7-1-2010

Summer 2010 Research Symposium Abstract Book

Trinity College

SIXTH ANNUAL
SUMMER RESEARCH SYMPOSIUM
TRINITY COLLEGE

TABLE OF CONTENTS

Poster # **Title**

BIOLOGY

Poster # **Title**

8. **IMPROVED AND TIME EFFICIENT SELEX OF DNA APTAMERS USING A MULTIPLEXED BINDING CONSTANT ASSAY**
Jessica Williams‘12

CHEMISTRY

9. **ALTERNATIVE ROUTE FOR PHOSPHONAMIDITE SYNTHESIS TO BE EMPLOYED IN EXPERIMENTATION WITH OLIGONUCLEOTIDES**
Monica Au-Yeung ‘12

10. **COORDINATION OF A PEPTIDE β–TURN MIMETIC TO TUNGSTEN: POSSIBLE APPLICATIONS FOR THE STUDY OF β-SHEETS**
Adam N. Boynton ‘12

11. **EFFORTS TOWARDS THE ASYMMETRIC SYNTHESIS OF CHIRAL PYRIDINE-BASED LIGANDS**
Kiyoshi Chandler ‘12

12. **INDIUM-PROMOTED COUPLING OF PROPARGYL ALDEHYDES WITH SUBSEQUENT CYCLIZATION IN BOTH ONE AND TWO POT SYSTEMS**
Mark Chesson ‘13

13. **CAN URIC ACID PREVENT APOPTOSIS IN INSULIN-SECRETING CELLS: A POSSIBLE PROTECTIVE ROLE IN TYPE 1 DIABETES**
Jackie Gottshall ‘13

14. **PROGRESS TOWARDS THE ASYMMETRIC SYNTHESIS OF CHIRAL BENZOCYCLOBUTENOLS**
Christopher Gromisch ‘11

15. **X-RAY PHOTOELECTRON SPECTROSCOPY STUDY OF PHOTOCHEMISTRY OF SALT SOLUTION SURFACES**
John Hasychak III ‘11

16. **INDIUM METAL PROMOTED COUPLINGS OF PROPARGYL ALDEHYDES FOLLOWED BY GOLD-CATALYZED CYCLIZATION**
Darleny Lizardo ‘12

17. **CONSTRAINED PEPTIDES CONSTRUCTED BY COORDINATION OF PROPARGYLCYSTEINES WITH TUNGSTEN**
Thomas A. McTeague ‘12, Zephyr D. Dworsky ‘10

Poster # **Title**

18. **TOWARD THE EFFICIENT SYNTHESIS OF Fmoc-L-Gla(OtBu)$_2$-OH**
Alicia Ortiz ‘12

19. **MEASURING METAL ION STABILITY CONSTANTS BY ^{31}P NMR**
David Patrick ‘11

20. **HPLC METHOD OPTIMIZATION FOR THE QUANTITATION OF PURINES IN BRAIN TISSUE SAMPLES**
David Pierce ‘13

21. **DEVELOPMENT OF A SYSTEM TO STUDY PHOTOCHEMISTRY OF THE LIQUID-VAPOR INTERFACE**
Baltazar Ramos Jr. ‘11, Edward Harrington Jr. ‘11, John Hasychak III ‘11

22. **CONFORMATIONS OF CYCLIC COMPLEXES FROM METALLACYCLES**
Duyen Tran ‘13

23. **SEM-EDS ANALYSIS OF COPPER AND CERAMIC ARTIFACTS**
Lan Anh Tran ‘13

COMPUTER SCIENCE

24. **DISTRIBUTED HASH TABLES ON AD-HOC NETWORKS**
Prasanna Gautam ‘11

25. **PORTABLE OPEN SEARCH AND IDENTIFICATION TOOL**
Prasanna Gautam ‘11, Benjamin Hartung ‘11, Greg Vaughan ‘12, Scott Eckenthal ‘12, Rachel Foecking ‘11

26. **CREATE YOUR OWN PHONE APPLICATIONS WITH APP INVENTOR FOR ANDROID**
Nina Limardo ‘11, Pauline Lake ‘13

ENGINEERING

27. **CONSTRUCTION OF A ONE-COMPONENT FORCE BALANCE FOR MEASURING AERODYNAMIC DRAG IN A LOW SPEED SUBSONIC WIND TUNNEL**
Andrei Marchidan ‘13, Roarke P. McCormick ‘13

Poster # **Title**

28. A STUDY ON SHADOWING EFFECTS FOR VEHICLE-TO-INFRASTRUCTURE COMMUNICATIONS ON-ROAD
Michael Rueger ‘13

29. DESIGN OF A STATIC LOADING DEVICE FOR INTERVERTEBRAL DISK COMPRESSION IN A RAT TAIL MODEL
Lorenzo Sewanan ‘12

ENVIRONMENTAL SCIENCE

30. ENVIRONMENTAL SCIENCE FIELD TRIP TO DEATH VALLEY AND THE EASTERN SIERRA
Christopher J. Binnie ‘12, Amy M. Duggan ‘12, Daniel Echavarria ‘12, Hannah C. Harvey ‘12, Giuliani Lopez ‘11, William B. Martin-Black ‘12, Renee A. Murray ‘12, Brittney M. Payton ‘12, Kelsey A. Semrod ‘12, Chris M. Wright ‘13

31. TOXIC TRACE METAL MOBILITY IN THE TROUT BROOK AT THE WEST HARTFORD LANDFILL, WEST HARTFORD, CONNECTICUT
Vicky Doñé ‘11, Shuyang Zhu ‘13, William Martin-Black ‘12

32. MAGNETIC PROPERTIES AS INDICATORS OF ALEWIFE POPULATION CHANGE
Michael Oleskewicz ‘13

33. SYNERGISM AND ANTAGONISM IN TOXICITY OF MIXTURES OF PHARMACEUTICALS TO *DAPHNIA MAGNA*
Pooja Shakya ‘11, Richard S. Kim‘13

NEUROSCIENCE

34. CONTRASTING EFFECTS OF A KETOGENIC DIET ON SEVERAL CHARACTERISTICS OF INFLAMMATION
Joshua H. Altschuler ‘13

35. EFFECTS OF A KETOGENIC DIET ON WEIGHT MAINTENANCE AND LIFESPAN OF R6/2 HUNTINGTON'S DISEASE TRANSGENIC MICE
Joshua H. Altschuler ‘13, Jess Cote ‘12, Rachel Riendeau ‘12, Jessie Ross ‘10, Tracey Suter ‘11, Julia Svedova ‘11

Poster # **Title**

36. MUSIC OR NOISE?
Elsie Arce ‘12

37. THE PREVALENCE OF MENTAL ILLNESS IN VARIOUS STAGES OF HOMELESSNESS
Ethiopia Kabtimer ‘13, Marta Zamroziewicz ‘13

38. PERFORMANCE OF CHILDREN ON THE MEMORY FOR INTENTIONS SCREENING TEST FOR YOUTH (MISTY)
Ginger Mills ‘12, Julianne Garbarino ‘11

39. MUSICAL PROPERTIES OF THE BRAIN
Oladayo Oyedele ‘11

40. URIC ACID MANIPULATION AND CELL DIFFERENTIATION: NEUROPROTECTION AGAINST OXIDATIVE STRESS?
Lisa Pierce ‘11

41. THE EFFECT OF ACUTE STRESS ON THE NEUROPLASTICITY OF NEONATALLY-ISOLATED RATS
Melike Sunay ‘10, Kat Smith-Petersen ‘11, Tashi Genden ‘12, Ela Cross ‘13

42. DETERMINING THE ONSET AND EFFICACY OF A KETOGENIC DIET AS A HYPOALGESIC AGENT
Tracey Suter ‘11

43. EFFECTS OF THE KETOGENIC DIET ON SYMPTOMS OF AUTISM IN BTBR+Ttf/J MICE: METHODOLOGY
Julia Svedova ‘11

44. NOTE INTERVALS IN THE BRAIN
Amelia Wattenberger ‘11

PSYCHOLOGY

45. VISUAL PERCEPTION OF A POINT LIGHT FIGURE BALANCING AN INVERTED PENDULUM
Shraddha Basnyat ‘13, Chislon Richardson ‘13, Austin Tewksbury ‘13

46. A QUALITATIVE ANALYSIS OF FIRST-YEAR MENTORS’ EXPECTATIONS AND EXPERIENCES MENTORING FIRST-YEAR STUDENTS
Geraldine Fernandez ‘12

BIOLOGY

1.

EXAMINATION OF THE NORMAL FLORA OF THE UPPER RESPIRATORY TRACT USING TERMINAL RESTRICTION FRAGMENT POLYMORPHISM AND CAPILLARY ELECTROPHORESIS

Melissa Blake ‘11, Tiffany Damiani ‘12
Faculty Sponsor: Lisa-Anne Foster

Bacterial communities play a vital role in the human body, assisting in the production of essential amino acids and the host’s resistance to disease. These host-associated communities colonize various sites in the body, adhering to tissues and organs; consequently assisting in the function of the host. In this investigation, bacterial communities of the upper respiratory tract, known as the normal flora, were examined. The normal flora, more specifically the α-hemolytic strains of *Streptococci*, are known to prevent the colonization of pathogenic bacteria, and thus diseases due to various properties known to interfere with the pathogens’ ability to colonize. It is hypothesized that an inverse relationship exists between systemic disease and populations of normal flora. Disruptions in the normal flora communities, such as physical disturbances and harmful human behaviors may have an adverse effect on the normal flora, allowing harmful pathogens to invade healthy human cells. Such behaviors may include smoking and inappropriate or chronic antibiotic use. In order to observe this relationship between the health of the host and the normal flora, terminal restriction length polymorphism was employed to examine the normal flora present in oropharyngeal samples. tRFLP was used to identify the presence of bacterial strains of interest and detect their abundances. Samples were collected from volunteers at Trinity College. Subjects completed basic health status surveys to accompany the oropharyngeal samples. Corresponding surveys were examined to illuminate any factors that may affect the composition of normal flora. In order to study the potential role of normal flora, it is necessary to construct an extensive database of the fragmentation patterns produced in the tRFLP chromatograms of known bacteria.

