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2007 Annual Research Symposium Abstract Book

Trinity College

TWENTIETH ANNUAL SYMPOSIUM OF TRINITY COLLEGE UNDERGRADUATE RESEARCH

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BIOLOGY

1.
MICROSCOPIC TECHNIQUES AS TOOLS FOR STUDYING EMBRYONIC DEVELOPMENT
Kristie Anderson ‘10
Faculty Sponsor: Daniel Blackburn

Vertebrate eggs contain structures external to the embryo, called extraembryonic membranes, which play essential roles in physiological exchange between the embryo and its external environment. The same extraembryonic membranes are responsible for sustaining the embryos in both viviparous (live-bearing) and oviparous (egg-laying) vertebrates. Microscopic techniques were used to investigate the structure and function of these membranes and their associated embryos. The first part of the semester was devoted to learning light microscopy and scanning electron microscopy. Techniques of light microscopy, including histological evaluation, preparative techniques, and photography were studied. Embryos and extraembryonic membranes from eggs of the oviparous corn snake, *Pantherophis guttatus*, were harvested at different stages of development. Embryos are prepared for light microscopy by fixation in formalin, embedment in paraffin, microtome sectioning, and histological staining. The membranes are prepared for scanning electron microscopy through chemical fixation, dehydration, and the application of conductive coating. Scanning electron microscopy is being used to study the surface of the membranes in detail, and to allow identification of specializations for physiological exchange. Because anatomy is closely related to function, specialized functions of the extraembryonic membranes during development can be inferred from their microscopic structure. Little is known about how the extraembryonic membranes of squamates (snakes and lizards), a major vertebrate group, serve to sustain an embryo throughout development. Therefore surface features of the extraembryonic membranes of *Pantherophis guttatus* can provide insight and clarification into the function of squamate extraembryonic membranes, and ultimately, their evolution.

2.
PRODUCTION AND PURIFICATION OF CYP126, CYP128, CYP140 FROM *MYCOBACTERIUM TUBERCULOSIS*, AND INTERACTIONS WITH AZOLE DRUGS
Scott Dale ‘07
Faculty Sponsor: Hebe Guardiola-Diaz

M. tuberculosis poses a major international health concern, especially in light of new antibiotic resistant strains. In order to identify potential targets for future medications, a more complete understanding of the organism’s biochemistry is needed. The goal of this project was to determine a methodology to produce and purify three p450 enzymes as they are expressed in M. tuberculosis (CYP126, CYP128 and CYP140). p450’s make up a large family of mono-ozygenase heme-containing enzymes. M. tuberculosis expresses an unusually high number of these enzymes (~20) for unknown reasons. Due to this high enzyme expression, p450s are though to be potential future targets for anti-bacterial azole drugs.

The enzyme’s genetic sequences were introduced via a pGEX plasmid into two bacteria strains (TOP and mv1304). The cells were cultured in Terrific Broth Media, and protein production was induced with IPTG. Samples were taken 14, 24 and 44 hours after IPTG induction, and pure

chimeric protein was isolated via GST-tagged affinity chromatography. It was found that mv1304 cells were more efficient at producing protein than TOP cells, but that longer growth time did not significantly lead to increased protein production. Once pure protein has been isolated, the binding between these enzymes and a battery of azole drugs will be examined.

3.

USE OF SCANNING ELECTRON MICROSCOPY TO EXAMINE FETAL MEMBRANES IN OVIPAROUS AND VIVIPAROUS SNAKES

Siobhan Knight '07
Faculty Sponsor: Daniel Blackburn

Fetal membranes contribute to embryonic function in reptiles by accomplishing gaseous exchange, water and nutrient absorption. Electron microscopy has contributed to our understanding of these membranes in viviparous reptiles. However, such membranes have never been studied via scanning electron microscopy (SEM) in any oviparous reptile. The absence of such information hampers attempts to distinguish specializations for viviparity and placentation. Also, fundamental features of the terrestrial egg remain uncertain.

In this study I used SEM to examine fetal membrane ultrastructure in two snakes belonging to the family Colubridae - the oviparous corn snake *Pantherophis guttatus*, and the viviparous brown snake *Storeria dekayi*. Two fetal membranes arise in both species - the chorioallantois, which serves as a site for gaseous exchange, and the omphalallantois, which functions in absorption. The omphalallantois consists, from eggshell inwards, of the omphalopleure, isolated yolk mass (IYM) and allantois.

Under SEM, the external surface of the chorioallantois appears featureless in both species. This membrane consists of broad, flattened cells that form a continuous sheet over the allantois. The omphalopleuric epithelium consists of cuboidal cells with bulging apices. In corn snakes one cell type exists and a network of ridges covers the surfaces. In brown snakes the epithelium consists of two cell types, one of which exhibits prominent microvilli. Later in development in both species the allantois invades the yolk cleft and lines the IYM. As a result the IYM progressively retreats until it disappears. During this time surface features of the omphalopleure take on the appearance of the chorion.

This study has shown the chorioallantois and omphalallantois differ in several ways. Thus they can be considered distinct membranes that play different functional roles. This study, as well as light microscopic and transmission EM studies on corn snakes, suggest these functions originated under oviparous conditions, and therefore predate viviparity.

4.

MUTATIONS IN THE LIGAND SERRATE AND THEIR EFFECTS ON NOTCH ACTIVATION IN *DROSOPHILA MELANOGASTER*

Brian Lee ‘07
Faculty Sponsor: Robert Fleming

Notch signaling is a conserved pathway in all metazoans critical for determining cell fate. The Notch protein is a hetero-oligomer composed of: an extracellular domain, which primarily contains 36 EGF-like repeats used to mediate Notch activation; a transmembrane domain; and an intracellular domain, which can translocate to the nucleus and cause expression of many different targeted genes. Notch activation is controlled by a proteolytic cascade triggered by direct association of the receptor, Notch, to various ligands, Delta and Serrate in *Drosophila melanogaster*, the common fruit fly. Serrate is a transmembrane protein that consists of a 14 EGF-like extracellular domain and a small intracellular domain. Previous research examining Serrate has located a hydrophobic stretch of amino acids in the 6th EGF-like repeat and a mutation removing this region, hydroΔ resulted in a loss of unidirectional Notch signaling. The purpose of this research was to determine the specific regions associated with the hydroΔ; mutation that may be important for unidirectional Notch signaling. Using recombinant DNA techniques, mutant constructs with different forms of hydroΔ; were produced and reintroduced into fly eggs to evaluate the effects of each deletion. Expression of the mutant constructs was not observed in the transgeneic flies. The DNA was sequenced and a stretch of nucleotides was found to be missing in the constructs. Crosses were also preformed to assay the signaling direction of a mutant Serrate. The assay was not sensitive enough to produce results. Further research is being conducted to rebuild the construct and replace the missing nucleotides as well as finding a more sensitive assay for testing signaling direction.

5.

INFLUENCE OF ONE-WAY ELECTROCOMMUNICATION ON RADIAL GLIA FIBER FORMATION IN THE BRAINS OF ADULT ELECTRIC FISH

Elizabeth McCarthy ‘07
Faculty Sponsor: Kent Dunlap

In adult electric fish *Apteronotus leptorhynchus*, social interaction increases the production of fibers in a cell type called radial glia. These cells are important for guiding the migration of new cells born in the brain. Such social interaction is a complex environmental stimulus with many components. These components include non-electrical stimuli (i.e. visual or tactile stimuli), reciprocal electrical stimulation (both fish are allowed to exchange aggressive electrocommunication signals called chirps), and one-way electrical stimulation (one fish receives a constant electric signal with no chirping). This study focused on how one-way electrocommunication influenced radial glia formation to determine if reception alone of an electric signal was sufficient to cause changes in brain structure. Fish were exposed to one-way stimulation for one week, sacrificed and their brains dissected. Brain sections were then labeled for radial glia using immunohistochemistry. Preliminary data suggest that one-way stimulation increases radial glia fiber density and that this influence is specific to the region of the brain responsible for electrocommunication behavior. Further data analysis is necessary to determine the exact magnitude of this relationship and also how the changes in brain structure induced by one-way electrocommunication compare to the changes that may be induced by the other components of social interaction.

6.

***IN VITRO* INVESTIGATION INTO THE EFFECTS OF A PPARδ AGONIST ON NEURITE QUANTITY AND LENGTH**

Sarah Sweatt '07
Faculty Sponsor: Hebe Guardiola-Diaz

Peroxisome proliferator-activated receptors (PPARs) are ligand modulated transcription factors that regulate the gene expression for many important biological processes. A subclass of these receptors, PPARδ, has its highest expression in the brain. The exact physiological function of PPARδs is unknown. In the present study we sought to investigate the effect of a known PPARδ agonist on the quantity and relative length of neurites on neurons grown *in vitro*.

CHEMISTRY

7.

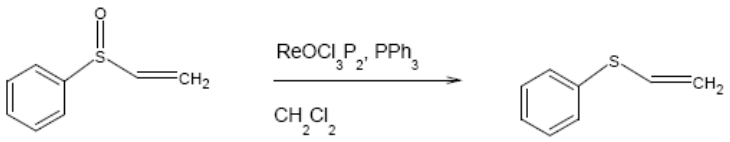
A STUDY OF RHENIUM-OXO COMPLEXES IN SYNTHESIS AND OXYGEN ATOM TRANSFER REACTIONS

Nicole Antunes '07
Faculty Sponsor: Maria Parr

Many metal-oxo complexes are known to have synthetic and biological roles. In particular, rhenium-oxo coordination complexes are one type that have been previously investigated and found to have a number of applications. An understanding of their properties and their possible applications in catalysis are important areas of interest.

The first part of this work focused on the synthesis of rhenium-oxo and rhenium-polyhydride complexes supported by diphosphine ligands. Diphosphine ligands, such as xantphos, were used to bind to the rhenium-oxo complex. The product, $ReOCl_3$(xantphos), was synthesized under argon using Schlenk line techniques. This photo-sensitive turquoise-green complex served as the precursor in the synthesis of the corresponding rhenium polyhydride complex. These complexes were successfully synthesized and analyzed by IR and proton NMR.

Researchers have been studying metal-oxo complexes for a variety of reasons, including their useful catalytic properties. An important criterion for a metal-oxo catalyst is that the species will catalyze oxygen atom transfer reactions rapidly under reasonably mild conditions. Rhenium(V)-oxo complexes of the type $ReOCl_3P_2$ have been found to be effective catalysts for this transformation (Scheme 1).



Scheme 1

We are interested in studying the oxygen atom transfer reactions with $ReOCl_3P_2$ complexes (P_2 = xantphos, DPEphos). These reactions will be followed and analyzed by proton NMR and GC-MS.

8.

A FIGHT AGAINST WATERBORNE DISEASE: DESIGN OF PARASITE-SPECIFIC INHIBITORS FOR *CRYPTOSPORIDIUM PARVUM*

Nicole Benjamin ‘08
Faculty Sponsor: Lizbeth Hedstrom PhD, Brandeis University

To date no effective drug treatment has been found for the waterborne parasite *Cryptosporidium parvum*, known to inflict fatal infections among immune-compromised patients. The enzyme targeted, inosine 5’-monophosphate dehydrogenase (IMPDH) controls guanine production, cell proliferation, and opens an opportunity for parasite-specific inhibitors. *C. parvum* IMPDH was purified using affinity chromatography. The pure protein was crystallized in four different conditions using the hanging drop vapor diffusion method. The most promising crystals formed in the absence of KCl. Two known parasite-selective inhibitors were determined to bind uncompetitively to the enzyme by measuring the activity of *C. parvum* IMPDH using UV-Vis spectroscopy.

9.

SYNTHESIS AND COUPLING OF TRIPEPTIDE BOC-LYS(Z)-ALA-LYS(Z)-NHCH3 TO FERROCENE AND TUNGSTEN

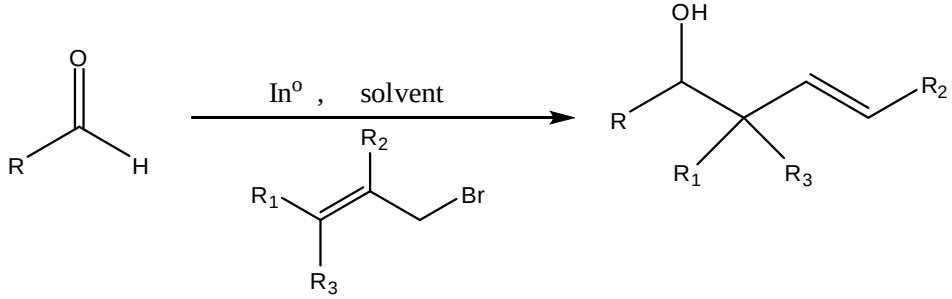
Neena Chakrabarti ‘09
Faculty Sponsor: Timothy Curran

The coupling of transition metals with peptides can result in the formation of secondary structures. The goal of my research is to successfully couple ferrocene and tungsten to a tripeptide and analyze the resulting structure of the peptide. For this secondary structure analysis, the tripeptide Boc-Lys(Z)-Ala-Lys(Z)NHCH3 was synthesized and separate aliquots will be coupled to ferrocene diacidchloride and the tungsten complex W(CO)3(dimethylthiocarbamate)2. Although it is predicted that the coupling of this tripeptide with tungsten will result in a gamma turn, this part of the procedure has not been analyzed yet. Future work will be directed toward purifying the tripeptide, coupling it to the ferrocene or the tungsten, and finally, analyzing the secondary structures of the tripeptide once it has been coupled.

10.

ACCELERATING EFFECTS OF *N*-METHYLFORMAMIDE WITH RESPECT TO AQUEOUS AND ORGANIC CONDITIONS IN INDIUM METAL PROMOTED COUPLING REACTIONS

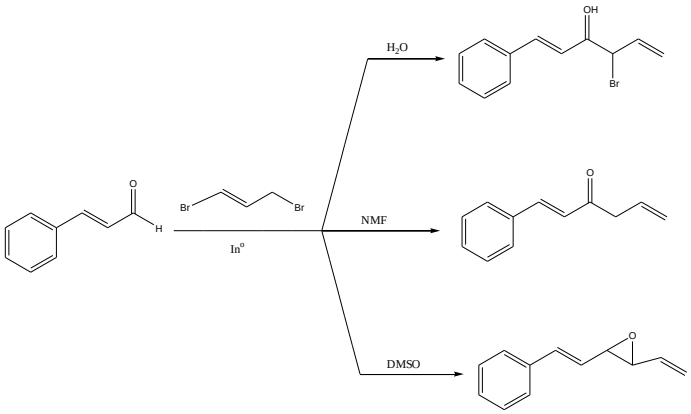
Kwame Frimpong ‘08
Faculty Sponsor: Thomas Mitzel



Understanding the flow of electrons during synthetic reactions is important in chemistry to aid in constructing models that predict product formation. Two of the more interesting reactions studied in organic chemistry are nucleophilic additions and Cope Rearrangements. Indium metal

has been shown to promote the formation of C–C bonds under aqueous conditions with good stereo- and regioselectivity. This presentation will aim to address the effect of solvent and variable reaction conditions on indium promoted reactions of allyl bromides to aldehyde functional groups.

