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Summer 2011 Research Symposium Abstract Book

Trinity College

SEVENTH ANNUAL
SUMMER RESEARCH SYMPOSIUM
TRINITY COLLEGE

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BIOLOGY

1.

A NEW GENUS AND SPECIES FROM THE NORTH ATLANTIC, *ARCHESTENOGRAMMA PROFUNDUM* (PHYLLOPHORACEAE, RHODOPHYTA), WITH TAXONOMIC RESOLUTION OF THE ORPHANED *LEPTOFAUCHEA BRASILIENSIS*

Tayoot Chengsupanimit '14, Craig W. Schneider, Gary W. Saunders
Faculty Sponsors: Craig W. Schneider, Gary W. Saunders (Centre for Environmental & Molecular Algal Research, University of New Brunswick)

A recent collection of a red alga from Bermuda showed great similarities to *Leptofauchea brasiliensis* from Brazil, providing the impetus for a morphological and anatomical evaluation of the two. Based on these studies, the two appear to be congeneric. Molecular phylogenetic analyses of the Bermudian plants showed them to be to be a new genus and species of the Phyllophoraceae (Gigartinales), *Archestenogramma profundum*. In light of our anatomical observations, our phylogenetic results also proved instructive as to the disposition of *L. brasiliensis*, a species that was suggested to be incorrectly assigned to the Rhodymeniales for over a quarter of a century and even recently excluded from *Leptofauchea*. The morphological and anatomical similarity of *L. brasiliensis* to *A. profundum* suggested its movement from the Faucheaceae to a new taxonomic placement in the Phyllophoraceae, as *A. brasiliense*, comb. nov.

2.

THE EVOLUTION OF GARTER SNAKE, *THAMNOPHIS SIRTALIS* AND *T. ORDINOIDES*, PLACENTAL MEMBRANES THROUGHOUT GESTATION

Jessica Chin '12
Faculty Sponsor: Daniel Blackburn

While most lizards and snakes lay eggs, about 20% of these species give birth to live young, which is known as viviparity. Viviparous reptile species possess placentas, which serve to sustain their embryos by providing a link between mother and embryo for nutrients and gas exchange. My research focuses on two species of the garter snake, *Thamnophis sirtalis* and *T. ordinoides*, both of which are live-bearing species. My research uses light microscopy to analyze the form and function of the garter snake's placental membranes over its gestational period. Thus far, I have chronicled the stages of garter snake gestation, embedded samples, and begun to create a series of microscope slides to stain. In the future, I hope to have a series large enough to show how the garter snake's placental membranes have changed over the course of development.

3.

AN EXAMINATION OF THE EFFECTS OF SMOKING ON BACTERIAL COMMUNITIES OF THE UPPER RESPIRATORY TRACT

Tiffany Damiani ‘12, Kelly O’Brien ‘12
Faculty Sponsor: Lisa-Anne Foster

Bacterial communities and their hosts are associated in a complex symbiotic relationship. The normal flora of the human body colonize various sites, adhering to tissues; consequently assisting in the function of the host. Colonization may reduce the host’s susceptibility to disease through a variety of protective factors. The normal flora, more specifically, α-hemolytic strains of Streptococci, are known to block attachment sites of pathogenic bacteria, compete with pathogens for resources, and produce toxins. It is hypothesized that an inverse relationship exists between systemic disease and populations of normal flora. Behaviors such as smoking and alcohol consumption in addition to health conditions such as asthma may cause disruptions in the normal flora. This alteration of the microbiota may adversely affect the host, allowing pathogens to invade healthy cells. This preliminary study investigates the effects of smoking on the composition of the bacterial communities of the upper respiratory tract. Terminal restriction fragment length polymorphism (tRFLP) was used to examine and determine the composition of bacteria of interest in oropharyngeal samples. Samples were collected with basic health status surveys from student volunteers at Trinity College. The surveys were examined to illuminate any health factors that may affect the bacterial composition. The tRFLP profiles of smokers had significantly fewer peaks than those of non-smokers, correlating to the presence of fewer bacterial species in smokers than in non-smokers. This data indicates that smoking limits the microbial diversity in the upper respiratory tract. A database of tRFLP profiles produced by known pathogens and known normal flora was constructed to use as a means of identifying bacteria of interest within an unknown oropharyngeal sample in future studies.

4.

ONTOGENY OF NEURONAL CELL SIZE AND NUMBER IN THE CHINESE MUD SNAIL, *CIPANGOPALUDINA CHINESIS*

Amy Hackett ‘14
Faculty Sponsor: Chris Swart

The class of gastropoda contains from 40,000 to 100,000 species of marine and terrestrial snails and slugs. The central nervous system has been studied in very few of these species however these few species have served as important model organisms in physiology and neuroscience studies. Based on the limited sample available it has been suggested that all gastropods follow one of two ontogentic trajectories – possessing very small neurons that increase in number as the animal gets larger or developing a nervous system with a relatively fixed number of neurons that become larger as the animal grows. While this is likely a false dichotomy additional species must be described to support the more likely scenario of variation between and across both conditions. While the gastropods with fewer but larger neurons have been popular and valuable models in neurophysiology research the many celled but small celled gastropod nervous sytem is likely a better model of vertebrate nervous systems and warrant additional investigation. Herein we describe the ontogenetic trajectory in neuronal number and size in the cerebral ganglion of

the Chinese Mud Snail, *Cipangopaludina chinensis*. Our data indicates that this species exhibits the "many large" neuron scenario with a twist: our data supports the idea that this animal is a protandrous hermaphrodite; transitioning from males as young adults to females as the become larger.

5.

CHARACTERIZING THE GROWTH ZONE IN *ARTEMIA* BY ANALYZING CELL DYNAMICS AND GENE EXPRESSION

Lorena Lazo de la Vega '14
Faculty Sponsor: Terri Williams

Our current knowledge of the development of segments in the phylum Arthropoda is mainly based on *Drosophila*, while our knowledge of other species is very limited. However, Drosophila forms all of its segments simultaneously, while most other arthropods form them sequentially in a region called the growth zone. The lab is using two crustaceans, *Artemia* and *Thamnocephalus*, and an insect, *Tribolium*, to analyze cell dynamics and gene regulation in the growth zone. Because segmentation from a growth zone is poorly understood, one of our first goals is to describe normal development of the growth zone in the crustaceans, *Artemia* and *Thamnocephalus*. We hypothesized that the growth zone in *Artemia* will stay the same size due to their sequential segmentation and because cell mitosis appears to play a large role in segment development. The animals were stained with an antibody to the segmentation gene, engrailed, and used to measure various features of the growth zone. The size of the growth zone in *Artemia* stayed constant while it decreased in *Thamnocephalus*. Although *Thamnocephalus* and *Artemia* are more closely related, the data showed that the growth zone in *Thamnocephalus* and the *Tribolium* embryos are similar since both decrease in size. We are now beginning to explore the location and function of cell division within the growth zone using BrdU and Hydroxyurea exposure data.

