzel

The idea of cyclization has been studied extensively in Organic Chemistry and has become an interest in the lab. The formation of a cyclized product has been achieved repeatedly in the field. However, our interest mainly focuses on establishing the appropriate reaction conditions to synthesize a cyclized product under a one-pot synthesis. These conditions include sonication, stirring, and change of solvents. To further understand the electro flow during this particular chemical reaction, different Lewis acid catalysts (AuCl and AuCl3) were used in hopes of inducing rearrangement and cyclization.

**20.**

**STEREOSELECTIVE SYTHNESIS OF 3’-DEOXY 3’-C-BRANCHED-CHAIN SUBSTITUTED THYMIDINE**

Mallory Thomas ‘11, Monica Au-Yeung ‘12
Faculty Sponsor: Richard Prigodich

The goal of this research project is to synthesize a phosphonamidite that will be able to be employed in solid-phase oligonucleotide synthesis. Double-stranded oligonucleotides containing a single phosphonate nucleotide could then be synthesized and used in studying the binding of metal ions to nucleic acids. Metal ion binding to nucleic acids is important in controlling nucleic acid structure. The phosphonate nucleotide will have the 3'-oxygen atom replaced with a methylene group. This phosphonate will have a unique 31P-NMR chemical shift compared to phosphate nucleotides and the coupling between the methylene protons and the phosphorus atom is sensitive to the binding of metal ions in inner sphere vs outersphere coordination modes. Thus far, three intermediate products have been successfully synthesized. Thymidine was the first (already-synthesized) deoxynucleoside used in the series of steps, along with numerous other reagents to convert from product to product. After each synthesis, tests such as TLC and column chromatography were used to purify each successive compound. Mass spectrometry and H-NMR spectroscopy were used to confirm the structure of each successive product.

# COMPUTER SCIENCE

**21.**
**POSIT: PORTABLE DISASTER MANAGEMENT TOOLS**
Antonio Alcorn ‘10, Gong Chen ‘12, Christopher Fei ‘10, Qianqian Lin ‘11
Faculty Sponsors: Ralph Morelli, Trishan deLanerolle

Imagine you are a rescue worker searching for victims and survivors in the aftermath of a hurricane or other natural disaster. Or, imagine you are botanist mapping a geographical area for an invasive species. Or, an environmental scientist searching for hazardous waste deposits.

What's needed is a portable tool that is able record information about */Finds/* and transmit it to a central server or control center.

As mobile phone technology becomes ubiquitous and more powerful, such a tool is now feasible. Building such a device on the FOSS Android platform would make it widely and freely available to rescue workers, environmental scientists, and other field workers.

**22.**
**IMPROVING THE KNOWLEDGE OF AN ARTICLE BY SEARCHING A DISEASE ONTOLOGY**
Fouad Elkhoury ‘11, Nicolae Dragu ‘12
Faculty Sponsors: Ralph Morelli, Takunari Miyazaki

InSTEDD (Innovative Support To Emergencies Diseases and Disasters) is a non-profit organization whose mission is to harness the power of technology to improve collaboration for global health and humanitarian action. Evolve, an integrated environment of InSTEDD, enables detection, prediction and response to health-related events. The current project extends the functionality of Evolve by serving the role of a plug-in within this system and augmenting the knowledge of news articles by parsing them and offering information about the most probable diseases that are referred to in the articles. As new news articles become available in Evolve, they are directed to our system which parses the words and tries to find matches with the Biocaster disease ontology (a medical vocabulary for diseases). Based on a scoring metric, the most probable diseases that are referred to in the news articles receive the most number of points. The output of the system is then given to human experts to check the veracity of the results and to confirm whether the news articles refer to a disease outbreak or not. Future work on this project should be directed towards improving the matching algorithm between the news articles and the disease ontology, and the scoring metric.

**23.**

## GNOME ACCESSIBILITY: MOUSETRAP AND VIZAUDIO

Rachel Foecking ‘11, Ryan Gee ‘11, Ted Nichols ‘10
Faculty Sponsors: Ralph Morelli, Trishan de Lanerolle, Takunari Miyazaki, Norman Danner (Wesleyan), Danny Krizanc (Wesleyan)

The GNOME Accessibility Project, part of the GNOME project, a free desktop environment for the Linux operating system, fosters open source application development that supports accessibility for all users regardless of physical or mental difficulties. This poster describes two new GNOME Accessbility projects being worked on by students at Trinity College and Wesleyan University as part of the Humanitarian FOSS Project: MouseTrap and VizAudio.

Mousetrap is a standalone GNOME application, started by Flavio Percoco Premoli, that allows users with physical impairments to move a mouse cursor. It uses a webcam to track the motion of any object visible by the camera and moves the mouse cursor along the path of the tracked object. Distributed with software that allows accessible mouse clicking, Mousetrap will give most physically impaired users access to the full functionality of a mouse.

VizAudio is a system that will help hearing-impaired users use GNOME applications. The idea behind VizAudio is to create a framework that allows developers to create direct links between audio events and visual events. For example, if an instant messaging client plays a sound when a message is received, the screen might flash to indicate to a deaf user that an event of interest has occurred.

**24.**

## COLLABBIT - COMMUNICATION MADE EASY

Dimitar Gochev ‘11, Eli Fox-Epstein ‘11, Sam DeFabbia-Kane ‘11
Faculty Sponsor: Ralph Morelli, National Science Foundation

Originally named VirtualEOC (Emergency Operations Center), Collabbit is a web-based system which aims to facilitate the sharing of potentially vital information between groups or individuals. The idea originated from the New York City Office of Emergency Management and the primary goal was to build a piece of software which would allow for rapid exchange of information among various organizations active in disaster. However, the flexibility of the system allows it to be used for many other purposes.