11.
FUNCTIONAL GROUP CONTROL THROUGH SOLVENT VARIATION
Alden Gordon ‘10
Faculty Sponsor: Thomas Mitzel



Varying functional groups of products usually requires a change in reactants and reaction solvents. This research has been aimed at controlling functional groups in the above reaction while maintaining reactants. The reaction run in NMF (N-Methylformamide) has been the most elusive, and was the focus of the work. Cinnamaldehyde, 1,3 dibromopropene, and indium metal were mixed in NMF (N-Methylformamide) and reacted for 24 hr. The product was then extracted with methylene chloride, separated in a column and analyzed with gas chromatography/mass spectrometry and nuclear magnetic resonance (NMR). Current research has yielded a successful reaction, with a loss of desired product in separation, and a relatively large excess of an alcohol side product. Future work will include repeating this reaction to reduce side products and perfect separation techniques. Success in these aspects of the research will present new means of functional group control that will be beneficial to other fields of research.

12.
SYNTHESIS OF THE TETRAPEPTIDE BOC-LYS(Z)-MET-ILE-LYS(Z)-NHME
Emmy Handy ‘08
Faculty Sponsor: Timothy Curran

A metal-ligand interaction can be used to tie two ends of a peptide chain together, yielding a metallacyclic peptide. In previous research, a 1,1’-ferrocenediacid chloride -link was used to cyclize the tetrapeptide (Lys-Ala-Val-Lys) by connecting the first and fourth lysine amino acids via amide bonds, which yielded a helical structure. A second tetrapeptide (Lys-Met-Ile-Lys) was synthesized via solution phase peptide synthesis to be similarly cyclized.

13.

FATE OF ILLICIT DRUGS BY POST-MORTEM FACULTATIVE BACTERIA: OPTIMIZATION OF ANALYTICAL EXTRACTION METHODOLOGY

Katharine Harte ‘08
Faculty Sponsor: Janet Morrison

The metabolites of drugs of abuse have mostly been established under pre-mortem conditions, but little is known about how these drugs metabolize post-mortem. It is also known that facultative bacteria present in the body during the putrefaction stage of decomposition degrade a variety of organic species. This project hypothesizes that these facultative bacteria metabolize drugs of abuse into as-of-yet unidentified products, which if found would drastically change the current methods of analysis of drugs of abuse in corpses. This spring four different drugs of abuse were extracted through solid phase extraction from thioglycollate growth medium, derivatized with MSTFA +1% TMS and analyzed through GC/MS to see their known metabolites. The particular extraction method used is still being investigated.

14.

DEVELOPMENT OF AN LC/MS METHOD FOR TRACE-LEVEL DETECTION OF OPTICAL BRIGHTENERS IN WELL WATER

Adam Hill ‘08
Faculty Sponsor: David Henderson

Contamination of rural wells by human waste is a significant concern to environmental scientists. It has been suggested that the optical brighteners commonly found in laundry detergent can be used to selectively detect domestic waste. A method is being developed to find trace levels of the brighteners DSBP and DAS1 via solid phase extraction and LC/MS. Additionally, MS/MS is used for further identification. An internal standard and calibration curve are used for quantification of brightener concentrations.

15.

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

Kristin Kremer ‘07
Faculty Sponsor: Thomas Mitzel

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

16.
THE VARIABLE TEMPERATURE ANALYSIS OF DIPEPTIDES BIS-ALKYNE TUNGSTEN COMPLEXES
Jessica Leandre ‘07
Faculty Sponsor: Timothy Curran

The objective of this research is to form three dipeptides, HCC-Ala-Phe, HCC-Gly-Lys(Z), and HCC-Trp-Met. Once formed, each dipeptide is coupled to tungsten to form a bis-alkyne tungsten complex. Variable temperature analysis of these complexes determines at what temperature the alkyne proton at 11.0ppm will coalescence into one peak. The result will be compared to the previous research where the variable temperature analysis of the alkyne proton from a monopeptide bis-alkyne tungsten complex coalescenced at 65 degrees.

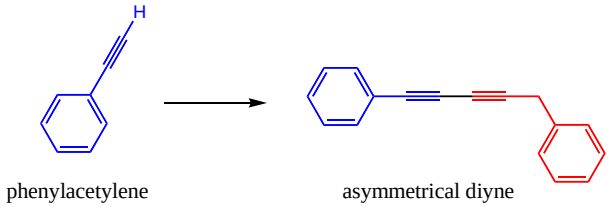
17.
DESIGNING A MORE COST-EFFECTIVE METHOD FOR THE SYNTHESIS OF 4-CARBOXYGLUTAMIC ACID
Madelyn Light ‘09
Faculty Sponsor: Richard Prigodich

4-Carboxyglutamic acid is an integral part of the peptide chain that forms osteocalcium, a protein thought to be involved in the building and remodeling of bones. Since it is a rare and expensive amino acid, it was decided that a more cost effective way of procuring 4-Carboxyglutamic acid was to develop a simpler and less costly method to synthesize it in the laboratory. Beginning with di-tert-butyl-malonate, a series of reactions was designed to form 4-Carboxygulatmic acid. The first step of this synthesis involved replacing the acidic hydrogen of the di-tert-butyl-malonate with a methyl-dioxolane group. This was achieved by reacting di-tert-butyl-malonate with 3 molar equivalences of NaH in THF at 0 °C, then adding 1.5 molar equivalences of 2-Bromomethyl-1,3-dioxolane and refluxing the solution overnight. After isolating the product and analyzing it via 1H NMR and GC-MS, it was determined that the desired product had been successfully formed. Future work will be aimed at increasing product yield and technique for the first step, and eventually moving on to the second step of 4-Carboxyglutamic acid synthesis.

18.
STUDIES TOWARD THE FORMATION OF AN ASYMMETRICAL DIYNE
John Love ‘10
Faculty Sponsor: Thomas Mitzel

Creating an asymmetrical diyne is the first step in a proposed scheme to create a carbon cage molecule. It can be seen in reaction Scheme 1 that an asymmetrical diyne could be formed from phenyl acetylene beginning with propargyl benzene. This poster will present studies toward this goal, as well as the use of alternate systems.

Scheme 1: Formation of an Asymmetrical Diyne



19.

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

Kathryn McColl ‘08
Faculty Sponsor: Janet Morrison

The metabolites of drugs of abuse have mostly been established under pre-mortem conditions, but little is known about the fate of these drugs under post-mortem conditions. Facultative bacteria present in the body during the putrefactive stage of decomposition are known to degrade a variety of organic species. This project hypothesizes that these facultative bacteria metabolize drugs of abuse into as-of-yet unidentified products, which if found would drastically change the current methods of post-mortem toxicology screening. Phase I of this project focused on the development and optimization of an ethyl acetate liquid-liquid extraction (LLE) method for the isolation of cocaine, methamphetamine, morphine, and phencyclidine from thiogylcollate growth medium. Following their isolation from the liquid growth medium, the target analytes were derivatized with MSTFA +1% TMS and analyzed by gas chromatography-mass spectrometry (GC/MS) to evaluate sensitivity and recovery. The LLE/derivatization method used produced inconsistent results among the four analytes tested. Therefore a modified method of liquid-liquid extraction was performed using sodium chloride, ethanol, and hexanes with the desired goal of producing a cleaner extract of target analytes from the culture medium. The sodium chloride/ ethanol/ hexanes LLE method provided the cleanest chromatograms seen so far.

This semester concentration has been solely on achieving quantitative results. Continuing with the new modified LLE method, working standards were made in order to create a calibration curve for each drug. With the calibration curve the percent recovery of the desired drug in the extracts can be determined. It was found that while the modified LLE method resulted in excellent recoveries of cocaine and PCP in a clean extract, recoveries of methamphetamine and morphine were poor, suggesting the need for pH adjustments.

20.

STUDY OF THE ELEMENTAL COMPOSITION OF BRONZE ROMAN COINS USING SEM/EDS AND LIGHT MICROSCOPY

Ashley O’Neal ‘10
Faculty Sponsors: Ann Lehman, Maria Parr

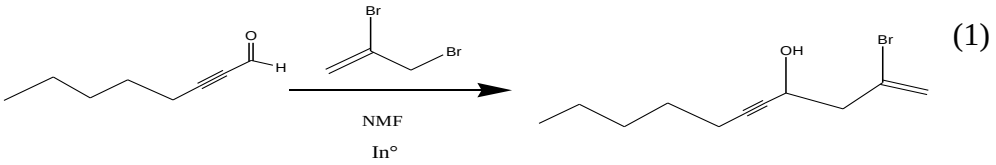
Two *Urbs Roma* coins, cast in the Roman Empire, are being analyzed for their elemental composition and surface morphology by light microscopy and scanning electron microscopy (SEM) with energy dispersive x-ray energy dispersive spectroscopy (EDS). The bronze coins had obvious surface corrosion, which was expected to present itself as different elements when analyzed by SEM/EDS. One coin was cut with a diamond saw and polished in order to provide a cross-section for analysis and to determine whether the corrosion products had penetrated the coin past the surface. In addition to copper, preliminary EDS analysis has shown the presence of several corrosion and possible alloy elements, including silicon, phosphorus, chlorine, calcium, iron, copper, silver, tin, and lead. In the cross-section of one coin, it was found that the corrosion elements penetrated the surface of the coin.

21.

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

Laert Rusha ‘08
Faculty Sponsor: Thomas Mitzel

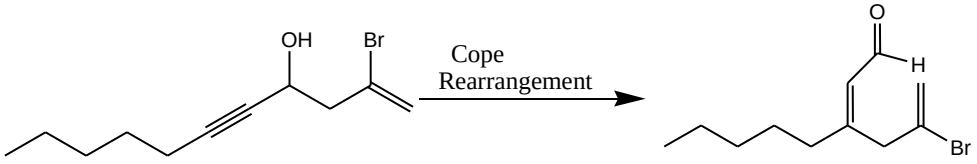
The goal of this project was to synthesize organic compounds that would serve as templates for antitumor drugs. We set out to create 3-(2-bromoallyl)oct-2-enal. In a 25 mL round-bottom flask we mixed 1 mmol oct-2-ynal with 1.5 mmol 2,3- dribromopropene and 1.1 mmol of indium powder in NMF solvent (as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



(1)

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

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



(2)

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

The alcohol product, 2-bromoundec-1-en-5-yn-4-ol, was formed with some success. The reproducibility of the reaction was a problem. We were not able to consistently form the alcohol product. The reaction parameters were tweaked and we found that NMF solvent works better then water, and that sonication at 50 degrees Celsius works better then room temperature. Even still the results were inconsistent, meaning the alcohol product would sometimes start to form after 8 hours and sometimes after 16 hours of reacting. We did not see any sign that the alcohol product was undergoing a cope-rearrangement.

22.

METHOD TO MONITOR WASTE WATER: TRACE LEVEL ANALYSIS OF TRICLOSAN

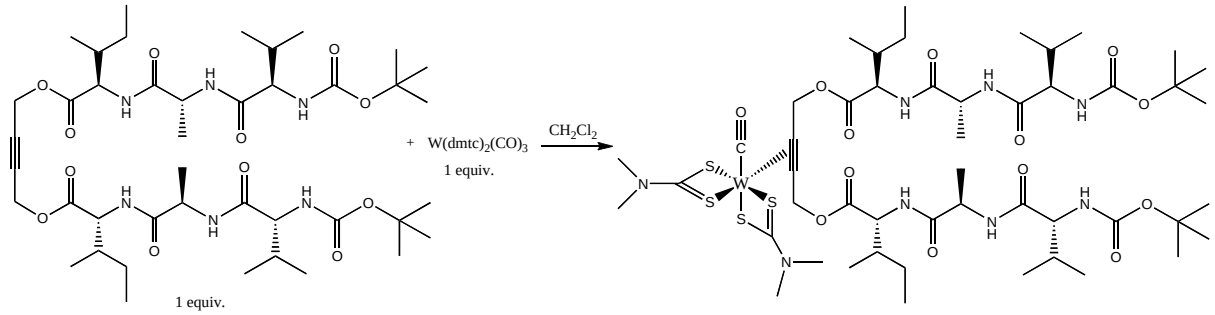
Erica Smith ‘08
Faculty Sponsor: David Henderson

Triclosan (5-chloro-2-(2,4-dichlorophenoxy)phenol) is used as a common biocide in commercial products. In an effort to track waste water in the environment, an analytical method for detecting triclosan using GC-MS is under development and optimization. In the method, triclosan is isolated and quantified using solid-phase extraction and an internal standard GC-MS method. The complete method has been shown to quantify part per trillion levels of triclosan. For extraction, 500mL of a water sample are filtered through a C18 filter disk where the triclosan is trapped. The triclosan is then extracted from the disks and concentrated before examining by GC-MS. Water samples have been collected from wells in Connecticut and compared to blank samples of deionized water. A study on the volume of water from which triclosan is extracted shows clearly an increase in triclosan in higher amounts of water. Alternative internal standards have been evaluated though the current internal standard used is d10-fluoranthene. A standard ELISA method for triclosan analysis is used for comparison to GC-MS results. Different amounts of triclosan have been found in well water and blank samples. However, because of the low detection limit, triclosan is often seen in the blank samples. Further work will include obtaining complete blank samples and subsequent application of the method to the study of well contamination in Connecticut.

23.