6.

ANIMAL VISITATION TO COMPOST PILES

Elle Lucadamo '12, Daniel Carlozzi '13, Sadichhya Adhikari '14, Bridget Tevnan '14
Faculty Sponsor: Scott Smedley

Backyard compost piles are a common, environmentally sound method of food waste disposal in suburban and rural areas. It has long been claimed that the addition of animal-based kitchen scraps (e.g., animal tissue, eggshells, and dairy products) to compost may increase wildlife visitation; however, this idea has not been tested. Our study provides such a test. Beginning in 2008 in Andover, Connecticut, seasonal replicates have been conducted in which three types of compost piles [vegetable products only (VEG), vegetable and animal product mix (MIX), and control (CON)] have been monitored using heat-motion sensitive cameras to record wildlife visitors. We here report findings from the autumn replicate from 2010 (R9). In R9 significantly more wildlife in general was attracted to the MIX pile than the VEG or CON piles, while no preference was seen between the VEG and CON piles. Of the most frequent visitors in R9, the American crow, opossum, and domestic dog displayed a preference for the MIX pile, while the

gray fox and raccoon showed no preference for pile type, and the gray squirrel showed a preference for the CON pile. Animals in the two previous fall replicates (R3 and R6) also displayed a significant preference for the MIX pile, however, in R3 wildlife visitors significantly preferred the CON pile to the VEG pile (atypical compared to replicates from other seasons), while in R6 the VEG pile was preferred to the CON pile (typical). It appears that overall visitation trends in the autumn are largely influenced by nut caching by gray squirrels in the CON pile. This behavior may vary between years, corresponding with annual variation in acorn production.

7.

EXPLORING SERRATE-NOTCH INTERACTIONS WITH SERRATE LIGAND MUTATIONS

Connor McElligott ‘14, Geoff Kwok ‘14
Faculty Sponsor: Robert Fleming

We have studied the Notch-signaling pathway where cellular signals are generated via interactions between the Notch receptor and the Serrate ligand. Notch is a receptor that when activated causes a series of catalytic reactions that ultimately affect the wing and many other aspects of development in fruit flies. The Serrate ligand has the ability to activate or inhibit the Notch protein receptor. Notch will only be activated if a Serrate ligand is expressed on an adjacent cell and comes into contact with the receptor. Notch can also be inhibited if Serrate is expressed on the cell receiving the signal. Our goal was to examine specific portions of the Serrate ligand to more completely characterize the portion of Serrate that mediates Notch inhibition. Serrate is made up of 14 EGF like repeats along with a DSL region and an intracellular domain. The Serrate segment from the N-terminus through repeat 6 has been found to have an inhibitory effect on Notch whereas repeats 7-14 have no ascribed function in either notch activation or inhibition. When repeat four, five, or six is individually removed, Serrate loses its inhibitory effect. Our goals were to remove repeats four, five, and six together to see if Serrate still loses the inhibitory effect. Additionally, we are moving these same repeats in between repeats 11 and 12 to establish if location is important for the activation or inhibition of Notch. In a different project, a minigene was constructed where repeats 7-14 were removed resulting in a mutated Serrate form that only exhibits the ability to inhibit Notch.

8.

THE EFFECTS OF THAPSIGARGIN, DTT, AND TUNICAMYCIN ON OLIGODENDROCYTE VIABILITY IN ENRICHED CULTURES

John McInnis III ‘12
Faculty Sponsor: Hebe Guardiola-Diaz

If cells are unable to resolve ER stress through the unfolded protein response, they will undergo apoptosis. Thapsigargin, DTT and Tunicamycin have all been shown to induce ER stress in vitro. Due to their high protein production load oligodendrocytes are particularly vulnerable to ER stress, which has practical implications for diseases such as multiple sclerosis and multiple system atrophy. In order to study ER stress, it was necessary to study the effects of each drug on

oligodendrocyte survival. This was done by creating time course exposures and dosage response curves for the effects of all three drugs on oligodendrocyte progenitors (OLPs) and mature oligodendrocytes (MOLs). Cell viability was assessed by Alamar Blue (AB) assay. There was a time and concentration dependant reduction in cell viability in response to the three drugs in both MOLs and OLPs. As was expected, the reduction in viability was more pronounced OLPs. Based on these results, the ideal concentrations for inducing ER stress are 2.0ug/ml of Tunicamycin, 100nM of Thapsigargin and 200uM of DTT. These concentrations are in agreement with those used throughout the scientific literature. This information will guide our future study of the effects of ER stress on the AKT/mTOR pathway in oligodendrocytes.

9.

SUBSTRATE SPECIFICITY AND PH RESPONSE OF THE CHOLINESTERASE IN THE CNS OF THE CHINESE MUD SNAIL, *BELLAMYA CHINENSIS*

Lisa Saa ‘14
Faculty Sponsor: Chris Swart

Cholinesterases are present throughout the body. In muscle and the central nervous system (CNS), the predominant cholinesterase is acetylcholinesterase (AChE) whereas it is butryl cholinesterase in the blood or hemolymph. Vertebrates and invertebrates possess both kinds of cholinesterases. There is variation in substrate specificity from taxa to taxa for both enzyme classes. Determination of substrate specificity and pH response for AChE from the CNS of *Bellamya chinensis* was determined using the three most commonly tested substrates: acetylthiocholine iodide (ACTI), butyrylthiocholine iodide (BTCI), and propionyl thiocholine iodide (PTCI). The results showed that the AChE from the CNS of the *Bellamya chinensis* has an optimum activity at pH 8.5 and greatest affinity for PTCI, followed by BTCI, and finally, ATCI.

10.