2.

THE EFFECT OF NOVEL AND STATIC SOCIAL STIMULATION ON BEHAVIOR AND BRAIN CELL ADDITION IN WEAKLY ELECTRIC FISH, *APTERNOTUS LEPTORHYNCHUS*

Michael Chung ‘11
Faculty Sponsor: Kent Dunlap

Many studies show that environmental and social stimulation increase brain cell production in adult animals. In rats, dynamic olfactory stimulation further increases brain cell survival compared to static olfactory stimulation. Similarly, in weakly electric fish, short term (dynamic) social stimulation was associated with an overall increase in brain cell addition whereas long term (static) social stimulation was not. My study explored how the degree of social novelty affects brain cell addition and electrocommunication behavior in adult electric fish, *Apternotus leptorhynchus*. Fish were housed in opposite ends of an aquarium separated by a plastic mesh divider for two weeks. Fish providing social stimuli were either replaced every 2 d, every 7 d or

not at all. Thus fish were exposed to either one, two or seven partner fish over a two week period. Chirping behavior (the mode of intraspecific electrocommunication) was quantified and the brains were collected for measuring cell addition. Chirp rates of all fish were highest at the outset of the experiment and declined over two weeks. Over the entire two week period, fish with seven partners chirped three times more than fish with one or two partner fish. Chirp rates of one partner and two partner fish declined to a lower basal rate compared to that of seven partner fish. Frequent novel social stimulation elicits an overall stronger behavioral response and mitigates the behavioral habituation to social stimuli. Brain cell survival will be quantified to determine if novel social stimulation is especially effective in promoting cell addition.

3.

LEAD LEVELS IN HARTFORD'S RED-TAILED HAWKS

Gina Dinallo ‘12
Faculty Sponsor: Joan Morrison

Previous studies have shown that raptors in rural environments are prone to lead toxicity because of residual lead shot that they ingest in hunter-killed carion. Lead toxicity (when not fatal on its own) causes changes in behavior that can cause raptors to be injured or killed. Lead toxicity in urban raptors has not been thoroughly examined, thus we sought to determine if red-tailed hawks in Hartford were accumulating unsafe lead levels. Although urban areas lack exposure to lead shot, we considered that hawks might obtain lead from other sources in the city.

Each hawk caught provided a blood sample that was analyzed via ICP spectrometry. Blood samples had previously been collected in a slightly basic lysis buffer, but this conflicted with the ability of the ICP to function, making it impossible to analyze our older samples. All new blood samples (n = 7) were collected in 0.6M HCl to avoid this problem. Another problem encountered was that the ICP was only accurate to within 0.1ppm. This variation had the potential to create large errors in the data due to the miniscule differences between background and unhealthy blood-lead levels (<0.2ppm=background, 0.2-0.6ppm=subclinical, 0.6-1.2ppm=clinical, >1.2ppm=severe clinical).

The seven blood samples collected in HCl buffer from juvenile hawks in different territories in Hartford were successfully analyzed and found to have lead levels less than 0.06ppm, indicating background levels even when accounting for +/-0.1ppm accuracy of the machine. These values supported our prediction that urban hawks in Hartford are probably not being exposed to unsafe lead levels in the city.

4.

INVESTIGATING THE MECHANISM OF NOTCH ACTIVATION AND THE ROLE OF ENDOCYTOSIS IN THE NOTCH PATHWAY OF *D. MELANOGASTER*

Lam Hoang ‘13, Ayiti-Carmel Maharaj-Best ‘13
Faculty Sponsor: Robert J. Fleming

The Notch cell signaling pathway is a mode of intercellular communication that plays a vital role in deciding the fate of developing cells. Present in nearly all multi-cellular organisms, the Notch pathway regulates cell differentiation, proliferation and apoptosis. In our experiments, we focused on Serrate, a molecule that causes activation of Notch receptors. Previous studies have shown that in order for Serrate to activate Notch, it must first undergo the process of endocytosis. Experiments were conducted on *Drosophila melanogaster*, fruit flies, carrying a mutant form of Serrate (Ser^{Del6}) that lacks the 6^{th} of 14 EGF-like repeats that constitute Serrate. Unlike wild-type Serrate, Ser^{Del6} does not exhibit the property of cis-inhibition of Notch and hence, co-expression of Serrate and Notch can occur. By observing the patterns of Notch activation caused by Ser^{Del6}, it is possible to evaluate whether endocytosis is necessary for activation of Notch. For the two portions of this experiment, fruit flies of the necessary genotype were crossed and the subsequent larvae were heat shocked to activate gene expression. The heads of fruit flies in the larval stage were dissected and treated with the appropriate antibodies, following which the imaginal wing discs were removed and examined. Notch activation was observed on the cells surrounding the cell expressing Ser^{Del6}, the Notch receptor on the cell that was itself expressing Serrate showed no activation.

Malfunctioning of the Notch pathway has been associated with a host of genetic disorders in humans, including Alagille syndrome. Additionally, because of its role in cell differentiation and proliferation, it also has great significance in the formation of cancers. Gaining a more substantial understanding of the mechanism of the Notch pathway could allow for the development of more effective treatments of such conditions in the future.

5.

A BIOSYNTHESIS EXPERIMENT TO DETERMINE THE ORIGIN OF THE NOVEL GERMACRENE SESQUITERPENE AND POLYPROPANOIDS IN THE DEFENSIVE SECRETIONS OF THE LADYBIRD BEETLE *DELPHASTUS CATALINAE*

Elle Lucadamo ‘12
Faculty Sponsor: Scott Smedley

Insects commonly use chemical defenses in the form of secretions to protect themselves from predators. Ladybird beetles are renowned for their use of alkaloids as anti-predator defenses. Previous work in our lab with the ladybird beetle *Delphastus catalinae* showed that the larvae and pupae secrete a novel germacrene sesquiterpene and polypropanoids from glandular hairs and furthermore that these secretions and the isolated compounds serve as defense from predators. This is the first demonstration of the use of non-alkaloidal chemical defenses by ladybird beetles. To determine if the germacrene and polypropanoids are synthesized *de novo* or sequestered from the beetles’ diet, I applied ^{13}C- labeled and unlabeled glucose to the eggs of the whitefly, *Bemisia tabaci*, on which the beetle larvae feed. Larvae were allowed to feed on the

glucose-covered eggs for 24 hours and then were sampled as pupae. The liquid chromatography-mass spectroscopy showed that there were significantly higher proportions of isotopically heavier to normal-weight germacrene (both before and after hydrolysis of adhering functional groups) and three polypropanoids in pupal secretions of beetles that consumed ^{13}C-glucose, demonstrating that the beetle biosynthesizes these newly discovered defensive compounds *de novo*.

6.

ELUCIDATION OF THE RELATIONSHIP BETWEEN RAPAMYCIN INHIBITION OF OLIGODENDROCYTE DIFFERENTIATION AND PPAR EXPRESSION IN RAT CNS TISSUE

Nitin Sajankila ‘13, Caroline Reiss ‘12, Angela Colantonio ‘11
Faculty Sponsor: Hebe Guardiola-Diaz

Oligodendrocytes are involved in lipid metabolism in the central nervous system and produce the myelin sheath, necessary for neuronal protection and rapid neuronal communication. Peroxisome proliferator activated receptors (PPARs), a type of ligand-activated nuclear receptor, play a role in adipogenesis via the Akt signaling pathway. Inhibition by rapamycin of the mTOR pathway, a downstream component of the Akt pathway, has been shown in adipocytes to downregulate production of PPARs and thus block adipocyte differentiation. The relationship between PPARs and lipid metabolism may extend to the process of myelination by oligodendrocytes. In order to study the relationship between rapamycin, mTOR, and oligodendrocytes, PPARB/D and PPARG levels were studied in oligodendrocytes variably treated with rapamycin over a four-day period. Analysis by qPCR, western blotting, and immunofluorescence were used to assess PPAR levels in the cells. Results are preliminary and thus inconclusive, but suggest that PPAR levels are not significantly affected by rapamycin.

7.