SIMULATION OF BETA SHEETS USING TUNGSTEN ALKYNE CHEMISTRY

Whitney Smith ‘07
Faculty Sponsor: Timothy Curran



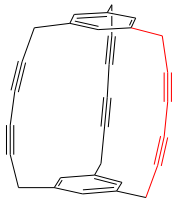
Previous research done in our lab has proven that two equivalents of alkynylpeptide reacts with one equivalent of the tungsten complex $W(CO)_3(dmtc)_2$, where dmtc = dimethylthiocarbamate. The product of this reaction is a tungsten bis-alkynylpeptide complex. The NMR spectra of these organometallic compounds have proven to be very difficult to analyze due to the many different conformational isomers present. In an attempt to simplify the system, we prepared tungsten mono-alkynylpeptide complexes using both symmetrical and asymmetrical alkynyldipeptides. The tungsten mono-symmetric complexes showed one conformational isomer to be present, whereas the mono-asymmetric complexes showed there to be two conformational isomers. With an understanding of how simple tungsten mono-alkynylpeptide systems behave, more complicated tungsten mono- and bis-alkynylpeptide complexes were made using symmetric alkynyltetrapeptides and alkynylhexapeptides. It was predicted that these molecules would conform in such a way that hydrogen bonds would form between the two chains of amino acids, simulating a beta sheet structure.

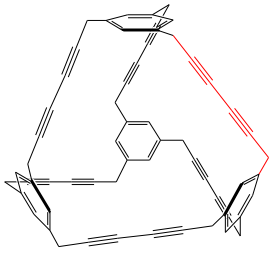
24.

USE OF ASYMMETRICAL DIYNE FORMATION EN ROUTE TO 3-D HYDROCARBON CAGES

Katharine Spencer ‘08
Faculty Sponsor: Thomas Mitzel

Homoconjugated 3-dimensional hydrocarbon cages are interesting synthetic targets for a number of reasons. The study of how 3-D homoconjugation may stabilize various cage structures or aid in the formation of endohedral complexes has vast implications in organic systems. This idea can be extended to larger homoconjugated cages such as C_{60} and other fullerenes. The smaller cages can be formed using asymmetrical diynes as a synthetic precursor. Stoichiometric coupling to form the asymmetrical diyne allows for application of this technique to the more complex C60 cage structure. Rational synthesis of the asymmetrical diyne will provide a backbone for the synthesis of these hydrocarbon cages.



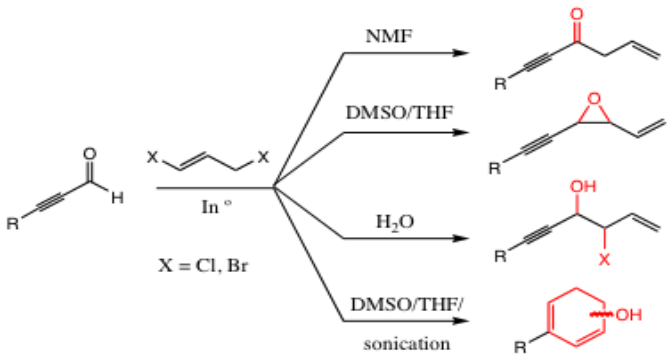


25.

USE OF SOLVENT CONDITIONS TO CONTROL FUNCTIONAL GROUP FORMATION IN INDIUM PROMOTED COUPLING REACTIONS

Rebecca Suflas ‘08, Timothy Scarella ‘08
Faculty Sponsor: Thomas Mitzel

Scheme 1: Functional Group Formation Control Through Solvent Effects



The ability to control functional group formation is paramount in organic synthesis. Previous studies in our group have shown that allyl-indium organometallic species may be added to propargyl aldehydes stereo- and regiospecifically. Use of 1,3-dihalopropenes as the nucleophilic species allows control of functional group formation within these systems simply by varying solvent and energy conditions of the reaction mixture.

Thus, beginning with a single set of starting reagents, it is possible to form, in a controlled fashion, an alcohol, ketone, epoxide, or bicyclic product simply by varying solvent and energy conditions within the reaction mixture.

COMPUTER SCIENCE

26.

VARIABLE ANALYSIS OF THE RSA PUBLIC KEY CRYPTOSYSTEM

Vinit Agrawal ‘10, Orko Momin ‘10
Faculty Sponsors: Takunari Miyazaki, Ralph Morelli

The RSA (short for Rivest-Shamir-Adelman, named after the surnames of the inventors) cryptosystem, one of the strongest forms of public key cryptosystem, accompanies extended runtime for decryption owing to the lack of vulnerability. The runtime and efficiency (security) of this system, which plays an integral part in internet security, are inversely related. The system’s algorithm works in that it chooses two large prime numbers "p","q" and through a number theoretic process obtains the values of two other variables "d" and "e", the values of which determine the encryption and decryption keys and also the above-mentioned factors. Studies have shown that for significantly small values of "d", the system becomes vulnerable to attacks. The cryptosystem is therefore being analyzed to study the relationship between the variables and the system’s strength and also to identify the set of values of the variables for which this strength can be optimized. For this purpose, the number theoretic background of cryptography was studied. Using Java programming language and utilizing the Java API BigInteger class, RSA was implemented. The experiments to be conducted using this code written in Java will reveal what initial values of "e" lower the value of "d", thereby making the system vulnerable. Various values for "e" would be fed into the system to obtain values of "d" which are lower than the vulnerability threshold. These experiments should act as an empirical proof toward the study conducted in this field earlier and produce scope for identification of patterns that may be used for further attempts at optimization of the system for achievement of even stronger security in the fields where RSA is employed.

27.

TRINITY ONLINE LAUNDRY SERVICES (T.O.L.S.)

Christopher Klein ‘07
Faculty Sponsor: Madalene Spezialetti

TOLS is a web based application that was designed to cut the time students spend doing laundry in a congested collegiate setting. The application allows users to view the availability of washers and dryers in any dorm on campus using a computer with an active internet connection. The application not only allows users to view the status of each laundry machine online, but also receive email notifications when certain machines become available for use.

ENGINEERING

28.

MULTICHANNEL NON-LINEAR VIBRATION ANALYSIS FOR THE DETECTION OF DISTRIBUTED GEAR FAULTS

Susmita Bhandari ‘07
Faculty Sponsor: Taikang Ning

In rotating machineries, the vibration signal bears the signature of faults . Early detection of such faults is possible by analyzing the signal using various signal processing techniques. In this project, a wood-lathe with external gears is considered as a typical representation of rotating machinery. Any faults in the gears will leave a signature in the form of increased non-linearity in the vibration signal. Techniques such as power spectrum analysis, bispectrum estimation and bicoherence analysis can detect and quantify the non-linearities present in the system. Such quantification can provide information about the type and severity of faults in the gear system. The rotating machinery is coupled with a data acquisition system and a Field Programmable Gate Array based processing system to collect and process vibration signal respectively to demonstrate the practicality of the proposed system.

29.

A STUDY OF EMISSIONS FROM A VEGETABLE OIL FUELED VEHICLE AND WAYS TO IMPROVE PERFORMANCE

Timothy Bockus ‘07
Faculty Sponsor: John Mertens

Vegetable oil can be used as an alternative for diesel fuel in compression ignition engines. This project studied tailpipe emissions resulting from vegetable oil fuel combustion and developed a method to modify the oil’s viscosity using resistance heating. Emissions were measured on vehicles fitted with a dual tank conversion system that requires the operator to select either diesel or vegetable oil by manually switching the fuel source tank. The dual tank system allowed emissions data to be obtained for both diesel and vegetable oil on the same engine under similar test conditions. Tests were performed with the vehicle on a dynamometer at speeds from 0 to 30 mph with loads from 0 to 6.5 hp. Emissions for both diesel and vegetable oil were measured using a five gas analyzer that measured the levels of HC, CO, NOx, CO_2, and O_2. No significant increase or decrease in gas levels were found for vegetable oil when compared to diesel levels. Exhaust gas opacity was also measured using a light extinction method and SAE standard J1667 smoke test procedure. At 30 mph dynamometer speeds, vegetable oil emissions resulted in a 37% decrease in opacity over that of diesel.

Viscosities of canola, sesame, and corn oils were measured using a Brookfield viscometer. Measurements were taken for oil temperatures ranging from 0°C to 80°C and compared with #2 diesel. Results show that vegetable oils have a higher viscosity than diesel at low temperatures and must be heated to 40°C to have a similar viscosity as diesel at 0°C. A prototype system using resistance heating was designed and built to lower the viscosity of a small quantity of oil in a pre-heat chamber that could be used for engine start-up eliminating the need for diesel and the dual tank system.

30.

HARVESTING HYDROGEN USING RENEWABLE WIND POWER

Jonathan Boreyko ‘07
Faculty Sponsor: John Mertens

The goal of this project was to develop a system that produces clean, renewable, and transportable energy. This was accomplished by designing and building a scale model wind turbine for use in a wind tunnel. The generated electricity from this wind turbine was applied to a water electrolysis apparatus to create pure hydrogen for use in hydrogen fuel cells. A high efficiency design for the wind turbine blades was accomplished through airfoil analysis and by writing a Microsoft Excel program that optimized and predicted aerodynamic performance. This blade design was then modeled on the 3D drawing program SolidWorks and sent to a machining company for creation. Reversible DC motors were obtained for electricity generation; the power and torque characteristics of the motors were chosen to match the theoretical outputs of the wind turbine at various wind tunnel speeds as predicted by the Excel program. A small-scale water electrolysis device was also obtained so that this electricity could be used to convert water into pure hydrogen for use in a clean burning hydrogen fuel cell.

31.

DEVELOPMENT OF AN UPDATED AND AUTOMATED MANUFACTURING SYSTEM FOR A LIQUID SOAP PRODUCT

A. Peter Dacey ‘07
Faculty Sponsors: Jose Davila, John Mertens, Joseph Palladino

Problem Statement:
The manufacturing of a liquid stain remover product currently employs aging equipment and an outdated, inefficient process. In a redesigning of the system, it was desired that the manufacturing time of the stain remover be reduced from two days to one, and that only general supervision of the industrial process be needed instead of the current labor-intensive requirements. Both of these constraints could be met by employing automated technology and computer control systems.

Design Process and Solution:
The manufacturing process was broken into portions and each one was prioritized based on its level of inefficiency. It was found that the procedures for physically mixing the completed batch, and the method of adding three highly-viscous fluid ingredients into the product batch, were the two parts that could be most improved, and a new process was developed for each. Using computer software and a positive-displacement flowmeter, a prototype system was designed and built that could simultaneously measure and add the fluid ingredients into the product batch automatically. In addition, a second prototype connected to a scaled mixer made use of the same software, along with relay controls, to stir completed batches intermittently and without supervision. Finally, once each system was tested to ensure that it met the project’s constraints, plans were drawn up for a full-sized version of each.

32.

WATER LEAK MITIGATION DEVICE VALVE TESTING

Marcus de Castro ‘07
Faculty Sponsor: John Mertens
Michael Roy, Hartford Steam Boiler Insurance & Inspection Co.

This project was designed to build a controllable testing rig that measuring flow and pressure of water through an electrically actuated water valve used in water leak mitigation devices followed by planned failure analysis of the valves. Water leaks due to plumbing, fixture, and appliance failures can result in catastrophic losses for both insurance companies and home-owners. According to The Institute for Business & Home Safety (IBHS), water damage has cost insurance companies nearly $6.8 billion each year. As a result of these losses being so great, numerous products relying on electrically actuated valves have been sold on the market to help alleviate and potentially prevent internal water failures.

A testing rig was designed to host various tests on three specifically selected valves including increased flow, excessive pressures, effects of mineral deposits, and accelerated corrosion, while simulating a typical residential plumbing system constructed from copper. Two of the three electrically actuated valves were controlled with the use of LabVIEW and a circuit incorporating two latching relays capable of handling a load of 500 milliamps. The testing rig design included a flow regulating valve capable of varying water flow from 0 to 60 gallons per minute, a fabricated piston system capable of increasing pressure to 125 pounds per square inch, a constructed Venturi meter to monitor flow, and a ¼ horsepower sump pump capable of flow rates up to 60 gallons per minute. Mineral deposit tests are performed with a water supply containing high levels of calcium. The valves are still in the process of the failure analysis.

33.

DESIGN OF AN UPPER ARM STRENGTH AMPLIFICATION MACHINE

David DuPaul ‘07
Faculty Sponsor: Harry Blaise

Human bodies are limited in the amount of force they can generate. The goal of this project is to design and construct a machine that increases the amount of weight a person can curl with his arm. The constraints on this design include safety, portability, ease of use, and a $175 budget. Also, the machine must function in such a way that the techniques and strategies used can be extended to any range of motion.

The resulting machine interfaces with the human body by means of electrode pads placed on the surface of an arm. These electrodes detect a myoelectric signal which carries information about the motion of the arm. This signal is filtered, amplified, and then used to control a linear actuator. The linear actuator is a compact device capable of pushing or pulling with a force of 150 lb over a 2 inch range of motion. This linear actuator is attached to a wooden framework that fits around a person’s arm comfortably and securely. The machine will be tested on a wooden dummy arm to verify that it works and is safe. Further changes will likely be necessary before this machine is fit for use on a human arm.

34.

THE HYDRAULIC CARDIOVASCULAR SYSTEM

John Halverson ‘07, Kevin D’Arrigo ‘07, Dennis Crowe ‘07
Faculty Sponsor: Joseph Palladino

Cardiovascular disease is the number one source of death in the United States. In order to investigate the causes and symptoms, a study of pressure, volume and flow with three major goals was completed. ν Construct an abbreviated mechanical model of the cardiovascular system ν Obtain “healthy” human data under as many realistic conditions as possible ν Manipulate the system in order to simulate an unhealthy human cardiovascular system A human heartbeat has been achieved; the correct pressure difference of 40 mm Hg between systole and diastole has been successfully obtained. Further, pulse wave velocity (the speed at which a single pulse wave travels through the body i.e. from neck to ankle) data points have been measured and it has been concluded that the greater the pressure, the lower the pulse wave velocity. It should follow that a constricted artery will yield higher systemic pressures (hypertension) while a bubbled blood vessel (aneurism) will yield lower pressures. Simulation of inotropic drugs (those that make the heart contract harder), as well as Starlings Law will also be demonstrated.

35.

DEVELOPING COST-EFFECTIVE SOLAR-THERMAL POWER FOR HOUSEHOLD AND SMALL BUSINESS APPLICATIONS

Jeffrey Jaworski ‘07
Faculty Sponsor: John Mertens

Of the existing solar-thermal methods of harvesting the sun’s energy, a combination of parabolic dish and Stirling engine was chosen as the most effective. The system consists of a large dish which focuses the sun’s rays to a single point, and a heat engine which converts that heat into mechanical energy. In an effort to decrease this cost, a dish was designed that would utilize plane mirrors instead of costly, precisely curved ones. A prototype was designed and built to a 1/6 scale, and has a projected area of .98m2. It consists of 450 sections of trapezoidal mirrors adhered to a fabricated steel frame. The design also utilizes a dual axis solar tracker, consisting of a rotational axis and an axis for elevation. The tracking hardware uses green LEDs as the light sensing components, which output a detectable voltage in sunlight. Future work includes machining and assembling a Stirling Engine which has already been designed to operate with this dish.