AGGRESSIVE SIGNALING OF ELECTRIC FISH IN SOCIAL GROUPS: EFFECT OF SPECTRAL CONTENT, AMPLITUDE, AND ELECTROTAXIS

Lorenzo Sewanan ‘12
Faculty Sponsor: Kent Dunlap

Aggressive signaling in the electric fish Apternotus leptorhynchus has frequently been studied during dyadic interactions in the lab, in which fish are highly aggressive and commonly injure each other. Yet under field conditions and in captive social groups, fish are relatively non-aggressive and even prefer affiliation to isolation. What about social groups inhibits aggression? To better understand the behavior of fish to such complex living environments, we examined the production of chirps, a common aggressive electric signal, when fish were exposed to stimuli that mimicked those found in social groups. We first demonstrated that fish chirped less in the presence of two fish than with a single fish. Fish were then presented with 1) a simple sine wave electrical stimulus that mimicked the electric discharge of a single fish or 2) a composite sine wave stimulus that mimicked the discharge of two fish. When the mean amplitudes of stimuli were held constant, fish chirped less to the composite signal than the simple signal, indicating that the complex spectral content of a composite signal inhibits chirping. When the composite

signal was twice the amplitude of the simple signal and fish were confined near the stimulus, fish chirped more to the composite signal than the simple signal, indicating that the higher amplitude created by multiple fish stimulates chirping. However, free swimming fish showed more electrotaxis to simple signals than composite signals, indicating that the ways fish distribute spatially may contribute to the reduction of aggression in social groups.

CHEMISTRY

11.
SYNTHESIS OF DI-TERT-BUTYL ALLYL MALONATE
Lauren Aber '13
Faculty Sponsor: Richard Prigodich

The focus of this project is to find a new method of synthesizing a modified amino acid, gamma-carboxyglutamic acid. Different bases and solvents were used along with varying molar equivalences of reagents and bases. The goal of this synthesis is to optimize the formation of the desired product without producing a side product. The reaction was run with Tetrahydrafuran (THF), Potassium Tert-butoxide, di-tert butyl malonate and allyl bromide to produce a small amount of product while Gas Chromatography-Mass Spectrum (GC-MS) was used to identify the components in the product. The process of making the modified amino acid was altered due to the presence of un-reacted starting reagent throughout the reaction. The reaction was run for varying amounts of time to determine if more di-tert-butyl malonate reacted over time, with differing conditions such as stirring vigorously at room temperature and refluxing. Refluxing the reaction did not show any decrease in the amount of un-reacted starting material. The reaction was run using Sodium hydroxide in THF then adding di-tert butyl malonate and allyl bromide after a specified amount of time. This method was found to react a greater amount of the starting reagent but was unreliable due to the reactivity of the Sodium hydroxide. The reaction is monitored by GC-MS and H1 NMR.

12.
DEVELOPMENT OF CALIBRATION CURVES FOR QUANTITATIVE ANALYSIS OF DIMETHYLTRYPTAMINE IN ORAL FLUID BY HS-SPME/GC-MS AND DEMONSTRATION OF DRUG DERIVATIZATION
Erika J. Adams '13
Faculty Sponsor: Janet F. Morrison

N,N-dimethyltryptamine (DMT) is a schedule I hallucinogen that is found in many plants but is also produced synthetically. Historically, DMT is used in a brew during religious ceremonies of many indigenous South American cultures; however, it has become increasingly popular among college students and young adults in recent years. In October of 2010, students at Georgetown University were arrested for operating a covert DMT manufacturing laboratory out of their dorm room.

The goal of the present study is to develop a reliable analytical method implementing headspace solid-phase microextraction (HS-SPME) and gas chromatography-mass spectrometry (GC-MS) for laboratory confirmation of DMT in oral fluid (saliva). Oral fluid sampling is the sampling method of choice because it provides a quick and noninvasive way to determine whether a person was under the influence of drugs at the time the sample was collected. Test kits for oral fluid sampling based mainly on immunoassay have been developed for roadside screening of a variety of drugs. The results of these 'on-site' tests are considered preliminary and require laboratory confirmation for forensic defensibility.

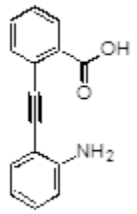
Results of internal standard calibration curve data designed to quantify DMT in oral fluid samples will be presented. 5-Methoxy-dimethyltryptamine was investigated as an internal standard. Derivatization, both in-vial and on-fiber, of DMT was investigated. It was observed that the sample matrix has a profound effect on DMT recoveries by SPME; the influence of solvent, and the presence or absence of salt and KOH will be discussed.

13.

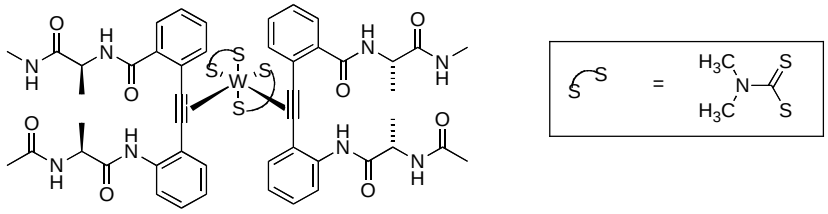
COORDINATION OF A PEPTIDE β-TURN MIMETIC TO TUNGSTEN: POSSIBLE APPLICATIONS FOR THE STUDY OF β-SHEETS

Adam N. Boynton '12
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 

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

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14.

LIGHT CATALYSED REACTIONS AT THE LIQUID-VAPOR INTERFACE IN CHLOROIODOMETHANE SOLUTION

Andy Delgadillo ‘13, Christina McGuire ‘13, William Tyler Nebel ‘14
Faculty Sponsor: Maria Krisch

Photochemistry is largely responsible for the dissociation of many halogenated organics in ocean water and in atmospheric aerosols. This can lead to the production of ozone depleting compounds. Research suggests that there is a difference in the photochemistry of bulk solutions versus at the liquid-vapor interface. Using a droplet train apparatus to create aerosols, our goal was to examine the effect of photochemical reactions on chloroiodomethane (CH2ICl). By varying droplet size, solution concentration, and exposing each aerosol droplet to an ultraviolet (UV) Pen-ray lamp we collected samples to analyze via gas chromatography mass-spectrometry. We looked to see whether there was a greater decrease of CH2ICl in smaller droplets than in larger ones, in accordance with theories about photochemical reactions at the liquid-vapor interface versus in bulk solution. However, our results thus far are inconclusive due to the variability in replicates. In the future we will introduce sodium chloride (NaCl) to the aqueous CH2ICl solutions, in order to determine whether putting the CH2ICl in a saline environment will produce more conclusive results. There are also plans to increase light exposure by using a 266 nm ultraviolet laser.