WILDLIFE VISITATION TO DIFFERENT TYPES OF RESIDENTIAL COMPOST PILES: A COMPARISON OF FALL-SEASON REPLICATES

Katherine R. Sausen ‘11
Faculty Sponsor: Scott R. Smedley

With the “Go Green” movement sweeping the nation, composting, an activity formerly undertaken primarily by serious gardeners and environmentalists, is now becoming a common household practice. Composting allows households to dispose of food waste without adding to landfills and creates a nutrient-rich supplement that can be used for gardening. Most composters add only vegetable-based scraps to their piles, believing the long-proclaimed notion that the addition of animal-based scraps will attract unwanted wildlife visitors. Surprisingly, no experimental data exist to examine this claim. Therefore, an experiment was designed to test this idea in a rural/residential woodland area. Beginning in February 2008 in Andover, Connecticut, 12-week long replicates have been conducted in which three types of compost piles (vegetable products only, vegetable and animal product mix, and control) have been monitored using heat-motion sensitive cameras to collect images of wildlife visitors. From September to December 2009 a sixth replicate was conducted. There were 455 independent wildlife encounters by 17

different species over the 84-day replicate. There were differences in wildlife encounters based on pile treatment (mix > vegetable only > control). Of the five most frequent visitors (opossum, American crow, gray fox, domestic dog, and raccoon), the opossum, American crow, and gray fox also showed a preference for the mix pile. These findings varied somewhat from those of the previous fall replicate, suggesting that environmental variability between years may affect visitation. With a growing number of households utilizing composting, understanding how the content of compost piles affects animal visitation is an important issue. Further work will compare replicates of all seasons to determine whether animal-based products consistently attract more wildlife to compost piles.

8.

IMPROVED AND TIME EFFICIENT SELEX OF DNA APTAMERS USING A MULTIPLEXED BINDING CONSTANT ASSAY

Jessica Williams ʻ12
Faculty Sponsor: A. Michael Sismour, PhD, George Church Lab, Department of Genetics and Wyss Institute for Biologically Inspired Engineering, Harvard Medical School

DNA aptamers are single stranded deoxynucleic acid molecules that have the ability to bind to target molecules for molecular recognition. Aptamers rival antibodies, proteins that bind to antigens in the body, because they have the potential to revolutionize medical diagnostics; they can be chemically synthesized in a lab and formed against specific target molecule(s).However, DNA aptamers suffer from the limitations that their development is both difficult and time intensive. Typically, to select aptamers with the highest binding affinity for a specific target molecule takes 20 to 40 rounds of *in vitro* selection or SELEX. Our goal is to optimize the existing SELEX technique to both shorten the selection time to three or four rounds and to allow for the selection of aptamers against multiple antigens in one-pot. This new selection technique will employ a few rounds of SELEX followed by an ultra-high throughput screen for protein binding affinity on a multiplexed DNA sequencer. To test our system, aptamers were selected against the human protein albumin via ten rounds of SELEX. Surviving populations of molecules from each round were clonally amplified onto one micron beads using emulsion PCR and placed in the Polonator multiplexed DNA sequencer for analysis. To obtain dissociation constant (K_d) values for each aptamer, Cy5-labeled albumin at varying concentrations was incubated with the bead-tethered aptamers, and the intensity of fluorescence on each bead was measured. The aptamers were then sequenced, thus correlating K_d with sequence for each species. To implement our technique, three rounds of SELEX were performed to develop aptamers against five cancer biomarkers in a single pot. Sequence and K_d values were determined for each protein, using our newly developed screening technique. This technique allows the development of multiple highly selective, high affinity aptamers for five proteins in less than one week.

CHEMISTRY

9.

ALTERNATIVE ROUTE FOR PHOSPHONAMIDITE SYNTHESIS TO BE EMPLOYED IN EXPERIMENTATION WITH OLIGONUCLEOTIDES

Monica Au-Yeung ʻ12
Faculty Sponsor: Richard Prigodich

A more efficient, alternative pathway to synthesizing a phosphonamidite is being developed to eventually be used in solid-phase oligonucleotide synthesis. Double-stranded oligonucleotides that contain a single phosphonate nucleotide can be used to study the binding of metal ions to nucleic acids which give insight into controlling nucleic acid structure. The phosphonate will have a unique ^{31}P-NMR chemical shift compared to phosphate. Thus far, three intermediate products have been successfully and consistently synthesized starting with thymidine as the first pre-synthesized reactant. The fourth intermediate product, an aldehyde, has been successfully but inconsistently synthesized. Mass spectrometry and H-NMR spectroscopy is being used to confirm the structure of each product. Once the fourth intermediate product is seen to be consistently synthesized, a few more steps will be required to eventually reach the synthesis of the phosphonamidite suitable for use in automated solid-phase oligonucleotide synthesis.

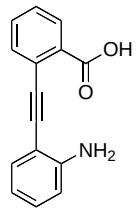
10.

COORDINATION OF A PEPTIDE β–TURN MIMETIC TO TUNGSTEN: POSSIBLE APPLICATIONS FOR THE STUDY OF β-SHEETS

Adam N. Boynton ʻ12
Faculty Sponsor: Timothy P. Curran

In 1995 Kemp and Li described the synthesis of 2-amino-2'-carboxyphenylacetylene (**1**) and its use as a peptide turn mimetic.[1,2] Their work showed that **1** does function as a β-turn mimetic, and that

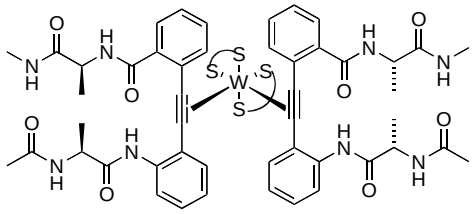
1

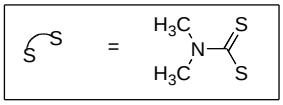


peptide derivatives incorporating **1** adopted β-sheet structures. A key structural element in **1** is the alkyne group that links both phenyl rings. Because of our ongoing interest in the use of tungsten-alkyne coordination for generating constrained peptides,[3,4,5] we have begun investigations into whether peptide derivatives of **1** can be reacted with $W(CO)_3(dmtc)_2$ to yield tungsten-bis(alkyne) complexes (like **2**), and whether the peptides maintain a β-sheet structure after coordination to tungsten. If the peptides do maintain their sheet structure, then it would be of interest to know whether the two β-sheets interact with each other via stacking arrangements.

Owing to solubility and oligomerization issues, there are very few model systems for investigating β-sheet stacking interactions.

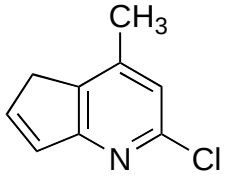
2





11.
EFFORTS TOWARDS THE ASYMMETRIC SYNTHESIS OF CHIRAL PYRIDINE-BASED LIGANDS
Kiyoshi Chandler ‘12
Faculty Sponsor: Olivier Nicaise

Chiral pyridine-based ligands have recently been used in enantioselective reactions due to their ability to coordinate with many metal ions and to promote high levels of enantioselectivity in metal-mediated reactions (Reagan, 2008). The pyridine-based substrate of 2-Chloro-4-methyl-5H-[1]pyrindine (**1**) was first synthesized in five steps, and then used to construct a chiral molecule by introducing a stereocenter via a deprotonation/nucleophilic substitution sequence. Nucleophilic substitution was achieved, but spectroscopic data seemed to indicate that the reaction took place at the undesired carbon atom of the substrate with all electrophiles used, creating an achiral molecule. It was concluded that further studies on this substrate would be stopped, and that studies on the original 2-chloro-6,7-dihydro-5H-cyclopentapyridine substrate would be revisited along with studies on the corresponding *N*-oxide compound.

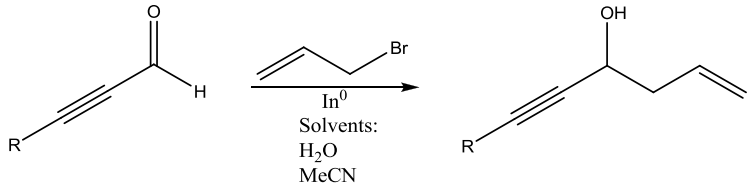


1

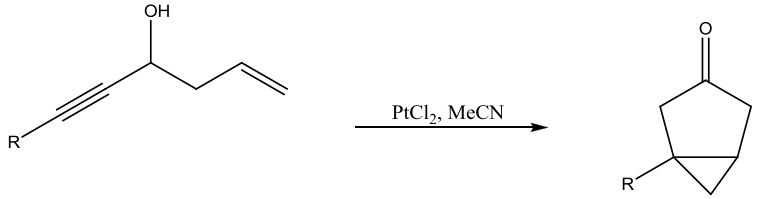
12.
INDIUM-PROMOTED COUPLING OF PROPARGYL ALDEHYDES WITH SUBSEQUENT CYCLIZATION IN BOTH ONE AND TWO POT SYSTEMS
Mark Chesson ‘13
Faculty Sponsor: Thomas Mitzel

This presentation will detail the status of our efforts to prepare and study these novel bioorganometallic species.

Our lab’s goal is to reduce the time and cost of producing bicyclic product by modifying the reaction from a many-pot process:

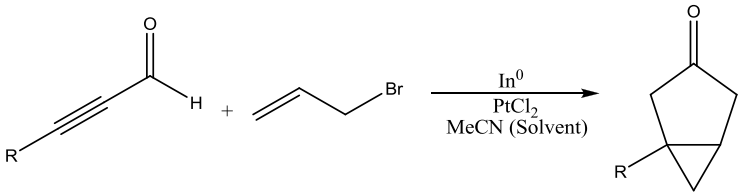


1st pot.



2nd pot. R= Hex, Hept, Oct, Phenyl

to a single pot reaction:



We have managed to successfully isolate cyclized product from the one pot reaction. In the future, we will attempt to improve yields both through the optimization of the techniques and conditions the one pot reaction is run under and through the improvement column chromatography techniques used in the purification process.

13.