36.

TEMPERATURE SENSITIVE COOLING VEST

Miranda LeBlanc ‘07, Jesse Turcotte ‘07, A.J. Pattison ‘07
Faculty Sponsor: Joseph Palladino

Many jobs today, such as surgeons, involve work in high temperature, high stress environments that require that they stay calm and cool. Current cooling devices are both expensive and short-lasting. The goal of this project was to design and build a temperature sensitive cooling vest that was inexpensive and has a longer cooling lifetime than existing devices. The final design of the cooling system contains tubing, a gear pump, and an ice bath to create a continuous, closed loop through which chilled water flows. Two types of tubing are used (vinyl and copper). Thirteen feet of vinyl tubing weaves through a polyester vest and connects with four feet of copper tubing

that spirals through a two gallon ice bath in order to re-cool the water. Unlike devices in the current market, this cooling vest is temperature sensitive. An SI Labs C8051F120 microcontroller is utilized in combination with thermistors to control this system. The microcontroller activates the pump when the inside of the vest reaches an uncomfortably warm temperature of 94°F. The pump is turned off when the temperature on the inside of the vest goes below 88°F. The system is powered by both a 9VDC and a 12VDC battery. This portable system has kept a person cool for 2 hours in uncomfortable temperatures. The total cost is less than $150, considerably less than the current market. While this system is only a prototype, it has proven to be very effective.

37.

DESIGN AND IMPLIMENTATION OF A DIGITAL STETHOSCOPE FOR REMOTE EXPLORATION

Allison Mathis ‘07
Faculty Sponsor: Taikang Ning

Motivation: To provide reliable and useful monitoring devices to continuously evaluate the health and fitness of astronauts without impeding their ability to function in a small, weightless environment.

Purpose: The goal of this project is to design and build an experimental, compact, cost-effective and wireless digital stethoscope that is capable of collecting heart sounds, performing basic auscultation diagnostic functions and transmitting digitized data to a host computer for further clinical analysis. Although electrocardiogram (ECG) monitors are available, stethoscope can provide valuable cardiovascular information regarding valve closings and blood circulation of the heart.

38.

WALKER, SEASON TWO: DESIGN AND CONSTRUCTION OF A WALKING ROBOT

Allison Mathis ‘07, A. Peter Dacey ‘07, Eli Roxby ‘09
Faculty Sponsor: David Ahlgren

Quadruped walking robots often have great difficulties turning corners due to the nature of their construction. However, if the robot is designed to never turn corners, but simply changes its axis of motion, this difficulty can be easily overcome. This can be accomplished by placing the legs on servos and reorienting them in relation to the main body of the robot whenever a turn in required. The purpose of this project was to build a robot body based on the thesis described above, and the program it to navigate the maze in the Trinity College Home Fire-Fighting Robotics Contest.

39.

CURRENT SHOCK TUBE RESEARCH

Scott Mussmann ‘09
Faculty Sponsor: John Mertens

Intro: The main goal of this research project is to complete the design and assembly of a new shock tube facility at Trinity College. A shock tube is a device that heats gases nearly instantaneously to a controlled temperature using supersonic shockwaves. In order to conduct shock tube experiments, the pressure within the shock tube must be at vacuum pressure; this pressure is typically 1 x 10-7 torr. A plastic diaphragm separates a low pressure gas in what is known as the driven section of the shock tube. A high pressure gas is then entered into the driver section, which is on the other side of the diaphragm. The high pressure gas then causes the diaphragm to break and the high pressure gas proceeds to interact with the low pressure gas.

Methods: CAD programs and previous design plans were used to design the shock tube that is currently under construction. More specifically, an apparatus was designed to allow gases to enter and exit the shock tube with minimal leakage. Parts for the apparatus were ordered and machining work was done on the shock tube. A custom made insert will be machined; this insert will serve as a removable wall for the shock tube and will allow for entry and exit of gases in the driven section. The shock tube is currently in the process of being assembled.

Discussion and Broader Implications: Shock tube experiments will be used to study Syngas – a mixture of H2 and CO produced from coal. Syngas can be a clean and domestically available source of energy in the future. Design of detailed models of its combustion process will aid future design of Syngas power plants. Mass production of Syngas is often used as fuel to generate electricity.

40.

CLOUD DETECTION FOR REMOTE SENSING USING FPGA TECHNOLOGY

Rayn Sakaguchi ‘07
Faculty Sponsor: Taikang Ning

The goal of this project was to create a hardware based image processing system to detect cloud formations. Cloud formations in satellite images contain information on storm systems and also act as a source of error in Earth surface studies. Prototype cloud detection algorithms were developed using MATLAB, which were then be converted into hardware. This project utilizes a hardware design approach known as System on a Programmable Chip (SOPC) where a software processor is implemented onto a Field Programmable Gate Array (FPGA) chip. Currently work is being done to improve efficiency and design of hardware image processing system.

41.
LASER RANGE FINDER FOR ROBOTIC APPLICATIONS
Owen Sanford ‘07
Faculty Sponsor: David Ahlgren

The goal of this project was to design and build a ranging sensor utilizing laser technology. Laser ranging sensors use laser light to determine distances and thus have a number of advantages; they are more accurate, faster and more reliable than most other systems. In addition, laser light does not dissipate quickly thus laser range finders can measure very large distances. Commercial laser range finders can cost over $2500 thus the primary consideration for the sensor was low overall cost.

Many different sensor design options were considered for this design problem. The goal was eventually reached by utilizing a low cost CMOS image sensor and a modulated laser in conjunction with a processor. The image sensor was used to collect color data from a specific field of view. Many image-processing algorithms were then explored to effectively determine the lateral position of the laser spot. This information was used to calculate the distance from the sensor to the laser spot through triangulation. This design yielded a sensor with range of 0.5m to 4m with a maximum error of 5% of the distance measured. The total cost of the entire system is estimated to be around $350 depending on the processor used to perform the calculations.

ENVIRONMENTAL SCIENCE

42.
DEVELOPMENT FOR MONITORING WASTEWATER IN THE ENVIRONMENT
Elisabeth Cianciola ‘10
Faculty Sponsor: David Henderson

Wastewater contamination of soil and water supplies can be determined using molecules found in human wastewater. Two such molecules are optical brighteners found in laundry detergents: diaminostilbene (1) (DAS-1) and distyrylbiphenyl (DSBP). In order to test analytical parameters, 10 ug/ml solutions of either DAS-1 or DSBP in dimethylformamide (DMF) were prepared and compared against an internal standard solution of calmagite. The optimal temperature, column, and mobile phase for evaluating the presence of these chemicals in solution were determined using high-performance liquid chromatography (HPLC) The mobile phase for this method is based on gradients of acetonitrile, methanol, and tenth molar ammonium acetate. It was intended that this data would be used to design the LCQ (apparatus based on an ion trap) mass spectrometry procedure, but the parameters found using the Hitachi HPLC yielded different results when applied to the LCQ system. Preliminary LCQ data indicate that peak retention times will be lower and the optimal temperature will be higher. A successful separation of the chemicals of interest was obtained at 55 degrees Celsius at a 10 ul injection volume after increasing the initial flow of methanol and reducing the initial flow of acetonitrile in the mobile phase. However, a new internal standard must be found, because the calmagite has been clogging the equipment. Once the details of this method have been ironed out such that it gives reproducible results, it will be applied to well-water samples in Connecticut. Local communities will then be able to identify potentially hazardous or substandard water supplies and address them.

43.

ACID DEPOSITION ANALYSIS OF PRECIPITATION SAMPLES FROM TRINITY COLLEGE IN HARTFORD, CT

Samantha Dolgoff ‘08
Faculty Sponsor: Jonathan Gourley

Acid deposition has been an environmental issue since the Industrial Revolution. Acid deposition forms when sulfur dioxides (SOx) and nitrogen oxides (NOx) are emitted into the atmosphere from the burning of fossil fuels. While in the atmosphere these compounds react with water to form sulfuric acid (H2SO4) and nitric acid (HNO3). Concentrations of these acids form in storm clouds and are released through either wet or dry deposition. Acid rain is especially a problem in the northeastern United States, which receives much its precipitation from storms that track over coal burning power plants in the Midwest. In addition, the high-density populations of the Northeast are a local source of acid rain pollutants. Precipitation samples were collected from Trinity College in Hartford, Connecticut and tested for pH, total free acid (H3O) and for concentrations of nitrates and sulfates. The storm track was recorded and the amount of rainfall was calculated from weather observations at Brainard Airport in Hartford. It was found that there was a correlation between pH and the concentration of nitrate and sulfate. When nitrate and sulfate concentrations rose there was a decrease in pH. There was also a correlation found between the size of the storm (amount of rainfall) and the concentration of nitrates and sulfates. The nitrate and sulfate concentrations varied greatly for the small storm systems, which may be a function of the variability in storm tracks. Certain storms were also of interest and may help to predict which storm tracks in the future will have higher or lower concentrations of nitrates and sulfates.

44.

USE OF URBAN ENVIRONMENTS BY THE RED-TAILED HAWK (*Buteo Jamaicensis)*

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

The red-tailed hawk (*Buteo Jamaicensis*) is a common and well-studied bird in North America, but has never been studied in an urban environment despite its prevalence in cities. This study was undertaken to assess the habitat use and home ranges of red-tailed hawks in Hartford. Six hawks were trapped between November 2006 and April 27 with bal chatri traps in the Hartford metropolitan area. Three hawks were captured in city parks, where they have reliably stayed. Two juveniles were captured on the Trinity College campus. One was consistently found along the Summit ridge, and one in Zion Hill Cemetery. One adult was captured on campus but so far spends a majority of its time in the neighborhood south of the campus. Standard measurements were taken to assess the general health of the bird and determine sex. They were then fitted with a fish and wildlife band, a color ID band, and a backpack style radio transmitter with frequencies ranging from 150-152 MHz. Hawks were released at the capture site and located approximately twice a week between the capture date and April 2007. Perch locations were described and marked with a GPS. Locations were not plotted if the hawk was soaring. Thus far the number of points per bird ranges from 3-34. Home range was calculated using the animal movement extension on ArcGIS. Home ranges encompassed both parks and neighborhood developments. We anticipate that we will gather new information about the use of the urban environment by red tailed hawks that may be used to manage city wildlife.

45.

ANALYSES OF SURFACE DEPRESSIONS IN WETHERSFIELD, CT FOR PALEOCLIMATIC EVIDENCE

Courtney Hugo ‘08
Faculty Sponsor: Christoph Geiss

Pingos are permafrost mounds or the relics of one that has formed in a climate cold enough to support active permafrost. They form from the accretion and freezing of groundwater and may be connected to other nearby pingos. The purpose of this study is to determine if a group of 42 scattered depressions covering approximately 145,000 m2 in Wethersfield, CT (Wintergreen Woods) is a pingo field. X-ray diffraction and magnetic susceptibility have been performed on a cross-section of cores from one potential pingo. There are no obvious patterns in these analyses. Quartz and illite are consistent throughout the entire depth of the core, but siderite is present in intervals from approximately 1.25m to 3.75m. There are also sporadic peaks in the magnetic susceptibility analysis. A qualitative description of the core’s color, texture, and grain size showed no regular laminations or bandings. These three analyses suggest a disturbance in the deposition of sediment which is characteristic of the formation of a pingo. Samples of organic matter from 4m and deeper have been sent to Arizona for radiocarbon dating. Soil cores from the surrounding area have been taken for comparison. If this study concludes these depressions are pingos, it would imply that Glacial Lake Hitchcock had drained rapidly and was followed by a long period of intense cold. This would contradict other paleoclimatic evidence for New England which shows the cold period to have ended shortly after the lake’s drainage.

46.

RELATIONSHIPS BETWEEN THE BREEDING BIOLOGY, DIET, AND RAINFALL: CRESTED CARACARAS IN FLORIDA

Kyle Pias ‘07
Faculty Sponsor: Joan Morrison

I examined the influences of rainfall on the breeding biology of the crested caracara (*Caracara cheriway*) in south-central Florida. The populations of these birds in Florida is isolated and listed as threatened. Previous studies have shown links between the decrease in rainfall seen in the fall and the initiation of nesting and the diet of the caracaras. In this study I examined the correlation between breeding parameters from Morrison 1999 and a variety of rainfall variables compiled from the National Oceanic and Atmospheric Administration (NOAA). These variables were analyzed using SYSTAT v. 8.0. The percentage of birds that nested early showed a significant negative correlation with infrequent rainfall from June to July. The percentage of successful showed a significant positive correlation with infrequent rainfall from January to February. The number of fledges from each nest showed a significant negative correlation with the total amount of rainfall from September to December. These findings support the hypothesis that caracaras depend upon prey items made available by dropping water levels to successfully produce young. This demonstrates the true complexity of the caracaras role in the dynamic south-central Florida ecosystem, and the level of care that needs to be taken when considering the management and conservation of this species.

47.

MAGNETIC ANALYSES OF LAKE SEDIMENT FROM FIDDLER AND LOUIS LAKE, WYOMING

Jacques Swanepoel ‘07
Faculty Sponsor: Christoph Geiss

Two sediment cores were taken from Louis Lake and two more from Fiddler Lake in February 2004. Magnetic susceptibility and paleomagnetic measurements were taken from these cores. These lakes are located in the Wind River Range near Lander, Wyoming in the Little Popo Agie drainage basin and are unique because of the fact that they only receive input from their respective basins and during the last glacial episodes they were dammed by glaciers that moved down the Popo Agie valley. The Fiddler and Louis Lake basins were not glaciated during the last two glacial episodes, which gave them a very complete sediment record. These sediment records are important because they can give insight into climate variability in this region during the Holocene and the late glacial period. The goal of this project was to construct a record of magnetization trends of sediment from these lakes and possibly link them to trends in the climate change during this period. Our results show significant correlation between our cores from Fiddler and Louis Lake. There is a very distinct and sharp rise in magnetic susceptibility that can be seen in all of the cores which helped with getting all the cores on the same depth scale. The fact that these cores seem to show these similar trends in magnetization means that we have a dependable record that can be used to relate environmental trends to our trends in magnetization.

48.