# ECONOMICS

**25.**
**GAME THEORY AND THE PERSISTENCE OF IRRATIONAL BEHAVIOR**
Trang Luong ‘11
Faculty Sponsor: Arthur Schneider

Game theory asserts that people will consistently behave rationally and act in their own self-interest. Said theory holds as true that players in competition will interact with an opponent so as to maximize their personal profit regardless of any losses made by the opposing player. Experimental data, however, has failed to support the assertions made by Game theory. In the first section of this research paper, we will explore concepts and phenomena that contradict Game theory, such as Regret theory, Prospect theory, altruistic behavior, and Theory of social preferences, and explain how players in competition will often behave irrationally against their own self-interest. The second section will consist of our explanation and elaboration on games designed to test for the manifestation of the above mentioned concepts and phenomena when actual players are placed in competition.

# ENGINEERING

**26.**
**POINT OF GAZE**
Kevin Huang ‘12
Faculty Sponsor: Taikang Ning

The use of personal computers oftentimes requires the use of the user’s hands (navigation via computer mouse, typing with the keyboard etc.). Therefore, those with physical impairments or disabilities that limit or prohibit precise motor function of the hands may find computer use difficult. Although these persons are unable to utilize hand motion as a method of computer use, specifically use of a computer mouse, tracking the location that the user is looking on a computer screen is possible through image processing with the proper instrumentation. This project focuses on the design and construction of an eye gaze tracking device, which consists of light emitting diodes (LEDs), a stereo camera and image processing hardware. The LEDs, placed at the corners of the computer screen, emit light that is reflected off the user’s cornea. A stereo camera is then used to capture the snapshot image of the user’s eye at various time points. Because of the curvature of the cornea, the glint positions relative to physical components of the eye, such as pupil center, optical axis and visual axis, can contain information of where the user is looking. However, since the physical properties of each human’s eyes are different, the user will be required to undergo a calibration phase. To estimate the point of gaze of the user, a series of image processing techniques and algorithms that relate the glint position to eye gaze will then be used. Future improvements include the addition of a “mouse clicking” function to fully emulate/replace the use of the computer mouse.

**27.**

**AN INEXPENSIVE NON-INVASIVE BEAT-TO-BEAT DETECTION OF BLOOD PRESSURE WAVEFORM AND ITS APPLICATION IN CARDIOVASCULAR SYSTEM**

Jin Feng Liu ‘12
Faculty Sponsor: Taikang Ning

One of major problems of the modern clinic is lack of non-invasive beat-to-beat detection of blood pressure waveform. This work presents a novel technique to measure blood pressure waveform noninvasively, and analyze the connection between blood pressure waveform and the cardiovascular health. The design consists of utilizing BIOPAC Photo Plethysmograph Transducer TP-TSD200 to monitor the blood pressure waveform, and BIOPAC PPG100C Amplifier to amplify and record blood pressure waveform. Furthermore, this work contains a designed filter which was simulated by using Orcad Cadences Capture, and then built it. The filters is use to minimize the background noise from the waveform. To validate the technique, we will monitor and record blood pressure from ten subjects, the results will be analyze and compare with other blood pressure monitoring technique. The observation will allow us to find the most efficient and accurate way to detect blood pressure.

**28.**

**TITLE**

Kumud Nepal ‘09, Adam Wright ‘10, Orko Momin ‘10, Young Ho Shin ‘11, Rahul Shakya ‘11, Prasanna Gautam ‘11, Sarthak Khanal ‘11, Binay Poudel ‘12
Faculty Sponsor: David Ahlgren

Q is an autonomous robot designed and built by members of the Robot Study Team at Trinity. The primary objective of the Q project is to design a robot that can autonomously navigate an unknown environment while avoiding obstacles. Q uses the NI CompactRIO as the main processor and utilizes a variety of different sensors including a differential GPS unit, a digital compass, a SICK laser range finder, and webcams to detect obstacles and guide its way through an obstacle course. A Dell laptop is used for user input and debugging purposes as well as to process image data streamed from the cameras. The main algorithm used for obstacle avoidance is a modified version of the Vector Field Histogram (VFH) with added path planning capabilities, allowing it to avoid nearby obstacles while maintaining its general direction. While Q is mainly used as an entry to the Intelligent Ground Vehicle Competition (IGVC), the methods developed are relevant to a wide range of robotics applications that require autonomous navigation in an unknown environment.

**29.**

## A REALISTIC ROAD MODEL FOR SIMULATING MULTIPATH AND AOA IN VEHICULAR NETWORKS

Ankit Saraf ‘10
Faculty Sponsor: Lin Cheng

Vehicular networks exhibit Dedicated Short Range Communications (DSRC) systems as a means to support safety and service operations on roads.

Because vehicular networks bring significant potential for a wide range of services and applications, it is important to have a detailed understanding of various vehicle-to-vehicle (V2V) propagation channels that cover different types of road scenarios. Using observations from realistic on-road data, this work describes a model for the V2V channel based on scattering objects distributed on the road and along the roadside. The model was developed in different versions with the addition of a new parameter or the improvement of an existing parameter in each new version. The basic scenario in all versions consisted of a transmitter and a receiver vehicle traveling on the same lane alongside other vehicles on the road in either a rural, suburban or a highway type road environment. MATLAB was used to simulate the model and to generate graphs. The existing code generates plots for signal strength vs. angle of arrival (AOA) and time delay of arrival (TDOA) of multipath components of the received signal from various on-road and roadside scatterers. However, the code can be easily changed to produce plots for other related information.