CAN URIC ACID PREVENT APOPTOSIS IN INSULIN-SECRETING CELLS: A POSSIBLE PROTECTIVE ROLE IN TYPE 1 DIABETES

Jackie Gottshall ˙13
Faculty Sponsor: William Church

The ability of uric acid to inhibit apoptosis in insulin-secreting cells was investigated. Type 1 diabetes results from the apoptotic cell death of insulin-secreting pancreatic β-cells. Apoptosis is known to be triggered by oxidative stress. Uric acid has been demonstrated to attenuate oxidative stress in biological tissues. The present study investigated the effect of uric acid on alloxan-induced apoptosis in RIN-m5F cells. Cells were treated with 7mM alloxan for 1 hour followed by 1 hour of uric acid treatment at a concentration of either 0.5mM, 1mM, or 5mM. The extent of apoptosis was determined by fluorometric staining of the cells using Hoechst 33342. The results suggest that uric acid pre-treatment may reduce the incidence of apoptosis in alloxan-treated cells. As a result of these findings, the role of uric acid in the toxicity of pancreatic β-cells seen in Type 1 diabetes should be further explored as a possible therapeutic strategy.

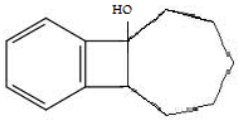
14.

PROGRESS TOWARDS THE ASYMMETRIC SYNTHESIS OF CHIRAL BENZOCYCLOBUTENOLS

Christopher Gromisch ‘11
Faculty Sponsor: Olivier Nicaise

Benzocyclobutendiol derivates have shown practical pharmaceutical applications through the specificity of particular chiral centers. The success of these products focuses on the synthesis of a particular enantiomer, a process which requires asymmetrical chemical synthesis. Synthesis of a particular subset of these molecules (benzocyclobutendiols derived from cycloketone derivatives), were accomplished under anhydrous conditions (N_2 gas) at low temperatures (-78^{o}C). A silyl enol ether intermediate was formed through the reaction of the starting cycloketone with LDA and TMSCl. This product was separated and purified. The silyl enol ether was deprotected using methyl lithium and reacted *in situ* with benzyne (the reaction of m-triflate bromobenzene and butyl lithium *in situ*), to form a product similar to Fig. 1. Current research focuses on the stereoselection of these compounds through the use of a chiral diol.

Figure 1



15.

X-RAY PHOTOELECTRON SPECTROSCOPY STUDY OF PHOTOCHEMISTRY OF SALT SOLUTION SURFACES

John Hasychak III ‘11
Faculty Sponsors: Maria Krisch, Hendrik Bluhm, Lawrence Berkeley National Laboratory

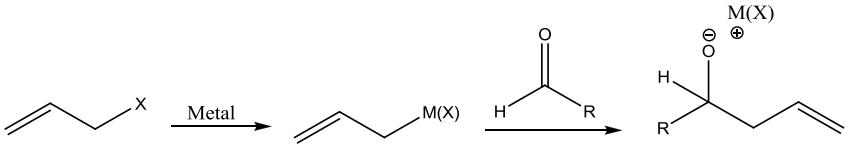
Many atmospheric aerosols undergo photochemical reactions which have a large effect on atmospheric chemistry. Studies have shown that the many tiny liquid droplets within an aerosol can react differently than would be expected of bulk liquids undergoing photochemical reactions, possibly due to their large amount of surface area relative to their volume. This study focuses on the photochemistry of pure potassium iodide solutions and sodium chloride solutions with halogenated organics on the surface of an aqueous solution, and the changes due to increased distance from the liquid-gas interface. Saturated solutions of the samples were exposed to an ultraviolet laser in a vacuum. X-ray photoelectron spectroscopy at the Advanced Light Source Synchrotron was used to analyze the contents of the solution at different depths of the surface of the solution, before, during and after UV exposure. Initial results do not show any depth dependent differences in the potassium iodide or sodium chloride photochemical reactions, data including the halogenated organics are not fully analyzed.

16.

INDIUM METAL PROMOTED COUPLINGS OF PROPARGYL ALDEHYDES FOLLOWED BY GOLD-CATALYZED CYCLIZATION

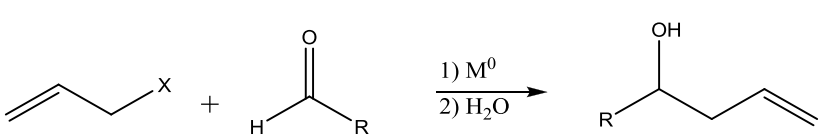
Darleny Lizardo ‘12
Faculty Sponsor: Thomas Mitzel

Organometallic reactions are one of the oldest techniques used in order to create carbon-carbon bonds. However, they usually follow a 2-step process that must be performed under inert conditions in organic solvents which can be a bit expensive, can lead to loss of product due to the two-pot system, and can even be harmful to the environment.



X= halogen (Cl, Br, I, etc)
M= Li, Mg, Cu, etc

In the 1900s, Phillipe Barbier was able to formulate a one-pot version of the traditional organometallic reaction after discovering that aluminium, tin, indium, and zinc are metals that promote carbon-carbon bond formation between alkyl halides and carbonyls. In our lab we are working towards an indium-promoted Barbier coupling of a propargyl aldehyde to an allyl bromide. We then hope that the coupled product undergoes a copestyle rearrangement where the final product would be a cyclized ketone, all in a one-pot system. The reason we are focusing on indium is because it is a useful metal promoter in carbon-carbon bond formation while under benign or aqueous solvent conditions, which is fitting of our lab since we aim towards more efficient, environmentally-friendly chemical processes.



X= halogen (Cl, Br, I, etc)
M= Mg, K, Na, In, Zn

17.

CONSTRAINED PEPTIDES CONSTRUCTED BY COORDINATION OF PROPARGYLCYSTEINES WITH TUNGSTEN

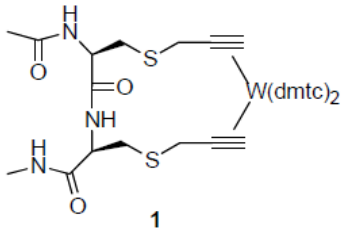
Thomas A. McTeague ‘12, Zephyr D. Dworsky ‘10
Faculty Sponsor: Timothy P. Curran

In prior work we have demonstrated that alkynes can be appended to peptide carboxylic acids (via acylation with propargylamine) and amines (via acylation with propargylchloroformate), that peptides bearing two alkynes can be prepared, and that reaction of these dialkynylpeptides with $W(CO)_3(dmtc)_2$ yields a cyclic peptide that incorporates the tungsten atom (which is called a metallacyclicpeptide). We have sought to use the tungsten-alkyne coordination to constrain peptides to specific three-dimensional conformations; in one case peptide turns were constrained by the tungsten-alkyne coordination. In an effort to create helical peptides we have appended alkynes to the side chain amines of lysines, and have constructed peptides having two of these alkynyllysines. Coordination of these dialkynylpeptides to tungsten has produced

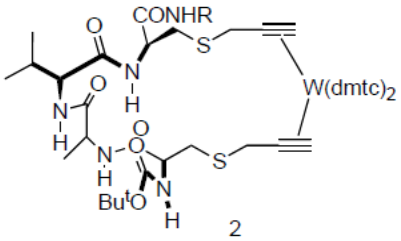
metallacyclicpeptides. Investigations using NMR spectroscopy has shown that these metallacyclicpeptides are too flexible to constrain the peptide to a specific conformation. In particular, in these metallacycles we have found that the two alkyne groups can rotate around the tungsten center, generating a number of conformational isomers in solution.

We have hypothesized that appending the alkyne group to the side chain amine of lysine locates the π-ligand too far from the peptide backbone for coordination to tungsten to constrain the peptide. Accordingly, we have begun investigations to see whether locating the alkyne group closer to the peptide backbone will make the complexes more rigid. Towards this end we have been investigating the use of propargylcysteine as our alkynylamino acid. Attractive features of propargylcysteine are that it can readily be prepared in multigram quantities from cysteine, and derivatives of propargylcysteine are easy to work with in peptide synthesis.

This presentation will discuss the preparation of peptides possessing two propargylcysteines, the coordination of both alkynes in these peptides to tungsten, and the conformational analysis of the resulting metallacyclicpeptides. Particular emphasis will be on the study of compounds **1** and **2**.



1



2

18.

TOWARD THE EFFICIENT SYNTHESIS OF Fmoc-L-Gla(OtBu)$_2$-OH

Alicia Ortiz ʻ12
Faculty Sponsor: Richard Prigodich

This study investigates an efficient new route for synthesizing Fmoc-L-Gla(OtBu)$_2$-OH. Glutamic acid is one of the twenty proteinogenic amino acids. Gla is the post-translationally modified form of Glu, having been carboxylated at the gamma position, and is found in many proteins. Fmoc-L-Gla(OtBu)$_2$-OH is the protected version of Gla suitable for solid-phase peptide synthesis, but is very expensive. For this project, a six-step synthetic route was devised for producing Fmoc-L-Gla(OtBu)$_2$-OH. Mass spectrometry and proton NMR spectroscopy were used to determine the products of each step. The current result is a small trace of the third of six products needed to complete the synthesis.

19.