ROOST CHARACTERISTICS OF RED-TAILED HAWKS (*BUTEO JAMAICENSIS*) IN URBAN ENVIRONMENTS

Frances M. Thomas ‘10
Faculty Sponsor: Joan Morrison

The Red-Tailed Hawk (*Buteo jamaicensis*) is a highly adaptable bird of prey, found in various habitats across North America (Preston and Beane 1993). Red-Tailed Hawk populations can thrive in urban areas due to their adaptability and ideal habitat being open land with sporadic foliage (Preston and Beane 1993). However, it is also the urban environment which poses the greatest threat to these Red-tail populations (Preston and Beane 1993). Thus, it is crucial to understand Red-Tailed hawk roosting activities in order to better manage and protect these birds. Past studies have shown that both urban and rural birds tend to roost in trees with denser foliage, more canopy cover, and those that are taller than randomly selected non-roost trees (Gorenzel *et al.*, 1995; Peh and Sodhi, 2002; Young *et al.*,1998) We trapped five hawks at 5 different sites in Hartford, CT and we tagged them using color bands and standard US Fish and Wildlife bands. The birds were also tagged with radio transmitters. At least two roost sites were found in the months of February, March, and April for each of the five birds. Roost trees were surveyed for diameter, height, species, area, and percent transmittance of canopy cover. For every roost tree, one random tree was located and surveyed for the same characteristics. There is no significant difference between roost tree and random tree height, roost tree and random tree diameter, and roost tree and random tree area. Through gaining a greater understanding of Red-Tailed hawk roost characteristics, we can better recommend to the city of Hartford and other cities with similar environments how to best protect and manage wildlife in urban environments.

HEALTH FELLOWS

49.

IN-HOSPITAL AND AT-DISCHARGE FACTORS INFLUENCING FOLLOW-UP CLINIC ATTENDANCE AND GROWTH AT FOUR MONTHS CORRECTED AGE IN VERY LOW BIRTH WEIGHT INFANTS AT CCMC

Armand DelRosario '07
Faculty Sponsor: Sarah Raskin
James Hagadorn MD MS, Isabella Knox MD, Department of Neonatology, Connecticut Children's Medical Center

Preterm infants often suffer from growth deficiency throughout infancy and childhood. Growth failure has been associated with poor health and neurodevelopment later in life. Diagnoses of necrotizing enterocolitis, bronchopulmonary dysplasia, intraventricular hemorrhage, as well as the use of hyperalimentation have been linked to poor growth in premature infants during hospital stay. In addition, mode and composition of nutrition are thought to have major impact on growth. However, factors influencing the growth rates following discharge of the very low birth weight (VLBW) infant subgroup (< 1500g) remain poorly defined in the literature. Furthermore, few studies explore the factors that affect the rates of follow-up attendance of VLBW infants after neonatal intensive care unit (NICU) discharge. In this study, we observe trends and further characterize the risk factors that predispose VLBW infants to growth failure, and describe variables that influence NICU follow-up clinic attendance at CCMC.

50.

EMERGENCY DEPARTMENT DISPARITIES IN PAIN MANAGEMENT FOR CHILDREN WITH SICKLE CELL DISEASE AT CONNECTICUT CHILDREN"S MEDICAL CENTER

Brian Lee '07
Faculty Sponsor: Laurel Baldwin-Ragaven
William Zempsky MD, Pain Relief Program, Connecticut Children's Medical Center

Sickle Cell Disease (SCD) is a serious and potentially fatal disease that is genetically acquired due to mutations in the gene coding for the β chains of hemoglobin. As a result, hemoglobin forms a sickled shape, damaging and clotting vasculature (vasoocculsion) as well as reducing oxygen transportation ability. Patients with SCD may require visits to the emergency department (ED) for adequate pain management caused by vasoocclusive episodes. Previous research has found that minorities have a lower quality of overall pain management in hospitals. The purpose of this research was to investigate health disparities in pain management for SCD patients who visit an urban children's hospital's ED for vasoocclusive pain because SCD is found primarily in African Americans. Patients with isolated long bone fractures (LBF) were used as a control because pain associated with vasoocclusive episodes has been correlated to LBF pain. A retrospective chart review was conducted using patients who visited Connecticut Children's Medical Center's (CCMC) ED from January 1, 2005 to December 31, 2005 for vasoocclusive pain or LBFs. Preliminary results on African Americans with SCD compared to African Americans with LBFs have shown that: they spend significantly less time in the waiting room [8.56±13.12 min vs. 21.00±52.69 min (p=0.027)], receive significantly more opiates [0.10±0.04 mg/kg vs. 0.08±0.03 mg/kg (p=0.043)] and are hospitalized for longer periods of time [4.32±2.52 days vs. 2.50±0.90 days (p=0.016)]. The likelihood of receiving opiate analgesic

and being hospitalized was found to be not significant. The preliminary data suggests that African American patients with SCD receive better hospital care compared to patients with LBFs at CCMC. Further data analysis needs to be conducted to determine other factors affecting pain management.

51.

CATEGORIZATION OF CHILDHOOD SYNCOPE

Cristina Wheeler Castillo ‘08
Faculty Sponsor: Sarah Raskin
Francis DiMario MD, Department of Neurology, Connecticut Children’s Medical Center

Syncope is characterized by a sudden loss of consciousness accompanied by loss of postural tone and a spontaneous recovery. By adolescence, it is estimated that approximately 30-50% of children experience at least one episode of syncope and the symptom accounts for 1% of hospital visits in one year. Syncope is a symptom whose causal mechanism or disease (etiology) is difficult to diagnose and is often misdiagnosed. It is important to distinguish benign etiologies from other life-threatening etiologies of syncope and from separate conditions, such as epilepsy. This clinical study applied uniform criteria for etiologic syncopal categories to determine what types of syncope are most common in children evaluated at CCMC (Connecticut Children’s Medical Center), and to investigate what diagnostic tests were most useful in the diagnosis. A retrospective chart-review was conducted using subjects referred to Neurology at CCMC for syncope from the past five years. Subjects were excluded if they presented with near-syncope alone or with epilepsy alone. Approximately 300 charts were reviewed. We expect to find fewer cardiovascular-mediated cases of syncope and more neurally mediated syncope cases in our study population, as cardiovascular complications are less common in children than it is in adults. We expected to find convulsive syncope (non-epileptic anoxic seizures) in some of the subjects and they were classified into specific etiologies. Data was analyzed using SPSS.

52.

HIV/AIDS IN HONDURAS

Todd Morrison ‘07, Armand DelRosario‘07, Brian Lee ‘07, Cristina Wheeler Castillo ‘08, Monika Zagaja ‘08
Faculty Sponsors: Sarah Raskin, Laurel Baldwin-Ragaven

This past March, the Trinity Health Fellows Program traveled to Honduras to gain a better understanding of how HIV/AIDS has crippled this developing nation. Thanks to a generous grant from the Mellon Foundation, students saw, firsthand, the challenges faced by healthcare providers.

These experiences helped them link urban issues here in Hartford to global issues throughout the Americas. It truly augmented the themes of the Health Fellows Seminar.

MATHEMATICS

53.
LINEAR PROGRAMMING SIMULATION OF THE COLLEGE ADMISSIONS PROCESS
Adam Leamon ‘07
Faculty Sponsor: Philip Brown

Every year, a small college looks to admit an incoming freshman class of at most 500 students that satisfies a series of rigorous requirements set out by the college. The college president, for instance, demands a freshman class that will eventually contribute $2.5 million to the college. Faculty stipulate that the average SAT score of admitted students be above 1250, and maintenance insists that the damage caused by students not exceed the budget of $85,000. The ultimate goal of the model is to optimize the distribution of admitted males and females into the college in order to educate the class at the lowest possible cost.

54.
A MODEL OF PREDATOR AND PREY ANALYSIS
Jon Simonian ‘07
Faculty Sponsor: Philip Brown

My poster will present a model of predator and prey analysis. Two species will start at given levels and through many generations, the populations of the two species will evolve into a limit cycle. Naturally, the number of predators depends on the number of prey and the number of prey depends on the number of predators so the actual population of either species depends on what the population of the other is at the same time. The poster will contain illustrations that show what the populations of the two species will look like graphically over time as well as explanations and examples of how the model theoretically works.

55.
MONTE CARLO SIMULATION FOR PREDICTING THE 2007 KENTUCKY DERBY
Clay Smith ‘08
Faculty Sponsor: Philip Brown

For gamblers around the world, a tool for predicting the outcome of this year’s Kentucky Derby would be very useful. Using Monte Carlo simulation, this project will predict first place, second and third place of this year’s race based on a thousand races computed by a computer program written in Fortran. When a number produced by a random number generator falls into a particular horse’s interval, which will be based on the horse’s odds of winning, placing or showing, the outcome for this horse will be stored. This process will be repeated a thousand times. Other experiments will computed such as the percentage chance that the least favored horse will come in third place, *etc*. A poster will be constructed including a diagram of the computer program and a model of a typical trial.

56.
CHAOS AND THE EXCHANGE RATE
Irena Tsvetkova ‘07
Faculty Sponsor: Philip Brown

Mathematical models fall into two categories: deterministic, in which the future state of the system is determined by the initial conditions, and probabilistic models. However, some deterministic models exhibit chaotic behavior, so that the furure state of the system cannot be predicted. Economists became interested in deterministic chaotic models as early as the 1970s, and have aimed at detecting chaos in financial economic variables such as exchange rates.

Chaotic exchange rate models are structural models built in discrete time (difference equations), and show that under the assumptions of PPP and interest parity, and introducing nonlinearities in the dynamic equations, it is possible to obtain a model capable of giving chaotic motion.

In 2002 Daniela Federici and Giancarlo Gandolfo came up with a continuous time exchange rate model, built as a non-linear set of three differential equations. Italian data was used to econometrically estimate this model and to analyze the presence of chaotic motion. This study shows that continuous time estimation of systems of nonlinear differential equations is a powerful tool in analyzing dynamic nonlinear problems.

NEUROSCIENCE

57.
INDUCED LONG TERM POTENTIATION IN THE HIPPOCAMPAL PATHWAY FROM THE DENTATE GYRUS TO THE ENTORHINAL CORTEX
Nicole Albino ‘10
Faculty Sponsor: Harry Blaise

The hippocampus is a small area of the brain that plays a significant role in human learning and memory and is believed to be the first stop for processing of sensory information before it is then transferred back to the neocortex for storage. Previous research has shown that sensory information makes its way through the hippocampus in a cyclical fashion, but does not fully prove the theory that the information then comes back out of the hippocampus to the further areas of the neocortex for long-term storage. Long-term potentiation (LTP) is the phenomenon by which the transmission of information through neurons becomes increasingly efficient due to frequent activation. Long-term potentiation recorded in the entorhinal cortex of the hippocampus after stimulation in the dentate gyrus would further support the theory that the role of the hippocampus in learning and memory is mainly one of consolidation. In this study, surgery was performed upon 70 day old male and female Sprague-Dawley rats to chronically insert a recording electrode in the entorhinal cortex and a stimulating electrode into the dentate gyrus. After a 3-5 day recovery period, a baseline signal from the brain was recorded at the intensity that evoked 50% the maximal population spike amplitude (PSA). LTP was induced via 0.1 Hz burst electrical stimulation. Results showed that LTP was induced and maintained in several of the rats, while a depressed signal was recorded in others. Because the enhancement of LTP indicates more efficient transmission of information through synapses, in this case more efficient processing and consolidation of information, our results tend to support the theory that information is cycled through the hippocampus and then transferred back to the neocortex.

58.

THE KETOGENIC DIET'S ANTICONVULSANT PROPERTIES: PREVIOUS STUDIES AND PRELIMINARY RESULTS

Ritika Chandra '10, Whitney Kukol '10
Faculty Sponsor: Susan Masino

The ketogenic diet, which is a high fat, low carbohydrate regimen, has been used as an alternative therapy for epileptic seizures since the 1920s. While the diet is known to be effective in children who do not respond well to anticonvulsant medications and to have fewer side effects than other treatments, it is difficult to maintain and not very palatable. Additionally, the mechanism behind the diet's anticonvulsant effects remains unknown. Previous studies and preliminary results reveal that adenosine, due to its role as an inhibitory neuromodulator and endogenous anticonvulsant, may play a key role in the diet's effectiveness. In order to test our hypothesis that the ketogenic diet alters the effect of adenosine in the hippocampus, weaned male Sprague-Dawley rats were fed either the ketogenic diet or a basal control diet for three to four weeks. Electrophysiology was then performed to test the endogenous influence of adenosine in the hippocampi of both groups. Preliminary recordings show a reduced response to extracellular adenosine in ketogenic hippocampal slices. These results support our hypothesis and parallel previous studies, that the ketogenic diet alters the influence of adenosine on brain excitability. Our findings may help develop a new assortment of novel treatments for individuals suffering from epilepsy and other neurological disorders.

59.

ANALYSIS OF fMRI IMAGES SHOW ERRATIC ACTIVATION OF THE TEMPORAL LOBE IN SCHIZOPHRENIC vs. HEALTHY CONTROL SUBJECTS DURING AN AUDITORY ODDBALL TASK

Urey Chow '09, Laura Pomeroy '09
Faculty Sponsor: Dan Lloyd

Schizophrenia is a mental disorder that affects about one percent of the world's population. It is classically characterized as having both positive and negative symptoms. Examples of positive symptoms include delusions, hallucinations, disorganized thinking, disorganized behavior, and catatonic behavior. Some negative symptoms include ambivalence, loss of motivation, loss of feeling, inability to experience pleasure, poverty of speech, and flat affect. One of the most common symptoms schizophrenics experience are auditory hallucinations, often in the form of voices that comment on the patient's behavior, order the patient to do things, warn the patient of impending danger, or converse with each other (usually about the patient). Therefore, we hypothesize that differences in temporal lobe activation may exist between healthy subjects and schizophrenic subjects, due to the temporal lobes' role in perception and recognition of auditory stimuli. In order to test this hypothesis, we used fMRI images obtained of both healthy control subjects and schizophrenia subjects during an auditory oddball task at the Olin Neuropsychiatry Research Center, part of the Institute of Living in Hartford, CT. These images were analyzed by Independent Component Analysis (ICA), a function of MATLAB. ICA is a data-driven type of analysis that measures activation in parts of the brain that work together during a specific task. Preliminary results show that component activations, shown as oscillations in the timecourse, are more erratic in schizophrenic patients versus healthy control subjects.

60.

EXPLORING THE RELATIONSHIP BETWEEN A LOW CARBOHYDRATE DIET AND THE NEUROMODULATOR ADENOSINE

Daniel Coleman ‘07
Faculty Sponsor: Susan Masino

Epilepsy is a prevalent neurological disorder that affects nearly 50 million people worldwide. Seizures are controlled by medication in 70-80 percent of epilepsy patients although many suffer side effects. The remaining 20 percent remain drug resistant. A low carbohydrate diet composed primarily of protein is effective in reducing or eliminating seizure activity, including cases of epilepsy that have not responded to treatment. Even though the anticonvulsant effects of the diet have been known for decades, the mechanism underlying its effect is unknown.