15.

STUDYING THE THREE-DIMENSIONAL STRUCTURE OF MALTOSE BINDING PROTEINS

Madeleine Hardy ‘12
Faculty Sponsor: Richard Prigodich

The objective of this research project was to study the maltose binding protein Mal3 in the thermophilic bacterium Thermotoga maritime. This protein’s three-dimensional structure is to be determined so it can be compared to the other two classes of Mal proteins and provide insight to the evolution of this third class, Mal3 protein. This was achieved by purifying and concentrating Mal3 protein that were obtained from Rosetta line cells with plasmids that contained the Mal3

gene. The protein was crystallized from solutions varying in concentrations of magnesium chloride and PEG 8000 and were observed using x-ray diffraction analysis. Although successful crystals were made, they did not diffract well when analyzed.

16.

SYNTHESIS AND STRUCTURE ELUCIDATION OF TERNARY MIXED CALCIUM RUTHENIUM HYDRIDES/DEUTERIDES (Ca2RuHxD6-x) THROUGH POWDER X-RAY CRYSTALLOGRAPHY AND INFRARED SPECTROSCOPY

Pathik Khatri ‘13
Faculty Sponsor: Ralph O. Moyer

The purpose of this research was to synthesize ternary compounds of the formula Ca2RuHxD6-x in order to elucidate the structures and possible applications of the compounds. Due to the hydrogen storage capabilities of Ca2RuHxD6-x compounds, there are possible alternative fuel applications. The compounds were synthesized by solid state reactions of molar amounts of CaH2, CaD2, CaHD with ruthenium metal under either a hydrogen, deuterium, or deuterium hydride atmosphere at high temperatures to yield one of several combinations of Ca2RuHxD6-x (x: 0-6). The ternary compounds were ascertained to be a face-centered cubic lattice of the K2PtCl6 structure by use of Powder X-ray crystallography and Rietveld Refinement. The composition was characterized with Infrared Spectroscopy. The mechanism of the solid state reaction established that composition was influenced by reaction gas atmosphere. With compound structure, chemical properties of the ternary compound were discovered.

17.

ANALYSIS OF NMR EXPERIMENTS ON β-CYCLODEXTRIN AND FLUORESCEIN

Richard Kim ‘13
Faculty Sponsor: Richard Prigodich

β-cyclodextrin is a seven sugar cyclic molecule with a cone like structure with two openings. This structure is important to study due to the fact that this molecule can behave like a container in interactions with other molecules. A particular use of this characteristic of β-cyclodextrin is to bind to fluorescein and delay its retention time in capillary electrophoresis experiments. Fluorescein is a dye commonly used to track and label cells in fluorescence microscopy. It has hydrophilic ends that has the potential to interact with the hydrophilic parts of the β-cyclodextrin. Through a series of proton NMR experiments, the structures of β-cyclodextrin and fluorescein were first studied individually. A COSY NMR experiment of fluorescein was done to assign the proton spectrum peaks to the protons on fluorescein. Finally, a NOESY NMR experiment was done on a sample with a 1:1 mole ratio of β-cyclodextrin to fluorescein to analyze the proton to proton through space interactions in the respective molecules to discover how fluorescein may interact with β-cyclodextrin.

18.

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. Generally, organometallic reactions follow a 2-step process that must be performed under inert conditions in organic solvents. Such conditions are expensive, may lead product loss due to the two-pot system and can even be harmful to the environment.

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. Indium is our metal of choice due to its ability of promoting carbon-carbon bond formation while under benign or aqueous solvent conditions. Ultimately, we would like to develop a more efficient, environmentally friendly chemical process that mimics
the old-fashioned organometallic reactions.

19.

CONSTRAINED PEPTIDES CONSTRUCTED BY COORDINATION OF PROPARGYLCYSTEINES WITH TUNGSTEN

Thomas A. McTeague ‘12, Zephyr D. Dworsky ‘11
Faculty Sponsor: Timothy P. Curran

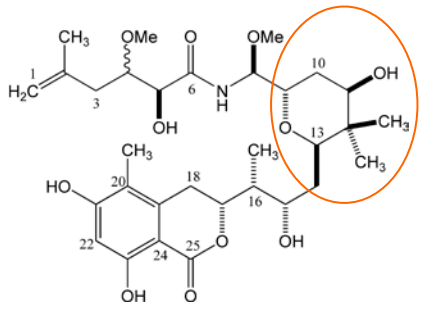
Ongoing work in our group is aimed at identifying and characterizing unique metal-ligand interactions that can be used to constrain peptides to specific secondary structures. One system that has been under active exploration is tungsten-alkyne coordination, since the tungsten can coordinate two alkyne ligands to produce an air-stable species. Alkynes are not found in the structures of the 20 common amino acids, so we have investigated the ability of synthetic, alkynylamino acids to coordinate to tungsten. In this presentation, the synthesis and coordination of peptides bearing two of these alkynylamino acids will be detailed. The resulting complexes are cyclic species that incorporate the tungsten in the ring - metallacyclicpeptides. In addition, the conformational analysis of these metallacyclicpeptides will be detailed. Finally, the ability of a pentapeptide bearing two propargylcysteines to form a metallacycle and to adopt an α-helical conformation will be presented.

20.
SYNTHESIS OF TETRAHYDROPURAN WITH THE ASSISTANCE OF KDPG ALDOLASE
Panida Pollawit ‘12
Faculty Sponsor: Timothy P. Curran, Jörg Pietruszka, Thomas Classen

The goal of this project was to synthesize tetrahydropuran (THP), a component of an anti-cancer toxin, psymberin **(1)**. In order to synthesize THP in a more efficient way, KDPG aldolase was planned for use in aiding the synthesis of THP. Previous research on the synthesis of psymberin in chemistry were successful but was too complicated for practical use. On the other hand, KDPG aldolases are very specific, they are only active in the presence of pyruvic acid and an aldehyde, which was one of the steps in the planned scheme. It would also be stereospecific, whereas a purely chemical approach would yield a racemic mixture. To purify the product, flash chromatography was used. Methods to analyze the compound included using ^{1}H-NMR and ^{13}C-NMR, and GC-MS, and TLC. Unfortunately, the substrate that was supposed to be provided to the aldolase could not be formed consistently due to the instability of aldehydes, so it was never introduced to the enzyme.