MEASURING METAL ION STABILITY CONSTANTS BY ^{31}P NMR

David Patrick ʻ11
Faculty Sponsor: Richard V. Prigodich

The binding of metal ions and other cations to phosphorus containing compounds is of general interest and has great relevance to the behavior of nucleic acids in the presence of electrolytes. ^{31}P NMR chemical shift changes can be induced by the binding of cations to phosphorus containing acids because of the increased possibility in shielding or deshielding. Using tetramethylammonium chloride to control chloride concentration and the non-ionizable compound trimethylphosphate as a chemical shift standard, the chemical shift and coupling constants were measured for methylphosphonic acid, methyl phosphinic acid, 5' adenosine monophosphate, and cyclic 5' adenosine monophosphate (cAMP). The concentration of metal chloride salts was also varied for each experimental compound. The association constants varied for each metal ion and phosphorous compound. The coupling constants for all the metals within each phosphorous compound were the same, and had the following values: methylphosphonic acid at 15.63 Hz, methylphosphinic acid at 13.66 Hz, and cAMP at 29.68 Hz. Other cationic ligands and retrials of the current ligands will be used to further this study.

20.

HPLC METHOD OPTIMIZATION FOR THE QUANTITATION OF PURINES IN BRAIN TISSUE SAMPLES

David Pierce ʻ13
Faculty Sponsor: William Church

The goal of this study was to develop a high performance liquid chromatography (HPLC) separation method for purines of biological importance in brain cell samples. The optimization of this methodology included determination of the most effective mobile phase, the proper wavelength setting for both channels of a UV detector, and the appropriate voltage and sensitivity settings for both channels of an electrochemical detector. The increased production of purines has been shown to have neuroprotective effects and reduce chronic pain. Therefore, the ability to quantify purine levels in biological samples is important in determining effective clinical therapies. Separation of the major purines (adenosine, hypoxanthine, inosine, uric acid, and xanthine) was optimized using a mobile phase comprised of 10mM tetrabutylammonium hydroxide (TBH), 28mM potassium phosphate buffer (pH=6.5), and 6% methanol. Separation was carried out at a flow rate of 0.50 mL/min and individual purines quantified using UV (dual channel 235 nm and 287 nm) and dual electrochemical detectors (ECD1: Epot= 200mV; ECD2: Epot= 400mv). Cell culture and brain tissue homogenates were analyzed to verify optimum separation conditions.

21.

DEVELOPMENT OF A SYSTEM TO STUDY PHOTOCHEMISTRY OF THE LIQUID-VAPOR INTERFACE

Baltazar Ramos Jr. '11, Edward Harrington Jr. '11, John Hasychak III '11
Faculty Sponsor: Maria Krisch

Unique aspects of the liquid-vapor interface cause its composition, and sometimes chemistry, to be different from bulk liquid. Here we discuss the development of a droplet train apparatus, using a vibrating orifice, to study photochemistry at the liquid-vapor interface. Our goal is to compare bulk and interfacial photochemistry to see whether differences between the two are substantial, with atmospherically interesting organics in solution serving as a proxy for atmospheric aerosols. We use gas chromatography-mass spectrometry (GCMS) as an analytical method to follow the photochemistry of CH2ICl exposed to a ultraviolet laser light and broadband ultraviolet lamp. Orifices of 50 and 75 μm were characterized to produce the UV exposed droplet trains. Preliminary results show a promising decrease in signal but the magnitude of decrease is variable. Future work will consist of examining more methods to track photochemical products, characterization of different orifice sizes, and reducing variability of GCMS CH2ICl data.

22.

CONFORMATIONS OF CYCLIC COMPLEXES FROM METALLACYCLES

Duyen Tran '13
Faculty Sponsor: Timothy P. Curran

The notion of using alkynes as ligands in coordination with Group VI metals began in the early 1960s when Tate and Augl studied the properties of $W(CO)(3\text{-hexyne})_3$ and found that the alkyne was linked to the metal via two separate bonds. The work was continued in the 1980s by Joseph Templeton at UNC-Chapel Hill, where extensive information on the synthesis and behavior of Group VI metals, particularly molybdenum(II) and tungsten(II) alkyne complexes, was obtained. He and his co-workers showed that the synthesis of a variety of tungsten(II) and molybdenum(II)-alkyne complexes was relatively simple, if prepared under the right conditions. More specifically was the establishment of the conformations and stabilities of the bis(alkyne) tungsten complexes. In our work we used Templeton's synthetic methods for forming bis(alkynyl) species. In his work two monoalkynes were coordinated to one metal. In this project one dialkyne is being coordinated to one metal, with both alkynes in the dialkyne being linked to the metal. Coordination of both alkynes in the dialkyne will generate cyclic structures, forming a metallacycle. Metallacycles employing bis(alkyne) complexes have not been reported before. The purpose of this research is to make such metallacycles and then determine their molecular shape. Under our experiment, a variety of complexes (1-hexyne & 1,8-nonadiyne) were reacted with $W(CO)_3(dmtc)_2$. The bis(alkyne) products were isolated, and their structures determined using NMR and MS methods. Electrospray mass spectrometry provided an isotope pattern for the molecular ion peak that is unique to the target molecule.. NMR provided information on the shape and flexibility of the molecules. The 1-hexyne complex was used as a control molecule for the metallacyclic 1,8-nonadiyne molecule. Results from this work will be presented.

23.
SEM-EDS ANALYSIS OF COPPER AND CERAMIC ARTIFACTS
Lan Anh Tran ‘13
Faculty Sponsors: Ann Lehman, Maria Parr

In this project, a scanning electron microscope (SEM) equipped with an energy dispersive X-ray spectrometer (EDS) was used to analyze two types of artifacts, a copper bead and pottery fragments. The Woodland period copper bead was excavated in Essex, Connecticut. The pottery fragments were unearthed in Caesarea, Israel, and are around 2,000 years old. All artifacts were first photographed from many different angles using a Leica StereoZoom4 light microscope in order to document their original states. A piece of each artifact was then cut and carbon coated before mounting onto a stub. The mounted samples were analyzed with a JEOL JSM-IC848A SEM equipped with an iXRF X-ray energy dispersive spectrometer. The EDS function of the SEM was employed to determine the elemental composition of the copper bead and pottery pieces. Various areas on the bead were subjected to elemental analysis and all areas showed a very high concentration of copper. Also present were traces of silicon and oxygen which could be the result of corrosion due to interactions with the environment or a characteristic of the vein from which the copper was taken. Traces of iron were also found in one area. The matrix of the pottery samples showed the presence of silicon, oxygen, aluminum, and calcium. This is typical for an aluminosilicate clay composition. Traces of other elements typically found in pottery such as sodium, magnesium, titanium, potassium, and iron were also observed. The inclusions found within the matrix were composed of either silicon or calcium, indicating the presence of sand particles (SiO_2) or shell material ($CaCO_3$), respectively.

COMPUTER SCIENCE

24.
DISTRIBUTED HASH TABLES ON AD-HOC NETWORKS
Prasanna Gautam ‘11
Faculty Sponsor: Timothy Richards

Distributed Hash Tables (DHT) is a new system that harnesses the storage and resources of large number of computers across the internet by providing a hash-table interface where the keys are hashes of the objects stored in the system. This kind of system is commonly used in peer-to-peer file transfer protocols like Bittorrent where the nodes may be distributed anywhere in the internet and may drop in and out of connection. This is analogous to Ad-hoc networks in mobile devices where mobile devices may be communicating with each other without needing a common network provider like a wireless router or a mobile network provider. Unlike sharing data over internet, ad-hoc networks pose unique challenges as nodes can drop in and out of the network, DHTs may be able to solve this problem by making small chunks of the data and replicating across nodes. This could potentially make sharing large amount of data across this type of network much more viable. These projects focuses on implementing distributed hash table algorithms on ad-hoc mobile networks and understand how those networks behave in contrast with conventional data transfer methods.

25.

PORTABLE OPEN SEARCH AND IDENTIFICATION TOOL

Prasanna Gautam ‘11, Benjamin Hartung ‘11, Greg Vaughan ‘12, Scott Eckenthal ‘12, Rachel Foecking ‘11
Faculty Sponsor: Ralph Morelli

POSIT (Portable Open Search and Identification Tool) is a general purpose mobile application for Android phones that supports field-based search activities. Configured for a crisis management search mission, it records geo-coded *Finds* using a form-based interface. When network service is available, these Finds can be synchronized to a central database. When network service is not available, a common constraint in disaster recovery scenarios, POSIT utilizes an ad-hoc networking protocol to share finds directly among phones. In addition to its use as a tool in post-disaster scenarios, POSIT can be used by botanists, environmental scientists and other researchers who need to record and share data during fieldwork. It can also record and map the search path of field workers during a search expedition. The path can then be viewed in real-time on the server. The paths for different search expeditions can be merged and viewed together on the server. Along with making the application run more robustly, the ad-hoc networking protocol was rewritten into a separate module removing various dependencies.

26.

CREATE YOUR OWN PHONE APPLICATIONS WITH APP INVENTOR FOR ANDROID

Nina Limardo ‘11, Pauline Lake ‘13
Faculty Sponsors: Ralph Morelli, Trishan de Lanerolle

App Inventor is an entirely visual method of programming mobile web applications for Android phones. It was created by MIT's Hal Abelson in conjunction with Google Labs. App Inventor uses a visual interface consisting of blocks and widgets, rather than the code found in traditional programming languages, to allow developers to create smart phone applications. Because of the accessibility of its interface and the power of its underlying execution model, App Inventor lets non-programmers create sophisticated mobile applications. App Inventor was just released to the public in July, but it has already been met with praise and optimism by computer science instructors as a promising platform for introducing students to computer programming and computational thinking.