This study explored whether adenosine, an endogenous neuromodulater and anticonvulsant, plays a role in the beneficial effects of the ketogenic diet. A decrease in neuronal excitability due to increased adenosine concentration could be responsible for decreased seizure activity associated with the diet.

Male Sprague-Dawley rats were randomly chosen from sibling cohorts and assigned to one of two possible treatment groups. The experimental group was fed a low carbohydrate ketogenic diet while the control group was fed a matched control diet for 3 to 5 weeks. Electrophysiological recordings of hippocampal slices tested the response to adenosine in ketogenic diet versus control animals. Neurochemical analysis of postmortem tissue showed a trend toward higher adenosine levels in ketogenic verses control animals. This study serves to explore the relationship between adenosine concentrations and the decrease in seizure activity seen with the ketogenic diet.

61.

NEUROPSYCHOLOGICAL CORRELATES OF THE "DEFAULT MODE" NETWORK IN SCHIZOPHRENIA

Abigail Garrity ‘07
Faculty Sponsor: Dan Lloyd
Vince Calhoun PhD, Olin Neuropsychiatry Research Center; Dept. of Psychiatry, Yale University School of Medicine; The MIND Institute

Neurocognitive impairments are well documented in schizophrenia. This research sought to determine the neuropsychological correlates of the default mode network in patients with schizophrenia and healthy controls. The “default mode” network, a resting state of brain function, has been shown to have altered temporal frequency and spatial locations in patients with schizophrenia. In addition, positive symptoms of schizophrenia correlate with aberrant connectivity of this network. It was hypothesized that increased neurocognitive impairment would be associated with greater spatial irregularity in the default mode of patients with schizophrenia. Functional MRI images were used from patients with schizophrenia (N=41) and healthy comparison subjects (N=40) from a resting state scan where the subjects were instructed to keep their eyes open and avoid sleeping. Independent component analysis (ICA) was used to identify the default mode component. A battery of neuropsychological test scores assessing pre-morbid IQ, attention, working memory, mental processing speed and executive function were spatially correlated with default mode images from patients and controls using Statistical Parametric Mapping (SPM2). Additionally, the Positive and Negative Symptom Severity

Assessment (PANSS) was used to examine three and five symptom dimensions in patients with schizophrenia. Default mode aberrations were correlated with increased neurocognitive impairment in patients with schizophrenia.

62.

ICA AND PHENOMENOLOGY: MILD INTOXICATION VS. SOBRIETY

Alexandra Gile ‘10, Kino Clarke ‘07
Faculty Sponsor: Dan Lloyd

The human brain is a complex and mysterious entity that has yet to be completely understood. One way that we can study the brain is by challenging it. Through setting up different tasks in the realm of virtual reality for the human brain to perform while monitoring its activity, we gain a better perspective on what is truly going on inside the mind. This method is vital in furthering our insight into human behavior via studying brain function. In performing our experiment, we wished to observe differences in neurological activity when an individual was given multiple simulated-driving tasks in both a sober state and a partially intoxicated state. A brain scanner monitored changes in the brain’s activity during this experiment and the functional magnetic resonance imaging data was then collected by using independent component analysis (ICA). By observing the ebbs and flows of the Component in comparison to the task, we were able to see how both the sober and partially intoxicated mind truly responded to the external stimuli. We wondered if the brain was actually at a disadvantage when the body’s blood alcohol level reached .05, or if performance might increase because of the driver’s wish to compensate for being semi-intoxicated. Our Component analysis revealed that the driver’s response might be faster after having a little bit to drink versus driving completely sober—we believe that this is largely due to the driver’s semi-drunk phenomenology. Combined with phenomenology, ICA is an incredibly useful tool in acquiring greater knowledge concerning human behavior and the brain.

63.

WEIGHT DISTRIBUTION, DYNAMIC TOUCH, AND A PING PONG BALL

Jacob Gire ‘10
Faculty Sponsor: William Mace

The property that allows a person to properly wield an object and have impressions about the size, shape and orientation of an object without the use of vision is known as dynamic touch. Perception of objects via dynamic touch relies heavily on how mass is distributed throughout the object in relation to where the object is grasped. With tennis rackets, it was found that the “sweet spot” could be determined simply by wielding a racket and the ability to perceive the location of the “sweet spot” on a racket is a basic capability developed through everyday activity. In this experiment perception via dynamic touch was tested by having an individual hit a ping pong ball while their hand and paddle were out of sight. The individual estimated where on the paddle the ball hit based on a 3x3 grid and this result was compared to the actual site where the ball was struck. A 35 gram weight was attached on the back of each paddle in order to manipulate weight distribution and distinguish some systematic pattern between weight distribution, perception, and performance. This research may give greater insight into the limitations and faults associated with perception via dynamic touch and provide more information on the human sense of touch.

64.

EFFECTS OF A HIGH FAT, LOW CARBOHYDRATE DIET ON ADENOSINE RECEPTOR ACTIVITY IN THE HIPPOCAMPUS

Jason Gockel ‘07
Faculty Sponsor: Susan Masino

The therapeutic effects of high fat, low carbohydrate (ketogenic) diets such as the South Beach or Atkins in treating seizure activity in intractable epilepsy have been known for almost a century. However, the mechanisms underlying the diet’s effectiveness have yet to be determined. Recent studies of the regulation of adenosine suggest that a ketogenic diet may regulate adenosine. Because adenosine is an important inhibitory neuromodulator, we designed an experiment to test for an interaction between the ketogenic diet and adenosine homeostasis. Newly weaned Sprague-Dawley rats were placed on either a basal control diet or on a ketogenic diet for a minimum of three weeks. After 3-5 weeks on the diet, a behavioral test was performed using a Y-Maze to determine if there were any behavioral differences found due to the ketogenic diet. Electrophysiological recording was also performed in hippocampal slices of animals fed either a control or a ketogenic diet. We tested for a difference in the endogenous influence of adenosine by applying both adenosine, and an adenosine A1 receptor antagonist. My hypothesis was that a ketogenic diet would alter the level of adenosine and possibly adenosine receptor concentrations within the hippocampus.

65.

ATTENTION AND MEMORY REHABILITION IN PATIENT P.C.

Elizabeth Gromisch ‘09
Faculty Sponsor: Sarah Raskin

Patient P.C. is afflicted with mild traumatic brain injury after a car accident. According to her neuropsychological evaluation, P.C. has had problems with planning, completing and switching between activities. She also has decreased clarity and speed in speech, as well as in writing and calculations. P.C. has hemiparesis on her left side, which makes it difficult for her to walk up and down stairs, though she was previously using a cane. She and her mother, who had accompanied her during the first half of the rehabilitation meetings, had filled out emotional and memory questionnaires. P.C. had indicated that she was more discouraged than she had been earlier, due to her problems remembering tasks and the lengthened time to complete them, and that she was more fatigued than before. Her mother also had noted mild anxiety, expressive deficit, and emotional withdrawal. In order to determine which rehabilitation techniques to use, the Brief Test of Attention and the MIST test, a memory test that ranges from 2 minutes to 15 minutes, were administered. P.C. showed deficits in memory tasks that required her to retain the information for more than 15 minutes. She had benefited from repetition of instructions, and improved in attention. P.C. was then given a series of Attention Process Training tasks, both written and listening, ranging in difficulty. These tasks have helped P.C. to focus her attention, with and without distractions during the testing, and she has improved in time and in errors. After one semester of attention and memory rehabilitation, the MIST test was re-administered. Results were much improved, with P.C. able to remember and perform tasks after 15 minutes. She has also become more engaged in conversation, and has been able to work on tasks longer. Future rehabilitation includes techniques for P.C. to improve in memory and attention.

66.

THE EFFECTS OF METHYLPHENIDATE ON THE AMPLITUDE OF N2 DURING A VISUAL GO/NOGO TASK

Nicolas Harrison ‘08
Faculty Sponsor: Sarah Raskin
Michael Stevens MD, Olin Neuropsychiatry Research Center, Institute of Living

Attention-deficit/hyperactivity disorder (AD/HD) affects approximately 5%-10% of children worldwide and 4% of adults. Deficits in cognitive processing associated with AD/HD include both attentional and inhibitory aspects. Previous research using event-related potential (ERP), which measures brain activity using electrodes on the surface of the scalp, has revealed a number of differences relative to controls as well as to subjects with AD/HD taking methylphenidate (MPH), and to some degree between clinical subtypes of AD/HD. One task often used to study inhibition is the Go/NoGo task, in which subjects are rapidly presented with a randomly ordered string of Go stimuli and NoGo stimuli. In response to Go stimuli, the subjects press a button, but to the NoGo stimuli they are to withhold their response. By using rapid stimulus presentation of predominantly Go stimuli, the button pressing response is prepotent. In this study, previously generated data from such a prepotent Go/NoGo task was used to analyze the affects of MPH compared to a placebo by looking at the amplitude of N2, a negative peak approximately 100-300ms after stimulus presentation. For N2 to be present, the subject must be paying attention and the stimulus must differ from expectation. Possible theories as to its psychological purpose include stimulus discrimination, target selection, and orienting response. Following results of other studies, N2 was isolated from frontocentral electrodes in response to the NoGo stimulus. The peaks from the trials were averaged, normalized and chosen by using ERPSS and MERPS, two UNIX based software platforms. It is expected that N2 amplitude will be greater in subjects taking MPH than those taking the placebo.

67.

CHARACTERIZATION OF THE ROLE OF CA3 MOSSY FIBERS IN INFORMATION PROCESSING IN HIPPOCAMPAL CIRCUITS

Connie Hernandez ‘10, Daisy Ramos ‘10
Faculty Sponsor: Harry Blaise

The hippocampus is responsible for memory processing. The hippocampal formation consists of the hippocampal trisynaptic pathway, which includes the dentate gyrus (DG), CA3, CA1, and subicumlum synaptic regions. The suggestion that long term potentiation (LTP), and long term depression (LTD), are the underlying mechanism of learning and memory indicate that LTP and LTD should be detectable throughout the hippocampal formation following application of high frequency stimulation (HFS) or low frequency stimulation (LFS), respectively. To test this hypothesis, electrodes were implanted in the DG and CA3. Three to five days after surgery, HFS was applied to the DG at the intensity that elicits 50% the maximal evoked response and recorded in the CA3. All recordings resulted in a noticeable reduction in synaptic strength (LTD), a possible effect of the predominantly inhibitory mossy fibers in the CA3. Reduction in synaptic strength may also be the result of below-threshold frequency stimulation, necessary to activate NMDA receptors. More tests need to be conducted in order to resolve the specific cause of this depressive-like effect and to figure out a way to achieve LTP in the CA3 region. This research may provide more information on the normal excitability profile of the DG and CA3 synapse and its involvement in overall modulation of hippocampal excitability and LTP. If the DG to CA3 synapse does not reliably support LTP an alternate hypotheses concerning how

information is encoded, but not stored in the hippocampus, rather is relayed through the entorhinal cortex to the cerebrum for storage, must be considered. Then again, if we do find a way to achieve LTP in this synapse, it could offer further insights into and confirm present theories on how information must enter the hippocampus to be processed and consolidated before being handed over to the neocortex for actual storage and recall.

68.

EFFECTS OF AGE, GENDER AND A1R RECEPTOR DEFICIENCY ON BIDIRECTIONAL HIPPOCAMPAL PLASTICITY IN FREELY BEHAVING MICE

Robert Hill '07
Faculty Sponsor: Harry Blaise

Synaptic plasticity, specifically long-term potentiation (LTP) and long-term depression (LTD), has become the mechanism most often used for learning and memory within the hippocampal formation. Differences between age, gender and adenosine A1 receptor (A1R) density on expression of synaptic plasticity are important to investigate as differences in these variables have been demonstrated in past studies on rats and other mouse models. In this study, male and female wild type (WT), heterozygous (HET) and knock-out (KO) for the A1R receptor mice were chronically implanted with microelectrodes in the perforant pathway and dentate gyrus of the hippocampus. After a one-week recovery period the animals were tetanized with a low (1 or 5 Hz), intermediate (15 or 30 Hz), or high (100 or 200 Hz) frequency stimulation protocol to induce either LTD or LTP. Population spike amplitude (PSA) percent changes from baseline were recorded from freely behaving mice over a period of up to 24 hours after tetanization in order to quantify and compare alterations in synaptic plasticity between age groups, genders and A1R density groups. Preliminary results show differences between young and aged mice for both the WT and HET groups after induction of a 100 Hz tetanization but not for the HET group receiving a 1 Hz tetanization. There were no significant differences found between genders due to the small sample size available. Differences in PSA values across A1R groups show the highest levels of both LTP and LTD in the KO group and the lowest in the WT. These findings suggest a mechanism for learning and memory between young and aged mice and also demonstrate the inhibitory effects of the A1R on synaptic changes within the freely behaving mouse hippocampus.

69.

TEMPORALITY IN fMRI EXPERIMENTS

Sarah Jenkins '09, Elizabeth Gromisch '09
Faculty Sponsor: Dan Lloyd

Scientific experiments are all based upon the assumption that though a single subject will perform more than one trial in an experiment, the subject's performance will remain constant over time. This directly conflicts with a phenomenological understanding of the importance of temporality. Our conceptions of time pervade every moment of our lives. A subject going through three successive trials while his brain is being scanned with fMRI will likely go through different phenomenological states as time progresses. For example, the subject will likely be more restless, tired, irritated, and distracted in the third run of the experiment than the first.

Due to these phenomenological factors, we hypothesize that the brain scan of a subject during the first trial will show less activity than a scan of the subject's brain during the third trial.

In this pilot study, we will use fMRI data from an experiment scanning the brain of a subject in a driving simulation. The subject went through three trials, and during each trial went through cycles where he fixated upon a screen, observed the driving simulation, and drove in the simulation. We will preprocess this data with Independent Component Analysis (ICA—a statistical technique which is used to isolate different components of a brain image associated with one another), and use the subtractive method to compare the first to the third trial. Next, we will identify the coordinates of activity in the brain and their corresponding Brodmann areas on this data. We will determine the cognitive functions traditionally associated with these Brodmann areas to see how brain activation changes over time.

70.