Tetrahydropuran

psymberin (**1**)



COMPUTER SCIENCE

21.
HAITI COMMODITY TRACKER MOBILE APPLICATION
Jason Baird ‘14, Megan Chiu ‘14, Xu Huang ‘14
Faculty Sponsors: Trishan de Lanerolle, Ralph Morelli

In order to monitor food shortages, the Acdi/Voca humanitarian organization in Haiti monitors food prices in local markets. Aid workers use this information to decide day-to-day or post-disaster food distribution across the region. Typically prices are recorded on paper. The information is then entered manually onto computers by food aid officials and then displayed via spreadsheets. This process is time-consuming and tedious. We developed the Haiti Commodity Tracker, a mobile app, to make this data gathering process more efficient and more accurate.

Agronomists go to several sites in the market and use the phone app to record commodity prices. Due to limited connectivity in rural Haiti, data is first saved to the phone’s database and then uploaded to a central server via text messaging (SMS).

Because the app is distributed under an open source license, it can be shared with other humanitarian agencies performing similar processes in Haiti and around the globe.

22.
FIELD GEOLOGIST
Jason Baird ‘14, Conan Huang ‘14, and Megan Chiu ‘14
Faculty Sponsors: Ralph Morelli, Trishan de Lanerolle, Jonathan Gourley

Field Geologist is an Android phone application developed with a Google app development kit named App Inventor. The app was developed to measure rock outcroppings, specifically two measurements called “dip” and “strike.” Dip is the steepest angle possible on the rock. measured down from ninety degrees, and strike is the compass heading ninety degrees to the left of that. All the user has to do to get these measurements is place the phone on the steepest part of the outcropping, at any rotation. The app records dip, strike, latitude, and longitude, and allows the user to choose or create a rock type. The main screen of the app shows a compass and measurements of dip, strike, latitude, and longitude. The compass shows the user the direction of north, and the direction of dip. When the user taps the compass, the app pulls up a rock selection screen, and records all the data about the current position. The second screen is a map that shows all points previously recorded, with dip markers pointing in the correct directions and numbers showing dip measurements. Users can create different sets of points, or “maps,” avoiding overlaps. Finally, all data can be uploaded to a server, then downloaded as a comma-separated values file, which can be opened in Microsoft Excel.

23.
TORSTATUS - A WEB APP THAT MONITORS THE TOR NETWORK
Vlad Burca ‘14, Diego Calderon ‘13 (Wesleyan University), Jeremy Fehr ‘13 (Wesleyan University)
Faculty Sponsors: Ralph Morelli, Norman Danner (Mathematics and Computer Science Department, Wesleyan University)

In an era where the privacy on the Internet is a major problem in computer security – your browsing can be traced, personal information is being posted all over the Web – Tor Network is meant to be an intermediate network between the user’s computer and the Internet. Its main purpose is to hide the computer’s identity (the IP address) when it goes out on the Web. TorStatus is a web application, created mainly for research purposes, that monitors the entire Tor Network, gathering information about all the Tor users. Originally being implemented in PHP, we refurbished it using Django, a Web framework that is based on Python. Some of its main advantages are the designer-friendly template system, the object-relational mapper and the cache system which helped us improving the loading speed of TorStatus. Therefore, we achieved great results not only in terms of loading speed (TorStatus being connected to a huge database of users), but also by creating a user-friendly interface which eases the research work.

24.
ARBITRARY INTEGER ARITHMETIC
Ben Hartung ‘12

Faculty Sponsor: Peter Yoon

Public-key encryption relies on the generation and multiplication of large integers. Accelerating basic arithmetic operations would allow the use of larger numbers for increased security. To this end, this project evaluates the implementation of two multiplication algorithms that attempt to take advantage of the Graphics Processing Unit's (GPU) ability to perform parallel computations efficiently. The first is the divide and conquer Karatsuba algorithm which recursively transforms multiplication operations into three smaller multiplication and two addition operations until the operands are small enough to efficiently multiply using the traditional n2 method where n is the number of digits. The second algorithm evaluated was the Schönhage-Strassen algorithm, which uses a Fast Fourier Transform (FFT) to treat each operand as a cyclic convolution that can be multiplied pointwise in a highly parallel operation. The implementation of the Karatsuba was found to be insufficiently parallel which resulted in no improvement over existing arbitrary arithmetic libraries such as the GNU Multi-Precision Library (GMP). In comparison the Schonhagge-Strassen's pointwise multiplication operations maps more naturally to a GPU, suggesting that further research into it will provide more favorable benchmarks relative to GMP.

25.

POSIT-HAITI: AN SMS-BASED OPEN SOURCE MOBILE APP TO ASSIST FOOD DISTRIBTION IN HAITI

Alexandre Zhang '14, Christopher Nobile '12, Nyi Htet '13, Sheena Elveus '12, Tina Lipson '14
Faculty Sponsors: Ralph Morelli, Trishan de Lanerolle, Rachel Foecking, ACDI/VOCA, USAID

Once a month in several remote locations throughout rural Southeastern Haiti, ACDI/VOCA holds distribution events during which food is given to over 10,000 pregnant mothers and mothers with infants. POSIT-Haiti is a mobile Android app that automates the data gathering and processing tasks aspects of such events, tasks that were previously done manually using paper forms. The app uses data entry fields to accept information from hundreds of beneficiaries and store it in its database. It then abbreviates that information and sends it via SMS messages to a central database in Jacmel. The app requires a username and password to access, and has normal, admin, and super user accounts. The app is localized into Haitian-Creole and French, the national languages of Haiti. POSIT-Haiti dramatically increases the speed at which new beneficiaries can be processed and their records updated, shrinking the time required from days and sometimes weeks to hours. In addition to designing and developing the app and the back-end server, a team of students from the Humanitarian Free and Open Source Software Project (HFOSS) traveled to Haiti in July to field test the app in remote rural regions of Haiti and train the ACDI/VOCA staff. With continued support from HFOSS, ACDI/VOCA is currently integrating the app into its daily operations.

ENGINEERING

26.