Our project focused on evaluating App Inventor as a suitable instructional environment for K-12. Our goal was to explore the still untapped research of how App Inventor can further stimulate high school students and encourage them to continue of the path of higher education for Computer Science. We will be furthering the research of Seymour Papert and MIT’s Logo Foundation who envision children using Computer Science to change their world and expand their minds. We worked with two high school CS teachers to create an instructional method for their high school classes, and also created 6 mobile web applications for the Android phone using App Inventor. Our applications were completed in a very short amount of time ranging

from a day to two weeks depending on the complexity of the application. Based upon our research, we believe App Inventor provides the necessary skills to learn Computer Science.

ENGINEERING

27.

CONSTRUCTION OF A ONE-COMPONENT FORCE BALANCE FOR MEASURING AERODYNAMIC DRAG IN A LOW SPEED SUBSONIC WIND TUNNEL

Andrei Marchidan ‘13, Roarke P. McCormick ‘13
Faculty Sponsor: Joseph Palladino, Asnuntuck Community College Machine Shop

Drag forces oppose the relative motion of an object placed in a liquid and are directly proportional to the object’s shape. The accurate measurement of drag forces on models is an indispensable tool for aeronautical engineers and designers. To accomplish this task, the construction of a simple one-component force balance to measure drag force in a subsonic wind tunnel was undertaken. The force balance uses a load cell from an electronic laboratory scale, which is equipped with four strain gauges mounted to a binocular spring element, whose geometry enhances the load cell’s sensitivity. This force transducer is connected to a wheatstone bridge amplifier that converts voltage resistance changes to measured voltage in a computer with a data acquisition system. Signals are then interpreted in a user-friendly LabView program to give the values for the measured strain and drag force that is applied on the model. The load cell was tested with various weights and showed a linear interpretation of the strain applied, accurate to a 9% error which will be taken into account during calibration. The design of the force balance was made in SolidWorks C.A.D. software and is currently awaiting manufacture at the machine shop from Asnuntuck College. This force balance will be used to measure drag force on bluff bodies in the Trinity Engineering wind tunnel.

28.

A STUDY ON SHADOWING EFFECTS FOR VEHICLE-TO-INFRASTRUCTURE COMMUNICATIONS ON-ROAD

Michael Rueger ‘13
Faculty Sponsor: Lin Cheng

The goal of this project is to determine the effects of shadowing and signal attenuation in a wireless communication channel between a receiver and transmitter in: urban, suburban, and rural street environments. Environments were varied based on the speed at which the receiver was traveling as well as lanes of traffic for the receiver and potentially the receiver to travel in. In all scenarios studied a standard car antenna was used as the receiver with either a light pole or a specially designed truck being used as the transmitter depending upon the case. All of the studies were done using programs generated in MATLAB with inputs that were changed to correspond to the various cases. The results that have been generated thus far showed an expected shadowing effect based on the location of the receiver and the transmitter and most signal changes can be explained. The only uncertainties that remain are increases in signal strength that occur with specific receiver and transmitter locations in the non-highway cases.

Eventually, this study may lead to the ability to get rid of large signal towers with smaller and cheaper transmitters being placed on light-posts or specially designed trucks.

29.
DESIGN OF A STATIC LOADING DEVICE FOR INTERVERTEBRAL DISK COMPRESSION IN A RAT TAIL MODEL

Lorenzo Sewanan ‘12
Faculty Sponsor: Nadeen Chahine, PhD, Feinstein Institute of Medical Research, North Shore Long Island Jewish Medical Center University Hospital

Intervertebral discs (IVD) are biomechanical structures which dissipate mechanical energy and transmit forces in the spine, allowing skeletal motility and integrity. IVD degenerative disease and lower back pain result in significant socioeconomic and clinical problems. IVD degeneration is caused by complex and interacting factors including nutrition deficiency, mechanical over-loading or mis-loading, various chemical and biological stimuli, and genetics. In particular, physiological and non-physiological loading of the IVD in vivo and in vitro has been shown to cause deterioration of the IVD structure and matrix and is associated with a biochemical response in the IVD, dependent on duration, magnitude, and modality of the loading. The current project focused on the development of a device for *in vivo* compression of IVDs for use in conjunction with additional injuries and insults to the rat tail model of the spine. Evaluation of different methodologies for loading showed that the modified Ilizarov-type design was the most consistent and effective mechanism for this model. Design of an Ilizarov-type static loading device necessarily depended on the anatomy of the rat model, the biomechanics of the IVD, and material properties of the IVD.

ENVIRONMENTAL SCIENCE

30.
ENVIRONMENTAL SCIENCE FIELD TRIP TO DEATH VALLEY AND THE EASTERN SIERRA

Christopher J. Binnie ‘12, Amy M. Duggan ‘12, Daniel Echavarria ‘12, Hannah C. Harvey ‘12, Giuliani Lopez ‘11, William B. Martin-Black ‘12, Renee A. Murray ‘12, Brittney M. Payton ‘12, Kelsey A. Semrod ‘12, Chris M. Wright ‘13
Faculty Sponsors: Christoph Geiss, Jonathan R. Gourley

From May 24th through June 5th, a group of nine students and two professors went to Death Valley and the Eastern Sierras on the Environmental Science program’s annual summer field study. Death Valley and the Eastern Sierras are both located in the western part of California. Past tectonic activity created the Great Basin, an area with mountains and valleys. The Great Basin has both the lowest and highest point in North America, which are only 85 miles apart. We traveled in a van to several base camps, from those camps we would then hike throughout to our points of interests. During the first several days of the trip we took several short hikes, starting with La Madre-White Rock Loop and Icebox Canyon at the Red Rock National Park. The short hikes prepared us for a seven-mile hike from Mahogany Flats to Telescope Peak, which went

from 8133 feet elevation to 11, 049 feet elevation. Our trip to the Eastern Sierras provided a contrast in geology to Death Valley. While hiking to the Inyo Craters we encountered snow high enough that we could not drive over it. The differences between the two regions were visible in the amount of vegetation and animals present in the Eastern Sierras vice Death Valley. The flora and fauna of Death Valley and the Eastern Sierras have many adaptations that enable them to survive. An example of this extreme adaptability to the extreme climate of Death Valley animals would be the pup fish, which can only survive in water temps of 110° F. The bristlecone pines, considered to be one of the oldest living organisms on the Earth are located in the White Mountains in the Eastern Sierras. Methuselah, the oldest bristlecone pine is over 4,00 years old. Bristlecone pines have adapted to the harsh climate of the White Mountains. Our trip helped us to better understand that various effects of geology on a region. The trip was a great experience, one I will never forget.

31.

TOXIC TRACE METAL MOBILITY IN THE TROUT BROOK AT THE WEST HARTFORD LANDFILL, WEST HARTFORD, CONNECTICUT

Vicky Doñé ‘11, Shuyang Zhu ’13, William Martin-Black ‘12
Faculty Sponsor: Jonathan Gourley

The Park River is an urban river that flows through greater Hartford, into the Connecticut River, and ultimately into the Long Island Sound. The Trout Brook, a channelized tributary of the south branch of the Park River has a history of toxic trace metal discharges from several metal finishing industries. In addition, the West Hartford landfill, a semi-closed unlined landfill facility, discharges its storm and waste water into the Trout Brook. Sediment samples were collected around the storm water outflow of the landfill on four different dates in the spring and summer of 2010 to determine whether the point source contributes to elevated toxic trace metal concentrations within the sediment of the Trout Brook. Before and after several rain events, samples were collected to observe how the rain events influenced the mobility of sediment and toxic trace metals in the channelized stream. We analyzed for nine metals including cadmium, iron, manganese, lead and zinc using inductively coupled plasma spectrometry (ICP-OES) after a weak acid digestion method that extracted metals adsorbed to silt and clay sized particles (grains < 63µm). Contour maps for each metal were constructed in ESRI ArcGIS 9.3 to map spatial and temporal variations of metal concentrations at different sampling sites before and after the rain events. For all trace metals (except cadmium and lead), there was a statistical increase (p-value < 0.05) in metal concentration after the rain events and a statistical increase (p-value <0.05) in metal concentrations downstream of the outflow suggesting a dynamic sediment bedload during moderate storm events.

32.
MAGNETIC PROPERTIES AS INDICATORS OF ALEWIFE POPULATION CHANGE

Michael Oleskewicz ‘13
Faculty Sponsors: Christoph Geiss, David Post, Derek West, Yale University

Alewives are anadromous fish that live primarily in the ocean and migrate inland to breed in fresh water. Over the past few decades, alewife populations have been declining in Connecticut, and Bride Lake is one of the few sites in the state where they can still be found in relatively large numbers. In collaboration with Yale University, this study characterizes the magnetic properties of Bride Lake sediments. We would like to know whether changes in alewife population size (as estimated from variation in nitrogen isotopic ratios) have had a geochemical effect on the lake environment. We measured several properties to characterize the magnetic component of the sediment. Variations in magnetic susceptibility (κ) were used to determine the relative depths of five partially overlapping sediment cores. Magnetic remanence parameters (ARM and IRM) were used to characterize the ferrimagnetic mineral component of the core. κ, ARM and IRM all show higher values for the core top than for lower areas. ARM – ratios (ARM/IRM) suggest that the magnetic minerals in older sediment are mostly fine-grained. S-ratios indicate variations in magnetic mineralogy. S-ratios display a correlation between sediment magnetic properties and the magnitude of Alewife runs (shown by variations in d15N). Bride Lake data was collected in the spring, and summer research explored sediment from Uncas Pond, a landlocked body of water where alewives cannot migrate. Differences in magnetic trends between the two data sets may therefore be attributed to the variation of alewife runs in Bride Lake. When compared, both d15N and magnetic values were found to have less variation in Uncas Pond. Future research will provide more insight into the history of alewife populations in prehistoric times as well as the processes that link alewives to sediment magnetic properties in CT lakes.