SEXUAL DIMORPHISM IN THE INDUCTION OF LONG-TERM PLASTICITY IN THE MULTI-SYNAPTIC PATHWAY EXTENDING FROM THE DENTATE GYRUS TO THE ENTORHINAL CORTEX IN FREELY BEHAVING RATS

Hannah Knipple ‘07
Faculty Sponsor: Harry Blaise

The hippocampal formation is crucial for information encoding and memory consolidation. Neurophysiological phenomena such as long-term potentiation (LTP) have been proposed as an underlying mechanism for information processing and memory consolidation in the brain. Sensory information typically enters the hippocampal formation from the neocortex, primarily via the entorhinal cortex, and is processed through the hippocampal trysynaptic circuit (consisting of the granule cells of the dentate gyrus and the pyramidal cells of areas CA1 and CA3) before being relayed back for storage to the neocortex through the entorhinal cortex. If this is indeed the case, the back projection from the dentate gyrus to the entorhinal cortex should be capable of reliably supporting induction of long-term plasticity. Many studies have demonstrated that LTP induction within the hippocampus is sex dependent, with males demonstrating greater levels of LTP than females. If the multisynaptic circuit from the dentate gyrus to the entorhinal cortex is capable of sustaining LTP, it is likely that LTP induced within this connection is sex dependent as well. To test this hypothesis studies were conducted in adult male and female freely behaving Sprague-Dawley rats. Animals of both gender were chronically implanted with a bipolar stimulating electrode in the dentate gyrus and a monoploar recording electrode in the entorhinal cortex. Single-pulse evoked field potentials were recorded and analyzed to assess whether high frequency stimulation can reliably induce LTP in this multisynaptic circuit. LTP was reliably induced in this pathway in both male and female rats. Preliminary data indicate a trend toward higher potentiation in females. Support Contributed By: NSF BES 0451285, NASA CT Space Grant College Consortium and Howard Hughes Medical Institute Grant to Trinity College.

71.

THE EFFECT OF INTOXICATION ON RETENTION AND HIPPOCAMPAL ACTIVITY: A TEMPORAL AND INDEPENDENT COMPONENT ANALYIS

Kristen McNamara ‘09, Alyssa Rautenberg ‘09
Faculty Sponsor: Dan Lloyd

According to Husserl, retention is the way in which the past is present to consciousness. The “now” must be understood in the context of the “just passed now”, and this is done through the retention of the “just passed now”. The purpose of our experiment was to see if intoxication had any effect on the amount of retention a person exhibited, specifically if retention would be decreased. We suspected that this decrease in retention could be attributed to alcohol disrupting hippocampal activity, as the hippocampus is responsible for memory formation. In order to test this, fMRI images collected from an individual performing a simulated driving task under an intoxicated condition and a sober condition were compared using Matlab, and brain images of hippocampal regions were compared using independent component analysis, a statistical measure for determining networks in the brain. First, a temporal analysis of the fMRI images was performed by comparing fMRI images taken over time. If an fMRI image was very similar to the one immediately before it, this suggested that a large amount of the same information was encoded in both. Through this analysis it was determined that there was less retention in the intoxicated trial than the sober trial. However, we did not find the suspected correlation between hippocampal activity and intoxication, which leads us to suggest further study in this area. In general, these results are consistent with the fact that if intoxicated enough, a person can have lapses in memory which disrupt their ability to recall certain events. Because retention is reduced, there is no longer proper temporal flow, which causes problems in the perception of the experience as one extension of time.

72.

THE REWARD SYSTEM: DESIRE AND GRATIFICATION

Joseph Minifie ‘08
Faculty Sponsor: Dan Lloyd

The urge of desire, although variable in intensity and focus throughout the human race, has a motivating force upon behavior. This is supremely true in the realm of alcohol and drugs, forces that create massive and at times devastating changes in the functionality of the brain. Within the brain, the mesolimbic dopamine pathway, which links the ventral tegmentum, located in the brainstem, to the nucleus accumbens of the basal ganglia, serves as the main reward pathway. This neural circuitry is responsible not only for the pleasure so often associated with intoxication, but more importantly, the impulse to continually use these substances. The hypothesis of this pilot study is that significant mesolimbic activation would occur in sober test subjects who were aware that they were about to receive alcohol. Furthermore, after becoming intoxicated, this activation would decrease. If correct, this hypothesis could provide an illustration of the neural substrate involved in the experience of desire and gratification. To quantify the degree of mesolimbic activity before and after alcohol consumption, Independent Component Analysis (ICA), an fMRI-based illustration of the brain components working together during a specific task, will be employed. The fMRI images were gathered from one test subject who completed three separate tasks: passive viewing of a fixation cross, observing a virtual-reality driving environment, and driving himself through the same environment. For each trial of the experiment, the subject was either sober, semi-drunk, or intoxicated, the order of which he was unaware of. The results of this experiment could provide further illustration of the

neural implications of addiction, yet they could also lend another dimension to the psychological experience of desire, motivation, and gratification.

73.

THE DURABILITY OF COGNITIVE REMEDIATION EFFECTS ON NEUROCOGNITIVE FUNCTIONS IN SCHIZOPHRENIA: A ONE-YEAR FOLLOW-UP

Margaret Moult ‘07
Faculty Sponsor: Sarah Raskin
Matthew Kurtz, PhD, Institute of Living

Neurocognitive deficits are a core component of schizophrenia and these deficits are not sufficiently responsive to antipsychotics. Cognitive remediation is a useful tool for improving these deficits, but the durability of such effects has yet to be thoroughly investigated. Over a period of twelve months, forty-two patients, diagnosed with either schizophrenia or schizoaffective disorder, participated in one of two groups: computer-assisted cognitive remediation (CR) which targeted specific neurocognitive functions such as memory, or a computer-skills (CS) training group which targeted non-specific cognitive functions. All patients in the study were assessed with a battery of neuropsychological tests prior to and immediately following training. Results from this study showed general improvements in both groups on neurocognitive measures, but there was a specific significant improvement in working memory for those in the CR group. In a single-blind follow-up study one year later, 11 patients from both groups were retested (4 CR, 7 CS), using the same measurements as before. The results revealed no significant differences between groups at any time period, indicating that the subjects in the follow-up study were not representative of the original sample. There was, however, a statistically significant improvement in spatial episodic memory for the CS group at follow-up, but no other statistically significant results were found for the subjects tested at follow-up in any of the domains, though the trends suggest that there was no loss of effect over time. Nevertheless, a larger sample size is needed to confirm this assertion. Future research may, therefore, focus on a larger sample size and a longer period of time for follow-up testing as well as how improvements in neurocognition may relate to social functioning and symptom reduction in schizophrenia.

74.

THE TEMPORAL EXPERIENCE OF SIMULATED DRIVING: A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY OF THE TEMPORALITY OF DRIVING WHILE INTOXICATED

Margaret Moult ‘07, Robert Hill ‘07, Abigail Garrity ‘07
Faculty Sponsor: Dan Lloyd

Functional Magnetic Resonance Imaging (fMRI) techniques can be used in a variety of ways to examine brain activation. Recently, fMRI techniques have been combined with philosophical theories in order to gain a phenomenological understanding of the brain. In particular, as argued by Husserl, phenomenological experience is affected by the temporal context, including both retention (the awareness of cumulative past experiences and perceptions) and protention (the anticipation of future experiences). The purpose of this study was to create a "Husserlian" temporal map depicting the subject's retention of past experience and protention of experiences to come using a neural network algorithm. The subject participated in three trials of a driving

task when sober and when intoxicated. The task was composed of periods during which the subject observed driving, fixated on the screen, and then performed the driving task. Protention and retention were examined during the driving portion of the task using the first and third runs of the sober and intoxicated state. We predicted that both retention and protention would be significantly diminished for the intoxicated state. This pilot study of one particular subject showed that during the sober state, a high level of protention and retention existed in the brain images during the driving condition of the task. As was hypothesized, intoxication had a significant impact on the subject's protention and retention, significantly reducing both. The effects of alcohol on attention, reasoning and memory probably account for the differences observed during the intoxicated state. Interestingly, during the third run of the driving task, greater protention was observed in the intoxicated state. This was attributed to an increase in concentration while intoxicated in order to complete the task.

75.

CORRELATING fMRI AND BEHAVIORAL DATA USING SIMULATED NEURAL NETWORKS

Michael Pierce ‘10
Faculty Sponsor: Dan Lloyd

Functional Magnetic Resonance Imaging (fMRI) is used daily in order to explore how the mind works. Very little is known, however, about how well this correlates with simultaneously collected behavioral measurements. The prodigious volume of both fMRI and behavioral data renders traditional analysis enormously difficult. On top of the huge amount of data, it is no secret that behavior is a result of different brain areas working in symphony, as such, deciding exactly what pieces of brain (fMRI) data to correlate with what behavioral data adds a whole new level of complexity to traditional methods. Using a study on the effect of alcohol on driving, which includes nine channels of behavioral data as well as 20 components from an Independent Component Analysis of fMRI data, we will use simulated learning neural networks in MATLAB, to establish a more sophisticated correlation. We expect that a neural network will be able to learn how to correlate the brain and behavioral data sets, perhaps better than traditional analysis. We will then explore the optimal size of the network’s hidden layer for such a task. Pending the network’s success, further experimentation will follow in terms of both brain data’s predictive value for behavioral states, and behavioral data’s predictive value for brain states. This work will add to an understanding of both how fMRI data is connected to behavior, and how one might separate fMRI signals associated with observable behavior from those signals associated with conscious thought.

76.

IDENTIFICATION OF STRESS RELATED COMPONENTS IN THE PRE-FRONTAL CORTEX OF SCHIZOPHRENIC SUBJECTS

Rachel Reece ‘09, Tiare Nakata ‘09
Faculty Sponsor: Dan Lloyd

Schizophrenia is a mental disorder characterized by distortions in perception and reality, is believed to be caused by brain damage, genetic disorders or a stressful event. The symptoms of schizophrenia are hallucinations, auditory delusions, and disordered thinking as a result of abnormalities in the neural networks in schizophrenic brains. Therefore we hypothesized that schizophrenic patients afflicted with these symptoms would have an atypical stress response when compared to healthy subjects. By identifying the prefrontal cortex as an area that is associated with stress, it is theorized that hyperfrontality in the prefrontal cortex would be observed in schizophrenics as they performed tasks requiring accurate perception. In the task, 10 schizophrenic subjects and 10 healthy controls were asked to respond to beeps that were interrupted randomly with odd noise. In this preliminary study, we examined the time course of the activation of components (using ICA) in order to determine where an increased stress response is located in schizophrenic subjects when compared to healthy control subjects. Through analysis of functional magnetic resonance imaging (fMRI) using Matlab, we tracked areas of the brain that are activated at the same time with the same strength, which revealed an interconnected neural network in the prefrontal cortex. The fMRI results demonstrated that there was increased activity in the prefrontal cortex of schizophrenic patients when compared to normal subjects during odd ball sound stimulus. Furthermore, in normal patients the neural network component that we identified also showed activation in the posterior of the brain that was not present in schizophrenic patients.

77.

BEHAVIORAL EFFECTS OF THE KETOGENIC DIET ON MALE SPRAGUE-DAWLEY RATS

Jessica Ross ‘10
Faculty Sponsor: Susan Masino

The ketogenic diet (KD) is a high-fat, low-protein, and low-carbohydrate diet that keeps the body in starvation mode and increases ketone body concentration. The KD was developed in the 1920’s as a means to treat epileptic seizures, but researchers lost interest in the diet as more drugs for the treatment of epilepsy were developed. The mechanism that allows the diet to alter brain function is still unknown. Nineteen male Sprague-Dawley rats were divided into a control group and a KD group and were then tested in a Y-maze to determine if the diet affected their spatial or locomotor memory. KD rats, on average, moved to different arms in the Y-maze over twenty percent more often than the control rats, meaning that the KD rats tended to be significantly more hyperactive than the control rats. Behavioral research needs to be conducted on a larger scale to determine if there is actually a significant difference in control animals to KD animals. Ideally, a broad study that follows the behavior and social development of children on the KD should be performed.

78.

BRAIN SCANS OF EXPERIENCE: AN INVESTIGATION INTO UNDERLYING NEURONAL STATES WHILE COMPLETING A DRIVING TASK

Ahmed Shahzad ‘08, Nicholas Harrison ‘08, Caleb Wasser ‘08
Faculty Sponsor: Dan Lloyd

A central postulate in neuroscience is that changes in the mind, like experience, have biological correlates in the brain. Neurophenomenology branches off of this idea and attempts to bridge the gap between biological descriptions of the brain and philosophical insights into the composition of consciousness.

In this study, we attempted to correlate brain activation patterns of subjects in a driving study and the states of experience using Independent Component Analysis (ICA) and Multidimentional Scaling (MDS). We used ICA on the fMRI brain scan data to isolate circuits of neuronal activation. Then we utilized MDS to create the distance matrix comparing the ICA components and a two dimensional plot depicting their dissimilarity.

In this pilot study, we compared runs of a driving simulation in which subject AF was sober, semidrunk or drunk. Our results illustrate that globally, the drunk and semidrunk states are highly similar and differ from sober. Due to these global findings, we can confirm that these relationships are not due to a few isolated components, but rather reflect changes across all components. Further analysis will help elucidate the relationship between these conditions by demonstrating variable clustering of the components. The clustering should reflect both the brain state that the subject was under (drunk, semidrunk, or sober), and specific components common across those states. Similar components should correlate to common underlying experiences, such as driving, boredom, or level of intoxication.

79.

PHENOMENOLOGY AND FUNCTIONAL BRAIN IMAGING: THE EFFECTS OF ALCOHOL ON CONSCIOUS RETENTION

Lydia Turner ‘09
Faculty Sponsor: Dan Lloyd

In the 1920s, Edmund Husserl structured consciousness of phenomena with 3 components: the present moment, protention, and retention. Retention is the awareness of past moments and their connections with the present moment. Phenomenology as a philosophy is the study of experiences or phenomena; designed to explain our consciousness by examining the way we actually experience the phenomena.

Almost 100 years later, we have incorporated new technology with long standing philosophy. Function Magnetic Resonance Imaging (fMRI) is the newest brain technology, using older MRI technology to measure the changes in blood flow in the brain through different experimental conditions. Using the fMRI images from a study on the effects on alcohol on driving performance, we were able to design a pilot study on one subject to actually measure the effects of alcohol on consciousness, specifically retention.

Using MatLab, we did a Temporality Analysis, which uses the data from the fMRI to measure how much information at every point of the test is retained in relation to another set point in the test. The study is set up so that the subject goes through a constant series of fixation on the

screen, actually driving the car, and observing the car driving. We set the final driving time as our comparison point. We ran the Temporality Analysis for our subject in a sober state, then semidrunk, and finally a drunk state.