GENERALIZED PRESSURE MODEL OF THE RABBIT LEFT VENTRICLE

Andrei Marchidan ‘13, Ryan L. Zukus ‘11
Faculty Sponsor: Joseph L. Palladino, NASA CT Space Grant Consortium

A generalized pressure model was recently proposed as a comprehensive model to assess mechanical performance of the canine left ventricle [1]. This work describes the isolated rabbit left ventricle. Isovolumic pressure was measured on isolated hearts from four adult male rabbits (3.9 kg average weight). Hearts were perfused via external gas-exchange chamber, roller pump and environmental chamber, maintaining coronary pressure and oxygen supply. Coronary perfusion pressure was kept constant at 100 mmHg; typical perfusate values were pO2 > 500 mmHg, pCO2 = 37 mmHg, pH = 7.35; temp. maintained at 30° C. Ventricular volume was controlled by a linear motor-piston-cylinder system using PID control. Pressure was measured by catheter-tipped pressure transducer (Millar). Ventricular pressure pv was described as a function of time t, ventricular volume Vv, four model constants a,b,c and d, and an activation function f(t) [1]. This model is based on underlying muscle contraction mechanics. Model parameters a, b, c, and d were extracted from end-diastolic pressures and peak developed pressures, from a set of isovolumic pressure curves measured on each rabbit heart at different end-diastolic volumes. The generalized pressure model (eq. 1) is a compact functional description of the rabbit left ventricle’s ability to generate pressure. This model may be used as a functional block of more extensive cardiovascular models. The parameter c may emerge as a measure of the overall mechanical performance of an individual heart. Animal experiments measuring isobaric heart beats and rapid changes in ventricular volume during otherwise isovolumic beats have been performed and are being analyzed to further test this model’s ability to describe left ventricular dynamics of the rabbit heart.

References:

[1] Palladino, J.L., Noordergraaf, A.: Left ventricular model parameters and cardiac rate variability. Proc. 33rd Ann. Int. Conf. IEEE Engineering in Medicine and Biology Society, Boston, MA, in press, 2011.

27.

ESTIMATION OF GAZE LOCATION FOR POINT-OF-GAZE

Binay Poudel ‘12
Faculty Sponsor: Taikang Ning

Overall goal of the project Point-of-Gaze is to create a system that is capable of tracking the movement of eye to move computer pointer using eye instead of an actual mouse. An image-processing algorithm was developed and tested in MATLAB to estimate the gaze location. Instead of using corneal reflection produced by light source placed before eye, canthus of eye was used to detect the relative position of the center of pupil.

28.

THE IMAGE RECOGNITION TECHNIQUE THAT CAN SAVE HUMAN LABOR

Han Wu ‘13
Faculty Sponsor: Lin Cheng

The image recognition technique has always been a useful tool in image processing. Facial recognition, a most common kind, can already be found being used in digital cameras and security systems. However, the techniques for distinguishing other objects or animals have not been well explored. This research explored the way to recognize different kinds of animals and objects in all kinds of images. Methods from various sources are examined, implemented in Matlab and modified. Among all the ways examined, a way to recognize the ear bone in an ear image was found potentially useful though it does not work on every case. Also a way was found to separate the foreground and background of photos taken at animals’ natural habitat. The way may be further integrated later to finally draw a contour of the animals in the photo if there is any.

ENVIRONMENTAL SCIENCE

29.
ANALYSIS OF TOXICOLOGICAL EFFECTS OF PHARMACEUTICAL MIXTURES ON DAPHNIA MAGNA

Airelle A. James ‘14
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 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. LC50 and NOAEL concentrations of diclofenac, metformin, metoprolol and propranolol were estimated. Daphnia were then exposed to all possible combinations of these drugs, all at their NOAEL concentration. Synergy was observed in these mixtures. The interaction of metformin and metoprolol was also explored at concentrations around their LC50s using the classic method of mixture toxicity. Again, synergism was observed. This relationship would not 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.

30.
MAGNETIC ANALYSIS OF FLUVIAL SOILS MAY AID IN RECONSTRUCTION OF ETHIOPIAN PALEOENVIRONMENTS

Brittney M. Payton ‘12
Faculty Sponsors: Christoph Geiss, William C. Johnson (University of Kansas), Valery Terwilliger (Université François Rabelais de Tours)

Recent archaeological and palaeoclimate studies show that climatic shifts occurring during the Holocene may have impacted cultural evolution and played a role in settlement patterns. The history of the Tigray Plateau in the northern highlands of Ethiopia is characterized by a succession of different civilizations and thus makes it an ideal location for assessing these possible impacts. The magnetic properties of fluvial sediments from five soil profiles in study sites near the towns of Adi Kolen , Mai Maikden, and Adigrat were analyzed in an attempt to aid in the reconstruction of the regional palaeoenvironmental history. Measurements included magnetic susceptibility (c), anhysteretic remanent magnetization (ARM), isothermal remanent magnetization (IRM), S ratios, coercivity distributions of IRM, and hysteresis loops.

A comparison with nonmagnetic data shows that most palaeosol horizons do not show any signs of magnetic enhancement. Modern soils from sites AKIII, MMII, and ATI are characterized by increases in concentration parameters (increases in c, ARM, and IRM values) but grain-size dependent parameters indicate that the added ferrimagnetic minerals are coarse-grained (ARM-ratios decrease). Modern soils in all five sites are heavily disturbed and may be difficult to use for calibration of palaeosols.

For palaeosol horizons at AKIII (200-400 cm), however, magnetic properties (increases in c, ARM, IRM, and ARM ratios) indicate some degree of pedogenesis and some soils could be interpreted as magnetically enhanced. This possible magnetic enhancement occurs during a time period when non-magnetic indicators suggest higher rainfall, more fire, and vegetation change and may therefore be of importance for the cultural history of the region.

31.

POTENTIAL ICE AGE REMNANTS IN WINTERGREEN WOODS

Jess Smith ‘14, David Mallick ‘14
Faculty Sponsor: Christoph Geiss

Glacial Lake Hitchcock drained approximately 16,500 years ago and left a variety of glacial features across Connecticut. One such feature is called the pingo, a frost mound with a built up rim and mainly horizontal deposit of soil. Other glacial formations include palsas and lithalsas, which are similar to pingos yet they do not form a rim around their frost mounds. There is also a feature called liquefaction, which is not glacial in nature, but can form depressions similar to those formed by the remnants of frost mounds. A collection of small water filled deposits can be found at Wintergreen Woods in Wethersfield, CT where the nature of their formations lies shrouded in mystery. Ground penetrating radar was used to collect data in a field of small water filled deposits and analyzed to view the stratification of the subsurface, which determines the nature of formation. Soil core samples as well as elevation measurements were coupled with the GPR results to further identify the feature. It has been hypothesized that the small water filled deposits were most likely formed by pingo remnants.