**30.**

## AUTOMATIC CLASSIFICATION OF RESPIRATORY STATE

Lorenzo Sewanan ‘12
Faculty Sponsor: Taikang Ning

Apnea is defined as the lack or severe reduction of the ability to breathe, which occurs most notably during sleep. Sleep apnea has been linked to hypoxia, hypercapnia, congestive heart failure in adults, and sudden infant death syndrome (SIDS). Especially in the case of infants, close and accurate monitoring of the respiratory state of individuals that are at risk for or experience sleep apnea is crucial to preventing any potential fatal effects by allowing timely intervention. This project focused specifically on the classification of respiratory based on the respiratory signal. The signal data was collected using a strain gauge transducer from volunteer individuals who emulated normal breathing, apneic breathing, and breathing with motion. Initial conditioning of the signal included amplification, filtration, and time epoch segmentation. Processing of the data included estimating respiration rate through use of a modified zero-crossing algorithm and analysis in the frequency domain of the signal’s energy through use of the Discrete Fourier transform. Preliminary results have shown that apnea can be always be indentified; however, in the case of normal respiration or respiration with much artifact, the state is sometimes not clearly determinable using these methods.

**31.**
**TRINFACTOR III**
Adam Wright ‘10, Orko Momin ‘10, Binay Poudel ‘12
Faculty Sponsor: David Ahlgren, National Collegiate Inventor and Innovator Alliance (NCIIA)

Trinfactor III is a peripheral device for the LEGO Mindstorms NXT -LEGO’s programmable brick for robot control- which was developed by Trinity College Robot Study Team under the funding of National Collegiate Inventor and Innovator Alliance (NCIIA). The Trinfactor III gives NXT users the freedom to connect eight analog sensors to their robot, instead of being limited to the sensors sold by LEGO. The Trinfactor III uses a PIC microcontroller to read from the eight analog sensors, and to relay the sensor data to the LEGO NXT via an I2C serial port. Recently, work was done to condense the prototype Trinfactor III circuit into a much smaller package in order to prepare it for commercial sale. Mentor Graphics PADS software was used to redesign the layout of the printed circuit board in order to make board smaller. Circuit elements were added to add features such as a “Battery OK” indicator and a power-saving feature that allows the board to shut off the sensor ports when they are not being used. SolidWorks, a 3D modeling software, was used to design a new enclosure for the product that can be easily attached to LEGO pieces. Upon the completion of the project, Trinfactor III will be an efficient and handy add-on to NXT.

# ENVIRONMENTAL SCIENCE

**32.**
**MERCURY CONCENTRATION IN SEDIMENT IN THE SOUTH BRANCH OF THE HARTFORD WATERSHED**
David Burszan ‘12
Faculty Sponsor: Jonathan Gourley

The South Branch of the Park River is an urban river that flows through the Hartford Watershed. Because there are many industries in the South Branch, it is possible that the branch has been polluted with mercury. Sediment samples were obtained from four brooks in the South Branch. The results show two trends. The first is that mercury concentration increases further downstream. The second is that point sources contribute to the mercury concentration in sediment. Because of this, some of the mercury in sediment is caused by pollution. Future research could compare mercury levels from the Hartford Watershed with water statewide. This would determine how healthy the Hartford Watershed is relative to the state average.

**33.**

## CONTROL OF INVASIVE JAPANESE STILTGRASS (*MICROSTEGIUM VIMINEUM*) IN CONNECTICUT USING MECHANICAL AND HERBICIDE TREATMENTS

Elisabeth N. Cianciola ‘10
Faculty Sponsor: Jeffrey S. Ward

Japanese stiltgrass [*Microstegium vimineum* (Trin.) A. Camus] is native to eastern Asia, and was first observed in Connecticut in the 1980s. It is an annual C4 grass which spreads by seed. As an invasive species, Japanese stiltgrass disrupts local ecosystems by outcompeting native grasses and herbaceous plants and seedlings for light, space, water, and nutrients. In turn, the fauna that depends upon the native biodiversity suffers as Japanese stiltgrass stands spread. To find the most effective means of curbing Japanese stiltgrass invasions, the Connecticut Agricultural Experiment Station implemented a two-year study examining possible treatments in 2008. Experimental and control plots were established in invaded riparian woods along the Connecticut River in East Haddam. Treatments varied in timing and strength (in the case of herbicides). Mechanical procedures (propane torching, hand-pulling, cutting with a string trimmer), organic herbicides (acetic acid, pelargonic acid), and synthetic herbicides (imazapic, fenoxaprop, glufosinate and glyphosate) were compared. To observe treatment effects on seed viability, seed collected from treated plots at the end of the first year was vernalized and planted in a greenhouse. No significant differences were expected between the mechanical methods and synthetic herbicides (which kill stiltgrass) and the organic and dilute herbicides (which merely prevent seed production). The effectiveness of treatments in the field was measured based on reduction of stiltgrass cover, stiltgrass above ground biomass at the end of the season, and stiltgrass seed weight at the end of the season. While all treatments reduced stiltgrass cover and seed weight, mechanical and synthetic herbicide treatments were equally more effective than organic herbicides for each dataset. Only mechanical treatments significantly reduced above ground biomass. All treatments were reapplied during the second year in order to observe effects on the dormant seed bank; the most effective treatments were subsequently applied to larger plots.