In this pilot study, we found that retention from the past driving periods was high in the sober state, significantly decreased when the subject was semidrunk, and hardly observable when the subject was drunk. This shows a significant correlation between the philosophy of mind and the scientific study of the brain, and shows that further research is possible and necessary to understanding how our brains relate to our actual experiences.

PHYSICS

80.
DESIGNING AND MODELING A HIGH EFFICIENCY WIND TURBINE
Jonathan Boreyko ‘07
Faculty Sponsor: Barbara Walden

The aim of this research was to design and theoretically model a wind turbine that had an efficiency of about thirty percent. The optimal cross-sectional shape of the blades was chosen by analyzing airfoils to maximize aerodynamic lift and minimize drag. An Excel program was then created to determine the ideal width and twist profiles for the blade design. This program also predicted the output power, torque, and efficiency of any given turbine system for any wind speed. In the end, a NACA 63-415 airfoil shape was decided upon, as was a constant-width blade with a nonlinear twist profile to maximize efficiency and torque. The program revealed that for the given design a maximum torque was reached at a tip speed ratio of about five and the efficiency of the wind turbine also reached a plateau at about this speed. This final blade design was then modeled on the 3D drawing program SolidWorks. See 'Harvesting Hydrogen Using Renewable Wind Power' to see how this design process was then applied to engineering applications.

81.
CONSTRUCTING AND TESTING AN ELECTRONIC COINCIDENCE COUNTER
David Bowers ‘10, William Raymund ‘10
Faculty Sponsor: David Branning

Spontaneous parametric downconversion is the act of forcing a single, high energy photon to split into two smaller particles. As the law of conservation of angular momentum might suggest, these two particles must have opposite spin, and thus they will make opposite decisions when presented with a choice of two spin-dependent paths. We can investigate these properties of photons using a technique called coincidence counting. A coincidence count occurs when the two particles arrive at photon detectors at the same or approximately the same time. Presently, devices that record coincidence counts cost upwards of $10,000. By simplifying the basic processes these devices rely on, it is possible to make a coincidence counter in a price range of about $200. This is done with the use of simple AND gates such as those used for digital logic. Currently, the coincidence counter in production fully functions, operating much faster than more complicated and expensive devices. It is designed to do only two experiments, however future versions are expected to have more flexibility. A cheaper machine increases availability to

students and universities alike, allowing more students and teachers to examine the world of quantum physics.

82.
INCREASING THE SAMPLING RATE OF A PHOTON COUNTER
David DuPaul ‘07
Faculty Sponsor: David Branning

Quantum optics is the study of single particles of light, called photons. The goal of this project was to increase the sampling rate of a photon counter using Labview so that data could be collected more rapidly. Several factors were thought to be limiting the speed of the Labview program. One factor explored was whether or not the program was slowed down by the refresh rate of the charts on the graphic user interface. Also, the binary file format was tested as a quicker way of saving the data than as text. A major limiting factor was how often the program was opening and closing files to save data. By saving less frequently and writing multiple data points to disk at a time instead of saving every new data point individually, the sampling rate has been increased by a factor of ten.

83.
MAGNETIC ANALYSES OF LAKE SEDIMENTS FROM SOUTH DAKOTA REVEAL CYCLICAL CLIMATE CHANGE FOR THE LATE HOLOCENE
Ryo Saotome ‘08
Faculty Sponsor: Christoph Geiss

In order to reconstruct the climactic history of the Mid-West, sediments from two lakes in South Dakota were magnetically analyzed. The magnetic susceptibility signal from sediment samples from Pickerel Lake contained peaks when plotted over depth, indicative of periodic dry periods in the area. However, the same magnetic susceptibility peaks were not found in sediment samples from Enemy Swim Lake, located less than a mile away.

When magnetic remanence measurements of both lakes were taken in an attempt to resolve the contrasting magnetic susceptibility signal of both lakes, it was found that these measurements had the same cyclical signal found in the susceptibility signal of Pickerel Lake. This suggests that the cyclical signal is indeed a signal of the climactic history of the area, but that the susceptibility signal of Enemy Swim Lake was drowned out by local effects. Further analyses concerning the content of the lake sediment samples (including total organic and inorganic carbon, clays and biogenic silica) are currently being done to find what exactly these local effects are.

PSYCHOLOGY

84.

THE ROLE OF FUNTIONAL MAGNETIC RESONANCE IMAGING AND VIRTUAL REALITY IN PSYCHOTHERAPY

Kara Carvalho ‘07
Faculty Sponsor: Randolph Lee

Since its development in the late 1800s, mental health treatment has undergone many changes. The incorporation of psychotherapeutic medication has drastically improved treatment of certain mental illnesses, especially when combined with talk therapy. In addition to medication, other methods of treatment have been used in conjunction with psychotherapy in an effort to improve treatment. Some of these methods, such as biofeedback, have proven effective for certain illnesses and continue to be used in these areas. Two recent developments, functional magnetic resonance imaging (fMRI) and virtual reality, have become important tools neuropsychological research. FMRI’s ability to non-invasively read brain activity and virtual reality’s success in creating naturalistic environments in which to study everyday activities have made these two tools quite popular, and especially effective when used together. There has been some recent effort to apply these tools to psychotherapeutic treatment. FMRI has shown moderate success as a biofeedback device, while virtual reality has proven helpful in creating regulated environments for immersion therapy for phobias. Virtual reality and fMRI have not been incorporated into other types of therapy, but their success in these two areas and their potential for helping us understand the complexity of the human brain suggest that they could become important additions to current mental illness treatment.

85.

REMEMBERING EVENTS ACROSS THE LIFESPAN

Rebecca Herter ‘07
Faculty Sponsor: Karl Haberlandt

I examined the recall of autobiographical events to explore how people retain memory for real-life events over the lifespan. I used a free recall task to assess participants’ recall of autobiographical recollections. In a total of four studies, 216 participants aged 18 to 89 years were asked to record memories of autobiographical events. The participants were then asked to report dates for the events they recorded. Subsequently, these events were plotted as a function of 1) the reported date and 2) the age of participant at the time of encoding to produce frequency distributions of autobiographical memories across the participants’ lifetime. Assuming that the participants encoded an equal number of events every day of their lives, the frequency distributions of autobiographical recollections provide a picture of the relative ease with which people recall autobiographical memories across the lifespan. The frequency distribution of events as a function of reported date revealed that the recall of very recent events was infrequent while the recall of more remote events increased as a function of time and eventually dropped off. The frequency distribution as a function of age at encoding revealed that recall was greatest for events that were encoded when participants were between the ages of 20 and 29. The elevated frequency of recollections observed between the ages of 20 and 29 in the lifespan retrieval curves is known as the reminiscence bump. Theorists assume that the reminiscence bump reflects processes of goal development and identity formation during adolescence and early adulthood.

86.

EFFECTS OF FAMILY AND SOCIAL STIGMAS ON THE RACIAL AND GENDER ACHIEVEMENT GAP AT TRINITY

Elizabeth Maynard '07
Faculty Sponsors: Dina Anselmi, David Reuman

The gap in academic achievement is a societal problem that plagues school districts across the United States. The disparity in academic achievement between different racial and ethnic groups has been explained in terms of a variety of school and family factors. The achievement gap has been studied most extensively in elementary and high school students. The present study focused on the effects of family academic value, student perception of faculty biases, stigma consciousness and stereotype threat on students'self perception of their academic abilities achievement as well as their actual academic performance in college students across gender and race. A sample of 24 Asian American, 24 Hispanic, 23 African American and 57 White students completed an online survey measuring their academic attitudes, experiences and achievement, as well as perceptions of family involvement. In the study, White students did report significantly lower levels of stigma consciousness, stereotype threat, perceived faculty bias and higher levels of academic achievement than the Black, Hispanic and Asian American participants. In marginally significant findings about family, Black students reported slightly higher levels of family academic value than did White students. Contrary to our hypotheses, few gender effects were found. Overall, the study confirmed that there is a significant achievement gap at Trinity College.

87.

ACADEMIC ACHIEVEMENT DIFFERENCES AMONG RACIAL GROUPS AT TRINITY COLLEGE

Alexandra Miller '07
Faculty Sponsors: Dina Anselmi, David Reuman

Past research has focused primarily on the achievement gap between Whites, Asians, Hispanics, and African-American individuals in both middle and high school. Both family and school factors have been found to play a role in achievement outcomes. In general research shows that White and Asian students' achieve higher levels of success in school than Hispanics and African-Americans. The purpose of this study was to discover if there is a similar achievement gap for college students and what factors might account for any differences in achievement. One hundred and twenty eight students (24 Asians, 24 Hispanics, 23 African-Americans, and 57 Whites) responded to a web based survey that included questions about students feeling of school belongingness, theories of intelligence, family values and expectations, and perceptions of their own academic abilities. The first prediction was that the race differences in achievement would exist for Trinity college students', and that school belongingness, theories of intelligence, family values, and perceptions of ones own academic achievement will have a large influence. The findings showed, there is a relationship between race and a variety of mediating variables – these variables however, did not predict the achievement gap that the study found exists at Trinity College. Perceptions of one's own academic abilities were not related to race, but were predictor of achievement. This suggests that individual's who perceive themselves as doing well are more likely to succeed academically.

88.

THE INFLUENCE OF RACE, FAMILY, PEER, AND SCHOOL FACTORS ON ACADEMIC ACHIEVEMENT AT TRINITY COLLEGE

Hannah Reynolds ‘07
Faculty Sponsors: David Reuman, Dina Anselmi

The intention of the present study is to elaborate on past research and determine the influence of a variety of racial/ethnic, family, peer, and school factors on academic achievement at the college level. The specific factors evaluated here are pro-academic peer norms, stigma consciousness, school belongingness, parental involvement, family academic values, and the mediating role they may play in the relation between race and achievement. Based on previous research, it was predicted that Black and Hispanic students would achieve at lower levels than White and Asian students due to differences in the described social factors. An online survey was distributed to a stratified random sample of Trinity College undergraduates. 128 students participated, including 24 Asian Americans, 24 Hispanics, 23 Blacks, and 57 Whites. Using a self-reported GPA measure, a significant achievement difference was found between Blacks and Whites in the predicted direction; however, no other ethnic groups differed significantly from each other in academic achievement. Further analyses showed that stigma consciousness, school belongingness, family academic values, and parental involvement were all associated with race; pro academic peer norms were not. No significant association was found between academic achievement and any of the hypothesized predictors, suggesting that the Black/White discrepancy in academic achievement is not due to the particular set of peer, family, and school variables investigated here. The findings did reveal an academic achievement gap as predicted, however the source of the racial achievement disparities is still unknown. Further research should be done to evaluate possible alternative variables that may affect academic achievement at Trinity College.

89.

PSYCHOLOGICAL DISTRESS AND CAREER CERTAINTY OF COLLEGE SENIORS

Maggie Rivara ‘07
Faculty Sponsor: Dina Anselmi

The senior year of college marks a critical phase in an individual's development. In anticipation of graduation and entrance into the career world, individuals are forced to adapt and make decisions which can cause significant amounts of psychological distress. Prior research has found that greater career uncertainty in college students is associated with higher levels of stress. The purpose of the study was to explore the relationship between feelings of stress and of being overwhelmed with career plans and career certainty for college seniors in anticipation of graduation. An electronic survey was sent to the entire Trinity senior class (n=487), measuring demographic and family characteristics, locus of control, plans after graduation, career certainty, stress and feeling overwhelmed. Two hundred and eighty one seniors (58%) completed the survey. No relationship was found between career certainty and reported stress, but lack of career certainty was strongly related to feeling overwhelmed by college seniors. Career certainty was significantly associated with research participation, internal locus of control, and plans after graduation. Stress levels were significantly related only to gender and plans after graduation. In contrast, feeling overwhelmed was significantly related to gender, college major, family income, plans after graduation, and importance of career services. This study found that feelings of being overwhelmed may be a better measure of the effects of the students’ career certainty than was measuring stress. Both career certainty and feelings of being overwhelmed during the senior year

were influenced by a number of other factors, some of which might be affected by better career counseling during college.

90.
ADIABATIC HYPOTHESIS IN ROWING
Ankit Saraf ‘10
Faculty Sponsor: William Mace

By classic definition, a system undergoes an adiabatic transformation when the change involves no transfer of energy into or out of the system. However, Kugler and Turvey have argued that a rhythmic biological transformation can be treated as adiabatic, despite the requirements of the conventional definition: a) the source of the energy that causes the change is in the system itself and b) the energy dissipated remains time or frequency independent. Subjects in the experiment were rowers at different skill levels, and were asked to perform the rhythmic action of rowing in a Concept2 indoor rowing ergometer at various stroke rates. Subjects either gradually increased or decreased their rate within a trial run. Data regarding stroke frequency, stroke time and power per stroke were collected through the Concept2 system. Power and stroke rate (frequency) were found to be highly correlated and the plot of power per cycle versus cycle frequency yielded in a linear relationship with a positive slope. In other words, power was found to increase linearly with frequency, and also it could be inferred that a certain portion of power for every cycle was constant, and independent of frequency, which was reflected by the power intercept of the line obtained. The power intercept however, was found to be both positive and negative, depending on the skill level of the rower: experienced rowers showing a tendency to give a positive intercept as opposed to inexperienced/untrained rowers who gave a negative intercept.

SCIENCE AND SOCIETY

91.
EXPLORING THE RIGHT TO BE GRANTED THE CHOICE OF PHYSICIAN ASSISTED SUICIDE WHEN ALL OTHER OPTIONS HAVE FAILED
Nana Kittiphane ‘07
Faculty Sponsor: Laurel Baldwin-Ragaven

Pain can be alleviated with professional treatment, but the suffering that stems from the pain is, at times, not curable. If the suffering becomes so unbearable that the individual decides that it is no longer worth it to continue living, then he or she should be provided the options to end it. Therefore, the main goal of this thesis was to prove that suffering is idiosyncratic, and the option of physician assisted suicide should be granted to competent individuals who are able to give informed consent. In the context of this thesis, terms and concepts were discussed and clarified because they are often used inaccurately as though they were synonymous. By using legal cases and studies involving competent individuals in the United States and internationally, the sources of suffering were explored and analyzed. In each case, although it may seem similar, the situation is distinct in its own way. As a result, this distinctness shows that suffering is individualistic and no one but the individual knows the degree of suffering. Therefore, if other options are no longer working then the choice of physician assisted suicide should be made available.