NEUROSCIENCE

32.
CHARACTERIZATION OF SMN2 EXPRESSION IN SPINAL MUSCULAR ATROPHY iPS CELLS
Brian Castelluccio ‘12
Faculty Sponsors: Dhruv Sareen, Clive Svendsen (Regenerative Medicine Institute, Cedars-Sinai Medical Center, Los Angeles)

Spinal Muscular Atrophy (SMA) is an autosomal recessive pediatric neuromuscular disorder that leads to degeneration of lower motor neurons. This results in muscular atrophy, paralysis, and often death. SMA is caused by a lack of functionality of the SMN1 gene and resultant lack of SMN protein. In humans, the gene SMN2 is nearly identical to SMN1, yet it produces truncated, dysfunctional protein, denoted Δ7 SMN. Because SMN2 can produce only 10-30% full length SMN protein (FL SMN), it cannot compensate for the lack of SMN1. One approach to studying SMA utilizes induced pluripotent stem cell (iPSC) technology to create in vitro models of SMA. Using iPSC strategies, motor neurons can be cultured from SMA patient fibroblasts and studied in vitro. When iPS cells are created to model SMA, they must be both screened for pluripotency and characterized genetically for FL and Δ7 SMN. In this investigation, 26 cell lines were characterized for relative levels of SMN transcripts. It was found that, in a given cell lineage, FL SMN transcript levels fluctuate during the reprogramming process. Additionally, a positive relationship was found between type of SMA and level of FL SMN transcript in the lines tested. This work is part of an ongoing effort to produce a reliable, well-characterized stock of SMA iPS cells for research on this disease.

33.
AN fMRI INVESTIGATION OF SOURCE MEMORY RETRIEVAL
Patricia Cavanaugh ‘14
Faculty Sponsor: Nicole Dudukovic

Many researchers today are working towards a comprehensive understanding of neural activity during source memory retrieval, or remembering contextual details about specific events. The prefrontal cortex (PFC) has been found to support cognitive control processes engaged during the retrieval of source memories. The medial temporal lobe (MTL) also plays a critical role in source memory, permitting the formation and retrieval of new associative memories, . It is has been shown that sub regions of the MTL, specifically within the hippocampus, are active during the retrieval of memories when recollecting details about an event, but this pattern of activation may differ depending on the type of details that are retrieved. To test this theory, functional magnetic resonance imaging (fMRI) was used to measure activity in the PFC and the MTL during the retrieval of two types of contextual details, conceptual and perceptual. Participants were scanned while retrieving perceptual details about the color of drawings, retrieving conceptual details about what question they were asked when they initially encountered the drawings, and engaging in recognition tests that required identifying items as old or new.

General source retrieval activation was found in the left dorsolateral and ventrolateral prefrontal cortex. Relative to retrieval of perceptual details, retrieval of conceptual details activated the left ventrolateral PFC, bilateral dorsolateral PFC and left temporal pole. The retrieval of perceptual details activated right anterior MTL regions and bilateral ventrolateral PFC. The results of this study suggest that the retrieval of different types of source memory are sub served by different neural processes. fMRI technology has already helped researchers to make huge leaps in brain mapping and the overall understanding of how different source tasks affect neural activation during memory retrieval.

34.

DIFFERENCES IN BRAIN CONNECTIVITY REORGANIZATION BETWEEN STROKE AND TUMOR PATIENTS

Jessica Cote ‘12
Faculty Sponsors: Emi Nomura, Ph.D., Mark D’Esposito, M.D. (Helen Wills Neuroscience Institute, University of California, Berkeley)

The brain is organized into highly specialized functional areas, or modules, and interactions among these areas allow for information processing and behavioral control. Brain injury negatively affects the organization of this functional network and causes major deficits in connectivity. However, the brain is capable of reorganization both during disease progression and after injury. Although this remodeling occurs with acute and long-term injuries, research has shown that post-lesional functional recovery is considerably better in chronic long-term lesions than in acute lesions. In the current study, we examined resting state functional magnetic resonance imaging (fMRI) data of patients with strokes and tumor resections to compare cerebral network reorganization in acute and slow-growing lesions, respectively. Lesions of stroke patients and tumor patients were hand-drawn according to visible brain damage on anatomical fMRI scans. Network organization was quantified using modularity, a graph theoretical construct that is the ratio of within- compared to between- module connections. Then we correlated time since damage with modularity in both groups to investigate the specific restructuring of functional networks following these two types of brain injury. Results showed that the type of damage (lesion from stroke or tumor resection) had a differential effect on recovery over time. Those patients recovering from stroke demonstrated a positive correlation between time since damage and modularity whereas those patients recovering from tumor resection showed a negative correlation between time since damage and modularity. Together, these opposing recovery trajectories suggest that acute lesions and slow-growing injuries involve different mechanisms of reorganization, which ultimately lead to distinct levels of recovered connectivity. This study provides a better understanding of brain plasticity and network organization, which may lead to improvements in recovery from brain injuries.

35.

THE EFFECT OF THE KETOGENIC DIET ON FORMALIN-INDUCED NOCICEPTION IN MICE

Jessica Fortin ‘14
Faculty Sponsors: Susan Masino, David Ruskin

The ketogenic diet is a high fat, low carbohydrate diet that adjusts the body’s metabolism to use ketone bodies instead of glucose for fuel. The diet has been proven effective in raising the seizure threshold of people with epilepsy, especially in children. The effects of the diet on pain sensitivity (nociception) are being studied in mice on the ketogenic diet against mice on a control diet. Mice were fed either a control diet or the ketogenic diet (8% protein) for three weeks. At 7-8 weeks of age the right hind paw was injected with a moderate 3% 10µL dose of formalin. The injected mice were then placed in an individual clear container and the amount of time spent licking and lifting the injected hind paw was recorded. Formalin induces a biphasic pain response where phase I mimics acute pain while phase II mimics chronic pain. The two genotypes of mice tested were wildtype (normal) and A1 knockout (lacking the adenosine receptor). While the data indicate no significant diet effect that supports the expected hypoalgesia hypothesis, there is a significant difference between wildtype ketogenic and control diet-fed mice in phase II with ketogenic diet mice exhibiting increased nociception. These data conflict with previous thermal nociception experiments where ketogenic diet-fed mice exhibited significant hypoalgesia. In addition, the genotype data also indicate an expected significant hyperalgesic effect in phase II for A1 knockout mice compared to wildtype mice. Future experiments utilizing novel methods will be conducted to clarify the diet effect and role of adenosine and determine the human clinical potential of the ketogenic diet as a potential therapy for pain.