**34.**

## ENVIRONMENTAL SCIENCE PROGRAM FIELD STUDY IN OREGON, AUGUST 2009

Ardath C. Dixon ‘10, Isabel M. J. Iwachiw ‘10, Stephen M. Sobolewski ‘10, Chris M. Gromisch ‘11, Amy M. Duggan ‘12, Panida A. Pollawit ‘12
Faculty Sponsors: Jonathan Gourley, Joan Morrison

From August 5th through 19th, six students and two professors traveled through Oregon and Northern California investigating the natural history, ecology, and human impact of the areas. The trip began at Cape Lookout State Park where we learned about the native plant and animal species, as well as the geology of the cape area. Moving south, we learned about the formation of massive sand dunes, the seasonal wind patterns that keep the dunes stable, and the history of the forest service's efforts to control the formations. From there, we traveled to redwood state and national parks where we could compare old growth to lumbered forests among the California coastal redwoods. Moving north into central Oregon, we stopped at Oregon Caves National

Monument to observe the marble and limestone formations as well as one of its endemic species. The trip then followed the High Cascade volcano range, stopping next at Crater Lake, where we learned the history of the lake and the volcanic formation in and around it. Traveling north, we spent some time hiking around the base and up to the summit of South Sister, a High Cascade strato-volcano. There, the changing types of alpine vegetation and igneous rocks were observed, as well as the effects of glaciers on volcanoes. The final days of the trip were filled with a day-long white water rafting trip in the Deschutes River, a visit to a county rodeo, and a tour of the Bonneville Dam on the Columbia River. This two week trip was both a fun and educational experience that offers Trinity students an opportunity to get out of the city life of Hartford and be outside among nature.

**35.**

**JAGUAR OCCUPATION AND IDENTIFICATION IN THE BAKHUIS MOUNTAINS OF SURINAME**

Amy Duggan ‘12
Faculty Sponsors: Joan Morrison, Jim Sanderson

The purpose of this project was to determine the number of jaguars in the study area and how many sites were occupied by the jaguars, which can be monitored to detect change. The study took place in the Bakhuis Mountains, southwestern Suriname, South America. Camera traps were placed at various locations throughout the area and run 24-hours per day more or less continuously from January 2006 until December 2008. In order to determine the density of the jaguars each jaguar photographed had to be uniquely identified. In order to determine the site occupancy the computer program PRESENCE was used to estimate the proportion of camera trap sites occupied by each species of large mammal during each 3-month season. From approximately 500 photographs of jaguars, we identified 36 males and 31 females. There were a total of 86 photos of females and 459 photos of males identified. Each camera trap site was "occupied" but not continuously during the study period. Over the course of the entire study occupancy for the jaguars varied from a low of 65.98 % to a high of 89.41 %, but in 2008 with 32 permanent camera sites occupancy varied from 79.40 % to 89.41 %. The results suggest that jaguar density and mammalian site occupancy can be monitored over the long-term to detect change that differs from normal background change.

**36.**

**MACROINVERTEBRATE POPULATION ASSESSMENT IN THE PARK RIVER'S SOUTH BRANCH**

Zachary Epstein ‘10, Brenna Spingler ‘10, Vicky Done ‘11, David Burszan ‘12,
Kelsey Semrod ‘12
Faculty Sponsor: Jonathan Gourley

The purpose of my study on macroinvertebrates is to determine something significant regarding the water quality of the South Branch of the Park River, which includes the Piper Brook, Mill Brook, Bass Brook and Trout Brook tributaries. I hypothesized prior to the commencement of my research that the overall quality of the South Branch's stretches of river would be more

polluted than those of the North Branch. The overall quality of cleanliness was then judged based on field work conducted during the months of June and July, 2009, through the collection of aquatic macroinvertebrates. Macroinvertebrates are great indicators of water quality because they are affected by a variety of biological conditions. Not all bugs maintain the same sensitivity to pollution, which can be observed in the example of the mayfly. Even a minute level of pollution in the aquatic environment may cause the mayfly populations to die out. It was through this differentiation that I was able to monitor and compare the qualities of water in the South Branch. It is not, however, a causal relationship and due to external factors we are not able to determine exact causes for a lack of taxa richness or high macroinverebrate diversity. Through my research, I was able to conclude that the South Branch does not provide a healthy environment for aquatic macroinverebrates. Very few pollution-sensitive insects were found in the cross-sections tested.

**37.**

**PREHISTORIC MERCURY CONCENTRATIONS OBTAINED FROM TWO CONNECTICUT LAKES ALLOW FOR RECONSTRUCTION OF PAST VOLCANIC ACTIVITY**

Isabel Iwachiw ‘10, William Tucker ‘09
Faculty Sponsors: Jonathan Gourley, Christoph Geiss

Lake sediment cores were extracted from two lakes in Connecticut using a modified Livingston corer; three long (9 and 12 m respectively) cores from Mudge Pond located in northwestern Connecticut (lat. 41°54’N, long. 73°28’W ) and one 11m long core from Lake Louise located in central Connecticut (lat. 41°51’N, 72°46’W). The goal of this study is to determine a regional record of mercury deposition through the Holocene in order to reconstruct past volcanic activity since a likely source of mercury deposition comes from volcanic emissions. Samples were taken every 2 cm from all three cores and dried at a low temperature (<40˚C) in an oven. Samples were ground by hand and homogenized. Subsamples, weighing between 3 and 10 mg, were analyzed in a DMA-80 Mercury Analyzer. Each sampling position within in the cores was measured a minimum of three times to account for sample heterogeneity. In both cores prehistoric mercury concentrations are low (5-40 ppb) compared to historic values (40-100 ppb), which are not part of this study. Preliminary analyses show a good correlation between the two cores taken from Mudge Pond, allowing us to obtain a local record of prehistoric mercury deposition for Connecticut, which can be interpreted in terms of volcanic activity in North America throughout the Holocene.