33.
SYNERGISM AND ANTAGONISM IN TOXICITY OF MIXTURES OF PHARMACEUTICALS TO *DAPHNIA MAGNA*

Pooja Shakya ‘11, Richard S. Kim‘13
Faculty Sponsor: Alison J. Draper

Pharmaceuticals escape wastewater treatment and contaminate aquatic environments; there is increasing concern about the exposure of aquatic organisms and the combined toxicity of this complex mixture of chemicals. Four human pharmaceuticals were chosen for this study: all are water-soluble and thus, complications of solvent effects are eliminated, and all are commonly used in the U.S. and have been detected in the aquatic environment. A 48-hour motility assay of <24 hour-old *Daphnia magna* neonates was used to examine the effects of a mixture of commonly-used pharmaceuticals. LC_{50} and NOAEL concentrations of propranolol, metoprolol, terbualine, and metformin were estimated. *Daphnia* were then exposed to all possible combinations of these drugs, all at their NOAEL concentration. Synergy and antagonism were observed in these mixtures. Metformin and metoprolol together (but not separately) were

synergistic with propranolol, additionally, terbutaline and propranolol were synergistic, but the addition of either metformin or metoprolol to the mixture antagonized the combined toxicity of the terbutaline/propranolol mix. None of these relationships would be predicted by the drugs' mechanism of action in humans. Frequent use of pharmaceuticals by consumers coupled with imperfect methods of wastewater treatment will likely increase pharmaceutical residue in the aquatic environment. Future experiments will be aimed at determining the mechanism of drug interactions observed in this study.

NEUROSCIENCE

34.

CONTRASTING EFFECTS OF A KETOGENIC DIET ON SEVERAL CHARACTERISTICS OF INFLAMMATION

Joshua H. Altschuler '13
Faculty Sponsor: Susan Masino

Inflammation is characterized by blood vessel dilation, fluid movement from across blood vessel walls, and white blood cell infiltration. We had hypothesized that the ketogenic diet (a very-low carbohydrate diet used to treat epilepsy) would have beneficial effects on inflammation. In initial experiments, we found that the ketogenic diet reduced swelling and fluid movement in experimentally-induced inflammation in rats (Ruskin et al. 2009, PLoS One). The present study extended this work to examine white blood cell infiltration. We injected two groups of rats, one on a ketogenic diet, and another on a typical rat pellet diet, with CFA (an inflammatory agent) into one hindpaw. After two days, paws were weighed, inflamed tissue was frozen, crushed, and dispersed in buffer. An enzyme assay for myeloperoxidase was performed on aliquots of this solution; myeloperoxidase is an enzyme present only in white blood cells (specifically, neutrophils). Replicating our prior study, ketogenic diet treatment reduced paw swelling. Yet, in the same tissue, ketogenic diet treatment also increased white blood cell infiltration. Therefore, the ketogenic diet unexpectedly has contrasting effects on different characteristics of inflammation. This pattern of effects might help inform us as to the mechanism(s) of the beneficial aspects of this diet, which remain speculative.

35.

EFFECTS OF A KETOGENIC DIET ON WEIGHT MAINTENANCE AND LIFESPAN OF R6/2 HUNTINGTON'S DISEASE TRANSGENIC MICE

Joshua H. Altschuler '13, Jess Cote '12, Rachel Riendeau '12, Jessie Ross '10, Tracey Suter '11, Julia Svedova '11
Faculty Sponsors: Susan Masino, David Ruskin

A ketogenic diet is a restricted diet that is high in fats and very low in carbohydrates. It is used clinically to treat epilepsy and has been found to be beneficial in several animal models of neurodegenerative diseases. Huntington's disease is an inherited fatal neurodegenerative disease caused by expansion of CAG polyglutamine repeats in the *huntingtin* gene. At disease onset, persons with Huntington's experience many symptoms, including weight loss and deterioration of cognitive and motor skills; their lifespan is shortened significantly. Here we tested the effects of a ketogenic diet in a transgenic mouse model of Huntington's disease (R6/2) to determine

whether the diet improves weight maintenance and longevity. Both R6/2 and control mice were placed on either a ketogenic or standard diet at 6 weeks of age and weighed twice weekly. For each mouse the date of natural death was recorded. We found that body weight was maintained by R6/2 mice on the ketogenic diet markedly longer than R6/2 mice on the standard diet (an additional 4.0 weeks for females and 2.5 weeks for males). In parallel, male and female control mice on the ketogenic diet gained weight at a faster rate than those on the control diet. While the ketogenic diet improved weight maintenance, in this study it did not improve longevity. There was a slight trend for females on the ketogenic diet to live longer than those on the standard diet, but the effect was not significant. These results suggest that the ketogenic diet helps maintain weight in an animal model of Huntington's. This finding is contrary to some ketogenic diet research, which cites caloric restriction as a key mechanism for improvement in animal models of neurodegenerative diseases. Separate analyses of effects of the ketogenic diet on cognitive and motor skills in R6/2 mice continue in a parallel study. In general, metabolic therapy such as a ketogenic diet may be useful in alleviating some symptoms of Huntington's disease. Supported by CHDI, NIH and Trinity College.

36.
MUSIC OR NOISE?
Elsie Arce '12
Faculty Sponsor: Dan Lloyd

Some argue that not everything is music, more specifically, noise is not music. Others, such as John Cage, argue that "there is no noise, only sound". In my lab this summer, we worked to compare the properties of music with the activity of the brain to see if the brain exhibited any musical properties. My project focuses specifically on whether or not people can tell that brain music is from brains and random music from random sounds. I had 15 participants listen to various clips of random sound and brains and found that the majority of the participants could differentiate between the brain and random sounds. This shows that brain activity is closely related to music, if not music itself.

37.
THE PREVALENCE OF MENTAL ILLNESS IN VARIOUS STAGES OF HOMELESSNESS
Ethiopia Kabtimer '13, Marta Zamroziewicz '13
Faculty Sponsor: Sarah Raskin

According to estimates in 2004, 1,625 individuals and 1,267 households are homeless in the Hartford region at any point in time . For the purpose of this research study the adapted definition of homelessness is an urban lifestyle "characterized by the absence of permanent housing, supportive family bonds, and no defined roles of social utility and moral worth." By conducting a series of interviews and assessments with 10 homeless individuals, the existence of alcohol and substance abuse (past or present), existence of brain injury (past or present), cognitive abilities, and finally the psychological health of these individuals were evaluated. A one-way analysis of variance indicated that there was a significant difference in reported psychiatric disorders between people in different kinds of homeless situations (i.e., street people or those subsisting in emergency shelters, those residing in transitional living facilities, and those

situated in subsidized apartments). These results are consistent with prior reports of the link between homelessness and the presence of psychiatric illness.

38.

PERFORMANCE OF CHILDREN ON THE MEMORY FOR INTENTIONS SCREENING TEST FOR YOUTH (MISTY)

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

One-hundred and sixteen children, between the ages of four and fifteen, were administered the Memory for Intentions Screening Test for Youth (MISTY), a novel test of prospective memory (ProM) based on the Memory for Intentions Screening Test (MIST; Raskin, 2009). The MISTY includes ProM measures that differ in time delay between instructions and response (two versus ten minutes), cue type (event-based versus time-based), and response type (verbal versus action). Overall, participants performed better on event-based than on time-based cues, and better on two- than on ten-minute delays. There were no overall differences between performance on verbal compared with action responses. Participants were divided into five age groups (five to six; seven to eight; nine to ten; eleven to twelve, and thirteen to fourteen years of age). Children ages 5 to 6 performed significantly more poorly on all ProM measures than all other groups, suggesting a large increase in ProM development around age 7. As age increased, performance on various stages of ProM improved. Younger children (five through ten years old) performed significantly better on shorter time delays than longer delays and on event-based cues than time-based cues. In the older groups there were fewer differences, with 11-12 year olds performing better on shorter delays but not differing on cue type or response type and 13-14 year olds not differing on any measure. There were no differences in any group’s performance depending on whether the response was verbal or action. Regarding the ongoing task, the youngest group performed most poorly, suggesting that their poor ProM performance was not due to focusing on the ongoing task instead. There were no gender or ethnicity differences. The results suggest that further studies that expand the age boundaries may provide further insight into the ages at which the different stages of prospective memory develop.

39.

MUSICAL PROPERTIES OF THE BRAIN

Oladayo Oyedele ‘11
Faculty Sponsor: Dan Lloyd

Specialized neural networks have been identified for processing music and language in the brain. A new method of cognitive research uses music to identify various forms of cognitive activity. Human cognition and attention can be reduced to variables and patterns representing temporal perception. Similarly, all forms of music carry properties of temporal and mathematical organization. Musical components can be used to represent neural activity, revealing aspects of cognition outside of visual boundaries such as functional Magnetic Resonance Imaging (fMRI). Using a rhythmical approach for cognition can be characterized by time intervals representing events in space and time (London, 2004). Rather than studying neural activity while performing a specific task, this study utilized images from patients in the resting state (rfMRI). The state allowed us to study cognition without the interference of motor and sensory tasks. Essentially,

correlation between the mind and music was the topic of interest. Is the mind a form of music? What can this music tell us about functionality in neural pathways and the mind as a whole?