**38.**

**MAGNETIC ENHANCEMENT OF LOESSIC SOILS ALONG A TOPOSEQUENCE AT BADGER RIDGE-HITCHCOCK NATURE AREA, IOWA, U.S.A.**

Chamae Munroe ‘10
Faculty Sponsor: Christoph Geiss

Variations in magnetic properties of loessic soil have been correlated to changes in contemporary climate and such correlations aid in the interpretation of older, buried soils. While many studies have been conducted on the Loess Plateau of China, investigations of Midwestern Loess in the US are limited. Our aim is to determine the regional processes responsible for the magnetic

development of the soil in Western Iowa. A total of 31 soil profiles from the southeast facing slopes of Badger Ridge located within the Hitchcock Nature Center in Honey Creek of Pottawattamie County were taken using a ½ in. manual soil push probe. The concentration-dependent parameters of magnetic susceptibility, isothermal remanent magnetization (IRM) and anhysteric remanent magnetization susceptibility (ARM) were measured. Highly eroded sites exhibited lesser degrees of magnetic enhancement than more stable sites. In depositional sites, the magnetic profiles were more variable and topographically influenced.

**39.**

**SEDIMENT MAGNETIC PROXIES REFLECT POST-GLACIAL CLIMATE CHANGE FOR EAST-CENTRAL NEW HAMPSHIRE**

Brittney Payton ‘12, Guiliani Lopez ‘11
Faculty Sponsor: Christoph Geiss

The magnetic properties of lake sediments from Pea Porridge Pond in New Hampshire were analyzed in an attempt to reconstruct the paleoclimatic history of the region. Our suite of measurements included magnetic susceptibility ($\chi$), anhysteretic remanent magnetization (ARM), isothermal remanent magnetization (IRM), S ratios, and coercivity distributions of IRM.

Magnetic susceptibility reflects the ease in which sediments are magnetized when exposed to a magnetic field and is related to the concentration and composition of the material in the sample. ARM is heavily biased towards the presence of small (0.1-1 μm) single-domain grains and the ARM-ratio (ARM/IRM) can be used as a magnetic grainsize proxy. S-ratios, measured in backfields of 100 mT and 320 mT correspond to the combined effects of changes in magnetic grain-size and mineralogy.

The oldest sediments (> 23m, > 13 ka) are characterized by high concentrations (high values of $\chi$, ARM, IRM) of coarse-grained (low ARM-ratios) ferromagnetic (S-ratios $\approx$ 1) magnetic minerals, representing an influx of predominantly clastic material.

The following transitional period (23 – 21 m, approx. 13 - 11 ka) is characterized by increasing organic matter and lower concentrations of ferromagnetic material. High ARM-ratios, however, indicate a large component of SD particles. Coercivity analyses reveal that these SD-grains are mostly of biogenic origin, produced by magnetotactic bacteria.

The top of the core (< 21 m, < 11 ka) is characterized by organic-rich sediment containing little magnetizable material. This may be due to the surrounding wetlands acting as a filter preventing magnetic material to reach the center of the lake, or a general stabilization of the landscape decreasing clastic influx. High ARM–ratios suggest the presence of single-domain grains, and low S-ratios suggest a relative increase in high-coercivity material, though coercivity analyses for this part of the core remain ambiguous.

**40.**

**ACID RAIN AND STORM WATER IN THE SOUTH BRANCH OF THE PARK RIVER**

Kelsey Semrod ‘12
Faculty Sponsor: Jonathan Gourley

Acid rain is a serious problem that affects large areas of the United States. It is especially damaging to lakes, streams, and estuaries as well as the ecosystems that inhabit them. Acid Rain causes a higher acidification in various bodies of water, damages trees and soils, and contributes to faster decay in buildings and other manmade structures. The purpose of this research and experimentation is to 1) track precipitation systems using national weather data and geographic information systems, 2) test rain water from Clemens Tower, and 3) analyze storm water runoff in the south branch of the Park River. Various parameters including pH and acid strength in rain water were tested to understand how polluted rain water in Connecticut is. Storm water in the Park River was also analyzed using similar parameters to understand how much acid rain is affecting the Park River, as well as to determine how much pollution has accumulated over time. Results show that the acid strength of rain water has decreased over the past 6 years. In addition, there is a correlation between the amount of acidity in rain water and the amount of precipitation: the less rainfall that accumulates, the more acidic it is. From this data, we can conclude that the more intense storms have a lower acidity than the smaller storms. Each storm may carry the same amount of pollution across the country, but the more rain that accumulates causes these emissions to be diluted more, and therefore they contain less harmful substances. This acidity may be attributed to global warming: it may have caused storms to become more intense, and therefore the acidity of rain water to decrease.

**41.**

**AQUATIC TOXICITY OF HISTAMINE ANTAGONISTS AND PROTON PUMP INHIBITORS**

Pooja Shakya ‘11, Rachel Riendeau ‘12
Faculty Sponsor: Alison J. Draper

Pharmaceuticals enter the aquatic environment through direct disposal and via wastewater systems. Many of these drugs resist degradation and remain in the environment at trace levels; however, pharmaceuticals constantly enter and persist in the environment due to the high use of drugs prescribed in the United States. The effects of this aquatic exposure remain largely unknown. Thus, this study investigated the acute toxicity of the antihistamines: H1 antagonists (fexofenadine, cetirizine), H2 antagonists (cimetidine, famotidine, ranitidine, nizatidine) and proton pump inhibitors (omeprazole, lansoprazole) to a freshwater invertebrate (*Daphnia magna*) and a fish, fathead minnow (*Pimephales promelas*). Only toxicity to lansoprazole was observed in *Daphnia magna* with a mean $LC_{50}$ value of 52 ppm; the other drugs tested did not cause toxicity at 100ppm. Similarly, toxicity to lansoprazole, omeprazole, and ranitidine was observed in fathead minnows with mean $LC_{50}$ values of 18 ppm, 37 ppm, and 17 ppm, respectively; the other drugs tested did not cause toxicity at 100ppm. Although reported environmental concentrations are lower than these toxicity values for these compounds, further studies on chronic exposure to lower concentrations, the drugs’ degradation products, and mixtures of drugs, as well as the impact of drugs on other organisms and the ecosystem as a whole, should be considered.

**42.**
**THE SOUTH BRANCH: THE CLEANER HALF?**
Brenna Spingler ‘10
Faculty Sponsor: Jonathan Gourley

Research was conducted on the south branch of the Park River to determine water quality estimates in an effort to compare values from the north and south branches. The sample sites in the south branch were strategically selected along the Mill Brook, Trout Brook, Bass Brook, and Piper Brook. Site testing included pH, conductivity, salinity, total dissolved solids, dissolved oxygen, and temperature measurements. Samples were also brought back to lab where ion chromatography tests were performed to determine chloride, nitrate, and sulfate values. These values were graphed against previous data values from the north branch of the Park River. Focus was placed on golf course locations throughout the Park River tributary to determine the impact of nitrate runoff on downstream water quality. Locations where inconsistencies were found were further investigated in an attempt to determine a source of pollution. The conclusion of our research indicated that conductivity, salinity, TDS, DO, chloride, and nitrate values for the south branch are significantly higher than values found in the north branch of the Park River. However the temperature, pH, and sulfate values for the north and south branch are not statistically different. Nitrate impacts due to golf course outflows need to be further investigated however, the correspondence in the two indicates a low level impact.

# NEUROSCIENCE

**43.**
**MODELING TEMPORAL CONSCIOUSNESS IN THE BRAIN WITH SUPPORT VECTOR MACHINE PATTERN INFORMATION ANALYSIS**
Brian Castelluccio ‘12
Faculty Sponsor: Dan Lloyd

Human consciousness involves complex awareness of temporal structure, including sequence and duration, but the neural basis for this upper level functioning is largely unexplored. Machine learning has shown promise in the field of cognitive neuroscience as a tool for exploring patterns in neural output data. This study posed two questions in a secondary analysis of functional magnetic resonance imaging (fMRI) data from an experiment that investigated changes in brain function with age. The present study aimed to determine whether the effect of time in the brain can be detected in fMRI data and, additionally, whether there was a difference in the encoding of temporal information in brains of subjects of different ages. Support vector machine (SVM) software, a tool for mathematically optimizing the separation of sets of data into subsets, was trained to separate fMRI data into the distinct time points to which they correspond using a model of the experimental timecourse. The software was then tested to determine whether it could group data points into the correct time structure. The SVM software was successful in modeling the experimental timecourse for both the young subjects (20-30 years of age) and the old subjects (65-87 years of age). It modeled the timecourse of the experiment for the old subjects more accurately than for the young subjects. These results indicate that temporal information is indeed encoded in brain activity but perhaps not in a consistent way for all humans. Although temporal experience is universal, its neural manifestation may not be constant.

**44.**

**THE EFFECTS OF NEONATAL ISOLATION ON SYNAPTIC PLASTICITY IN THE MPFC-BLA OF FREELY MOVING RATS**

Rachel Clark ‘12, Aalok Pandey ‘12
Faculty Sponsor: Harry Blaise

The research intended to examine how neonatal isolation of freely moving rats influences the ability of neurons that are originated in the mPFC (medial prefrontal cortex) and that project to the BLA (basolateral amygdala) to increase in synaptic strength. Two sections of male rats were examined: neonatally isolated, which were placed in heated (30° C) isolation chamber for 1 hour 2-9 days after birth and non-handled, which remained with DAM (mother) without disturbance until weaning (PN 25 days). We sent the stimulating electrode into the medial prefrontal cortex and recording electrode into the basolateral amygdala of both sections of rats, which were 70 days older but younger than 120 days. We didn’t get any strong signals, and most of the times, the signals were just noise. Therefore, it was impossible to work on this research project any further.

**45.**

**EVALUATION OF URIC ACID MANIPULATION WITH ALLOPURINOL**

Fatimah Finney ‘11, Derek Kim ‘12, Timothy Liu ‘12, Amelia Lewis ‘11
Faculty Sponsor: William Church

Oxidative stress is thought to contribute to the pathology of neurodegenerative diseases such as Parkinson’s disease. Uric acid (UA) is an endogenous antioxidant that is thought to regulate ROS generation (a measure of oxidative stress). Our goal was to develop a protocol that alters UA levels in cell culture and measure the amount of ROS generated. SH-SY5Y neuroblastoma cells were treated with varying concentrations of UA and allopurinol, a xanthine oxidase inhibitor to assess the relationship between UA levels and overall cell viability. ROS levels were determined using fluorometric conversion of $H_2$DCF-DA to dichlorofluorescene (DCF). Uric acid content in cells was determined by HPLC with electrochemical detection. Cell survivability was assessed using a Live/Dead Cell Assay. Allopurinol produced a dose-dependent decrease in UA content and cell survivability. ROS generation was increased in allopurinol-treated cells and decreased in UA-treated cells. These results suggest that alterations in neuronal uric acid levels can alter cell survivability via a mechanism associated with ROS production.