40.

URIC ACID MANIPULATION AND CELL DIFFERENTIATION: NEUROPROTECTION AGAINST OXIDATIVE STRESS?

Lisa Pierce ʻ11
Faculty Sponsor: William Church

SH-SY5Y cell cultures were used to investigate the neuroprotective properties of uric acid in toxin-induced neurodegeneration. Additionally, the effect of differentiating these cells on toxicity was evaluated. Endogenous levels of uric acid, an antioxidant thought to be involved in the pathology of Parkinson's disease, were altered using xanthine oxidase inhibition by allopurinol treatments. Cells were treated with 0.5mM rotenone for 24 hours. Live Cell/Dead Cell assays were performed to evaluate the viability of the cells from each treatment group and assess the effect of altered uric acid levels on cell survival. The importance of using differentiated versus undifferentiated SH-SY5Y cells in neurotoxicity studies is controversial. Retinoic acid was used to differentiate cells prior to uric acid level manipulations. It was found that retinoic acid induced a morphological change in the cells and altered the sensitivity of the cells to rotenone. The results of this research suggest that additional evaluation of the effects of differentiation on neurotoxicity susceptibility is needed.

41.

THE EFFECT OF ACUTE STRESS ON THE NEUROPLASTICITY OF NEONATALLY-ISOLATED RATS

Melike Sunay ʻ10, Kat Smith-Petersen ʻ11, Tashi Genden ʻ12, Ela Cross ʻ13
Faculty Sponsor: Harry Blaise

The basolateral amygdale (BLA), a region of the brain associated with stress response and emotional arousal, and the dentate gyrus (DG) of the hippocampus, associated with learning and memory, have been shown to be connected synaptically creating a linkage between brain activity subserving memory and emotion. To investigate this link, the effect of acute stress on the hippocampus and amygdala in neonatal rats were studied through measurements of long-term potentiation (LTP) in neonatally stressed and non-stressed rats. LTP—an increase in the strength of the synapse between connected neurons—has been shown to play an important role in the formation of memories and associations. We studied two groups of rats: an experimental group (ISO) which was isolated from their mother and siblings for one hour daily from days 2 to 9 of life; and a control group (NH) which was not isolated or handled by humans. Once both groups of rats matured to adulthood (70-120 days old), stimulating electrodes were implanted into the basolateral amygdala and recording electrodes were implanted into the dentate gyrus during stereotaxic surgery under anesthesia. One week after the surgery, LTP was induced in the dentate gyrus through tetanization of the basolateral amygdala. Ninety minutes after LTP induction, rats of both groups were acutely stressed through the use of a movement-inhibiting restrainer for 30 minutes. Following application of the acute stressor isolated rats showed more highly enhanced LTP compared to rats of the control group. These results suggest acute stress results in markedly

altered synaptic response patterns in the brain and appear to confirm stress-induced differences in behavior observed in both animal and human clinical studies.

42.
DETERMINING THE ONSET AND EFFICACY OF A KETOGENIC DIET AS A HYPOALGESIC AGENT
Tracey Suter ‘11
Faculty Sponsor: Susan Masino

A ketogenic diet is a high fat, low carbohydrate therapy commonly used to treat pediatric epilepsy. When fed this type of diet, the body metabolizes ketones as the main source of energy rather than glucose. Based on several hypotheses (including increased central adenosine, fewer free radicals and fewer reactive oxygen species) ketone metabolism would be predicted to reduce pain and inflammation. This prediction was validated in a recent study by Ruskin *et al.* (2009, *PLoS ONE*), where it was shown that maintaining a ketogenic diet for 3-4 weeks reduced pain (hypoalgesia) and peripheral inflammation. The aim of the current research was to determine the time course of the development of hypoalgesia. Young rats were fed either a ketogenic diet or a control diet after weaning (3 weeks old) for varying times (up to 4 weeks) and placed on a warm plate; hypoalgesia is expressed as a significant increase in the time that the animals stand on the warm plate. Behavioral testing of hypoalgesia was paired with measurements of whole blood glucose and ketone levels during the same time period. We found a gradual increase in ketogenic diet-induced hypoalgesia, comparable to its time course in treating epilepsy. These results suggest there may be similar complex metabolic and physiological mechanisms underlying the ketogenic diet’s success in reducing pain and treating epilepsy. Supported by NIH, NSF and Trinity College.

43.
EFFECTS OF THE KETOGENIC DIET ON SYMPTOMS OF AUTISM IN BTBR+Ttf/J MICE: METHODOLOGY
Julia Svedova ‘11
Faculty Sponsors: Susan Masino, David Ruskin

The ketogenic diet (KD) is a restrictive diet high in fats and low in carbohydrates and proteins that significantly reduces frequency of seizures in epilepsy. There is some evidence that the KD may also have positive effects on aspects of behavior, cognition, and autistic behavior. In particular, studies have showed that a long-term treatment of epilepsy with the KD can also cause improvements in behavior and symptoms of autism in children (Pulsifer et al. 2001, Evangeliou et al. 2003). In addition, animal studies demonstrated that the diet may act as an antidepressant and it may be beneficial in suppressing symptoms of Rett syndrome (a type of autism) in rodents (Murphy et al. 2004, Mantis 2009). However, due the limited number of studies, it is not completely understood whether the KD improves behavior and symptoms of autism. Moreover, to our knowledge, there has been no study that would investigate the effects of the diet on autistic behavior in mice. We are proposing a study that would illuminate how a long-term treatment with the KD changes behavior in BTBR T+tf/J model of mice, which imitates symptoms of autism. Using this model and a control group of mice, we will focus on

three behavioral tasks testing the three major symptoms of autism: communication (the social transmission of food preference test), sociability (three-chambered sociability test), and repetitive behavior (the self-grooming test and the marble burying task).

44.

NOTE INTERVALS IN THE BRAIN

Amelia Wattenberger ʻ11
Faculty Sponsor: Dan Lloyd

Brain activity has been found to mirror many musical properties -- this study compared the size distribution and directionality of intervals between successive notes in music and between successive levels of brain activity in fMRI data. Brain data was compacted into 20 components, which were then transformed into a musical format and processed in the MIDI toolbox. A comprehensive library of MIDI music was collected from the web and similarly processed. Both the music and the brain data were found to have significantly more large, positive and small, negative intervals. They also both had significantly more relatively small than relatively large intervals. However, the BOLD response measured by fMRI machines has also been found to have these properties. The brain data reinforced the "brain activity is like music" metaphor, but further research is necessary to determine whether the results are simply a property of the hemodynamic response.

PSYCHOLOGY

45.

VISUAL PERCEPTION OF A POINT LIGHT FIGURE BALANCING AN INVERTED PENDULUM

Shraddha Basnyat ‘13, Chislon Richardson ‘13, Austin Tewksbury ‘13
Faculty Sponsor: William M. Mace

In the early 1970s, Gunnar Johansson discovered that ten to twelve bright spots representing the motion of body joints, called a point light display, could provide compelling visual information of a person walking, running, dancing, or performing a number of activities. Extensive research on haptics has revealed a number of properties of wielded objects, like sticks, that can be detected without vision. We selected a stick-balancing task to see what aspects of a stick could be revealed in the point-light format. This study sought to discover whether an observer could extract sufficient information to estimate the length of a stick balanced by an actor in a point-light display. An actor was filmed balancing five sticks ranging from 24 to 48 inches in length. JPEG images were created from these videos using iMovie HD; these images were converted to point-light displays using original Java programs. Five websites were created for different random orders of 10 displays per stick (50 total). Observers were each assigned a website and asked to estimate the length of the stick balanced. The observers were informed that the sticks were less than 60 inches in length. The estimates of two out of ten observers showed a systematic estimation of the stick lengths, one of which was in the positive direction. This result showed that the information was in fact there but quite subtle.

46.

A QUALITATIVE ANALYSIS OF FIRST-YEAR MENTORS' EXPECTATIONS AND EXPERIENCES MENTORING FIRST-YEAR STUDENTS

Geraldine Fernandez '12
Faculty Sponsor: Laura Holt

The transition from high school to college may be overwhelming for first-year students, who must devise adjustment and coping strategies in order to successfully integrate into the college environment. In an effort to support students during this transition time and decrease attrition rates, an estimated 85% of higher education institutions in the United States offer some type of supportive programming for first-year students. One specific way in which colleges/universities may support first-year students is by proving them with a mentor (i.e., faculty members, upperclassmen) to assist them with the transition. Despite the vast amount of research aimed at exploring the structure of such programs and their efficacy, very little research has considered the characteristics, expectations and perspectives of mentors as constituents of the mentoring relationship and its possible outcomes. The present study used qualitative research methods to uncover common themes in mentors' reports of their expectations and experiences as first-year mentors at Trinity College. The results revealed a consensus amongst mentors regarding their experiences and expectations. Prior to serving in their role as a mentor, mentors appeared to have a solid understanding of the roles of mentors but seemed to lack awareness on possible challenges they might encounter while mentoring. Mentors reported providing their mentees with more academic and less social help, thus seemingly taking on more of the role of a tutor than of a mentor. As a result, clarifications and distinctions between the role of mentors and tutors should be made in the future in order to establish a clearer framework and enhance the role of the mentor.