**46.**

**BI-DIRECTIONAL SYNAPTIC PLASTICITY IN ADENOSINE A1 RECEPTOR-DEFICIENT FREELY BEHAVING MICE**

Brittany Gay ‘10, Valeria Barbier ‘10
Faculty Sponsor: Harry Blaise

Adenosine has been implicated in learning and memory due to its presynaptic and postsynaptic inhibiting effects on synaptic transmission at NMDA receptors. NMDA receptors at high frequency or low frequency are known to mediate long-term potentiation (LTP), which is a long-

lasting increase of a synaptic response following stimulation and long-term depression (LTD), which is the decrease of the synaptic response following stimulation. Since both LTP and LTD both serve as a potential model of learning and memory, the goal of this study was to investigate adenosine's role in learning and memory through the process of manipulating the synaptic plasticity induced by Low Frequency Stimulation (LFS) in transgenic mice. In the aim of the study it was hypothesized that mice without the A1R gene would show the greatest expression of LTD and LTP. To support the hypothesis, an experiment was designed to look at the role of the A1R gene in LTP and LTD in wildtype, heterozygous and knockout laboratory mice by performing stereotaxic surgery and recording from the dentate gyrus through stimulation of the perforant path. During the ten week period, we assigned the task to learn the surgical and recording techniques that will permit us to carry out the study. As a result, we did not get the chance to record any data during the summer. We hope to continue this study during the Fall semester.

**47.**

**PROSPECTIVE MEMORY IN CHILDREN: TIME VERSUS EVENT-BASED CUES**

Ginger Mills '12, Julianne Garbarino '11
Faculty Sponsor: Sarah Raskin

Prospective Memory, the ability to remember to do something in the future, is an imperative function of daily life for both adults and children. This study examines prospective memory in children, specifically time versus event-based cues. Twenty children, between the ages of four and ten, took the Memory for Intentions Screening Test for Youth (MISTY), a novel test of prospective memory based on the Memory for Intentions Screening Test (MIST; Raskin, 2009). In agreement with our hypothesis, children performed significantly better on the event-based cues than on the time-based cues. This suggests, in accord with past research, that children have difficulties with time monitoring and respond more effectively to event-based prospective memory tasks.

**48.**

**EFFECTS OF THE KETOGENIC DIET ON PHYSIOLOGY AND BEHAVIOR OF R6/2 HUNTINGTON'S DISEASE TRANSGENIC MICE**

Tiffany Ruiz '10, additional authors?
Faculty Sponsors: Susan Masino, David Ruskin

Huntington's disease (HD) is an inherited neurodegenerative disease caused by expansion of CAG polyglutamine repeats in the *huntingtin* gene. The ketogenic diet (KD) is a restricted diet that is high in fats and very low in carbohydrates, and has been found to be beneficial in several animal models of neurodegeneration. We tested the effects of the KD in a transgenic mouse model of HD to determine whether the diet delays or improves symptoms. Both R6/2 and control mice were placed on either the KD or control diet (CD) at 6 weeks. Animals were tested at 4, 6, 8, 12 and 16 weeks using the rotorod test of motor coordination and Y-maze to assess locomotion and working memory. Mice were weighed twice weekly, deaths were recorded, and CAG lengths measured. Core blood and brain tissue was also collected to measure mitochondrial

and blood ketone levels. The study showed that the diet has no effect on lifespan; however, it is seen in the transgenic mice that females have a longer lifespan than males. For both genders and mouse types, the only weight gain difference found in regards to the CD and KD was between the control male mice. R6/2 mice performed worse than control mice in Rotorod testing; however, both control and R6/2 males on the KD performed better than the CD animals. KD increased locomotion in wild-types, but had no discernable effect on the locomotion of the R6/2 mice. R6/2 males on the KD showed impaired spontaneous alternation scores, whereas females did not. Overall, the KD did not significantly benefit longevity or improve symptoms in the HD mice. Regional analysis of brain energy levels and blood ketone levels are ongoing.

**49.**

**AFFECT OF ACUTE STRESS ON SYNAPTIC PLASTICITY IN NEONATALLY ISOLATED ADULT RATS**

Melike Sunay ‘10, Mahvesh Ansari ‘10
Faculty Sponsor: Harry Blaise

This study was performed to examine whether acute stress affects electrophysiological properties of the amygdala and hippocampus of the neonatally isolated rats. The previous studies have reported that there is a link between stressful events and changes in brain activity. The locations of these changes have been reported in areas such as hippocampus and amygdala, which are associated with learning, memory, and emotions. For this study, two different groups of rats were used, isolated (ISO) and non-handled (NH). The rats in were isolated from their mother and siblings for an hour a day for seven days (experimental group). The other group did not experience handling or isolation (control group). When rats reached 70 days of age, electrodes were implanted in the hippocampus and amygdala of both groups. Five days after the surgery, baseline of brain signals were recorded and long term potentiation (LTP) was induced to measure synaptic plasticity. LTP represents enhanced synaptic transmission that is believed to underlie learning and memory. One hour after LTP was induced, rats from both groups underwent an acute stress consisting of 30 minutes of restraint in a plastic restrainer. We hypothesized that the stress induced rats will show small and prolonged long term potentiation compared to that of stress free rats. However, the data generated was not sufficient to base a conclusion. Further work is needed to accumulate more data.

**50.**

**EFFECTS OF THE KETOGENIC DIET ON BEHAVIOR AND TEMPERAMENT OF AUTISTIC AND NON-AUTISTIC CHILDREN**

Julia Svedova ‘11
Faculty Sponsors: Susan Masino, Francis DiMario MD, Connecticut Children’s Medical Center

The ketogenic diet (KD) is a restrictive diet high in fats and low in carbohydrates and proteins commonly used for treatment of intractable epilepsy. It has been demonstrated that the KD significantly reduces frequency of seizures. There is some evidence that the KD may also have positive effects on some aspects of behavior, cognition and autistic behavior. We proposed a two-phase study to examine effects of the KD on epileptic children with or without autism. Phase 1 is a retrospective design to examine epileptic children who initiated the KD since January

2004. The aim of Phase 1 is to describe different clinical and behavioral features of the population on the KD. Phase 2 is a prospective design to determine the effects of the KD on behavior and temperament of epileptic children who have not yet started the diet. Parents of subjects in both phases obtain three parental surveys by mail to assess their child's behavior, temperament, and autistic behavior. Currently, the results of the surveys from Phase 1 together with clinical and demographic data are being reviewed and assessed. The data show that out of 18 subjects recruited for Phase 1, 50% (n=9) have autistic behavior and 67% (n=12) are cognitively impaired. The behavior scale revealed that 44% (n=8) of children were evaluated to have significant attention problems and 33% (n=6) were withdrawn. The temperament scale showed that 56% (n=10) of subjects have mild intensity, 50% (n=9) have decreased activity level, and 44% (n=8) have lower threshold of response. This brief assessment of behavior and temperament indicates that the children with intractable epilepsy treated with the KD have multiple significant behavioral issues. Therefore, if the KD shows to be effective in improving certain autistic and behavioral features, it could become a successful therapeutic tool for treatment of intractable epilepsy. We are hoping to demonstrate this phenomenon in Phase 2 (prospective study).

**51.**

**NEUROANATOMY AND CATECHOLAMINE EXPRESSION IN THE CEREBRAL GANGLION OF THE CHINESE MYSTERY SNAIL, *CIPANGOPALUDINA CHINENSIS***

Mike B. Taylor '10
Faculty Sponsor: Charles Swart

Chemosensation especially olfaction is the most important mode of sensory experience for most freshwater snails. The motor and sensory control of olfaction in snails is known to take place in the Cerebral Ganglion. *Cipangopaludina chinensis* snails are large, invasive, fresh water snails of southeast asia. They have been introduced tothe U.S. through Asian food markets and have established healthy breeding populations across most of the U.S. We designed a series of experiments to understand the basic neuroanatomy of the cerebral ganglion in this little studied snail. Our goals were to determine the total number and relative size and position of neurons in the ganglion, and to characterize the presence of serotonin in these cells. This work is to be correlated with an ongoing project describing the subset of these cells involved in motor and sensory olfactory processing. Fluorescent DNA markers propidium iodide and DAPI were used to approximate the total number of cells. To approximate the number of serotonin cells, ganglia were viewed under green light after being stained by the non-specific catecholomine stain, glyoxylic acid. We also tested a specific serotonin marker 5,7 DHT. Although DAPI failed to provide adequate staining for cell counts, propidium iodide indicated that each cerebral ganglion contains approximately 600-800 total cells. Glyoxylic acid staining proved to be inconsistent but indicated a range of 30 – 150 catecholamine containing cells per ganglion. This is consistent with results from previous studies. 5,7 DHT successfully stained axonal tracts but not cell bodies. Standard data on gender and size led to the unanticipated finding that this animal is likely a protandrous hermaphrodite.

# PHYSICS

**52.**

**PHOTON COUNT RATE AND COUNTER FAILURE OF A COINCIDENCE COUNTING MODULE**

John Bower ‘12, Adam Katcher ‘12
Faculty Sponsors: David Branning, Mark Beck, Whitman College Department of Physics

Poisson and Gaussian statistics were examined to determine the relationship between the mean photon count rate of a Coincidence Counting Module (CCM) and the risk of CCM counter failure. The CCM counter has sixteen digits of binary storage per time-bin. Exceeding $2^{16}$ photon arrivals within a time-bin interferes with accurate photon counting for that time-bin. In this paper we calculate that for a 400 Hz CCM, limiting the mean count rate to 25.4 million photons/second or less is sufficient to provide over 99.999% confidence that no time-bins will encounter this storage issue, even in counting experiments running for as long as two weeks of continual operation.

**53.**

**FRUSTRATED TWO-PHOTON CREATION IN A TIME-DEPENDENT CAVITY**

Adam Katcher ‘12, John Bower ‘12
Faculty Sponsor: David Branning

351 nm light from an Argon ion laser was annihilated into 702 nm photons by spontaneous parametric downconversion in a KDP nonlinear crystal. A mirror may then be used to reflect all photons back into the crystal, creating a second opportunity for downconversion. The two possibilities of creating downconverted photons interfere, so that it is possible to frustrate the crystal’s emission. A fast optical switch may be then used to activate a Pockels cell placed between the mirror and crystal. The Pockels cell acts as a waveplate, preventing the interference so that photons may be counted. But will the downconverted photons emitted by the crystal reach a photodetector immediately after the Pockels cell is activated, or only after some time delay? Photon counting data may be analyzed to determine whether there exists such a time delay in photon arrivals.

# PSYCHOLOGY

**54.**

**PERCEIVING ASPECTS OF THE HAMMER THROW IN POINT LIGHT DISPLAYS**

Alicia Ortiz ‘12
Faculty Sponsor: William Mace

The present study explores the technical components of the hammer throw which can be seen when video frames have been reduced to only 14 moving points – particularly “good form” and effectiveness of the throw. Gunnar Johansson (1973) stimulated interest in “biological motion” by showing that a few points of light on a person's joints and head were rich in information about both characteristics of a person and their activity, however the frames alone look like nothing but sets of points. Very little work has been devoted to the exploration athletic skills and rotation, and this might present a variety of problems. When trying to solve these problems, this research used techniques developed by Professor Ralph Walde to digitize common video and thereby create point-light movies. In our case, we created films that consisted of tracking 14 points over the frames of a video clip; the person's joints, head, and the weight being thrown. Only these moving points were visible. The clips that were used were taken from Division III men and women’s hammer events. Five clips were chosen based on the judgments of the best and worst form and distance for men and women. From this another five clips were created and also used which had only the light for the hammer visible. The students were then asked to judge the form and distance of each of the 10 clips compared to all of the other clips twice; once on the left and once on the right. A number of strong effects will be reported.