36.

THE EFFECT OF THE ANTIOXIDANTS ASCORBIC ACID AND URIC ACID ON UNDIFFERENTIATED AND RETINOIC ACID-DIFFERENTIATED SH-SY5Y CELLS

Pamela Hathway ‘12, Vishakha Negi (Trumbull High School)
Faculty Sponsor: William H. Church

Ascorbic acid (AA) and uric acid (UA) are antioxidants with neuroprotective properties due to their potential to scavenge reactive oxygen species (ROS). Low levels of UA have been observed in neurodegenerative diseases such as Parkinson’s Disease and Multiple Sclerosis. High doses of AA have been shown to decrease tumor cell viability while having no impact on fully differentiated neurons, making this a potential cancer therapy. The current study is being conducted to investigate the effects of AA and UA on a human neuroblastoma cell line. SH-SY5Y cells were differentiated by treatment with 10 µM retinoic acid for 7 days. Both differentiated and undifferentiated cells were then treated with 25 – 1000 µM AA or 100 – 200 µM UA. Cell viability was determined using fluorescent staining methods. Preliminary results will be presented. It is thought that differentiated cells will respond to the antioxidants in a qualitatively different way than undifferentiated cells.

37.

THE EFFECTS OF ALCOHOL ON COGNITIVE FUNCTIONING IN COLLEGE STUDENTS

Sarah Isaac ‘14
Faculty Sponsor: Sarah Raskin

Binge drinking is defined as a pattern of consumption of ethanol that raises the blood alcohol concentration to at least 0.08 gram percent or above. This pattern of behavior has been previously suggested as a significant cause of brain and cognitive damage. This study evaluates drinking trends, memory, and cognition in young adults, 18 to 21 years of age. More than 501 first year students have been tested at Trinity College, and the two-year follow-up visits for these students are currently being completed. Participants in this study were categorized into one of four groups: never drank, drank but never binged, binged but not in the last 30 days, and binged in the last 30 days. They were administered a mental health screening, the M.I.N.I. (Mini International Neuropsychiatric Interview), to determine whether they were applicable for the study and to analyze any trends that could explain drinking behavior. Additionally, participants were presented with a battery of cognitive and memory tasks using JANET and COGSTATE software in order to assess characteristics such as attention, working memory, and executive function. It has been demonstrated by these tests that subjects that have binged in the past thirty days are much more likely to have alcohol and substance abuse disorders and mood disorders such as a depressive episode. Furthermore, the group that binged in the past thirty days performed the worst on tests measuring declarative and working memory with social drinkers showing the poorest performance on a test measuring impulsivity. Overall, alcohol has been shown to have a noticeable effect on cognitive ability, though it is important to determine how often an individual has binged when measuring the degree of impairment.

38.

THE EFFECT OF THE KETOGENIC DIET ON THE SOCIABILITY OF A MOUSE MODEL FOR AUTISM

Michelle Murphy ‘14
Faculty Sponsors: Susan Masino, David Ruskin

The ketogenic diet is a low-carbohydrate, high-fat diet that is used as a treatment option for epilepsy. It has been suggested that the ketogenic diet could also be a possible treatment for autism because of the high occurrence of epilepsy in people with autism. Although the cause of autism is unknown, the disorder is characterized by impaired social and communication skills. A mouse model for autism, termed "BTBR," is an inbred strain of mice that shows some of these distinctive symptoms of autism. The ketogenic diet's effect on the sociability of these BTBR mice was determined by using the three-chambered sociability test. In this experiment, a mouse was first placed in the central chamber, which had doors to the next-door chambers. Then the time that the mouse spent touching the cages in the adjacent chambers that were either empty or contained other mice was determined. Two 10-minute phases were timed: the first phase had a new mouse placed in one of the cages and the second phase had the mouse from the first phase plus another novel mouse placed in the other cage. It was found that the BTBR mice on the control diet demonstrated significantly less sociability than that of the normal mice on the control diet. It was also found that the BTBR mice on the ketogenic diet showed a significant increase in sociability compared to the sociability of the BTBR mice on the control diet. These data demonstrate that the impaired sociability of the BTBR mice was reversed by a ketogenic diet.

Finding evidence that a ketogenic diet can alleviate symptoms of autism in mice is important because the ketogenic diet could be used to treat autism in humans. In a related study, preliminary experiments are being done with transgenic mice that lack adenosine receptors. This study aims to determine how adenosine is related to autism and the mechanism of the ketogenic diet.

39.

CHANGES IN PURINE TISSUE CONTENT IN VARIOUS BRAIN STRUCTURES OF RATS FED A KETOGENIC DIET

Alexandra Nicaise ‘13
Faculty Sponsor: William H. Church

Previous studies have indicated that the ketogenic diet, a high-fat low-carbohydrate regimen, has the ability to reduce pain and inflammation in rats, as well as reduce the duration and frequency of seizures. The mechanism by which these effects are produced is unclear. Purines are known to play a role in pain pathways in the brain. The work presented here is part of an ongoing study investigating changes in brain purine content in rats fed a ketogenic diet. Tissue punches of brain areas associated with pain perception were analyzed. Purine content was quantified using HPLC. Protein content was measured using a Modified Lowry Protein Assay. The reproducibility of this assay was evaluated and found to be consistent over time. Data analysis of purine content in the somatosensory cortex, thalamus, hippocampus, PAG, and cerebellum found a significant increase in adenosine tissue levels in the somatosensory cortex of rats fed a ketogenic diet. RT 10, currently an unidentified compound, was also found to be significantly higher in the somatosensory cortex of rats fed a ketogenic diet. The results indicate that purine neurochemistry is changed in rats fed a ketogenic diet. These rats also demonstrated hypoalgesia, suggesting a potential mechanistic relationship between brain purines and nociception.

40.

VERIFICATION OF PEAK ASSIGNMENTS IN QUANTITATIVE STUDY OF PURINE CONTENT IN RAT BRAIN

Samuel Scinto ‘12
Faculty Sponsor: William H. Church

It has been reported that rats fed a ketogenic diet experienced an increase in pain tolerance and a reduction in inflammation (Ruskin et. al 2009). The current project focused on identifying the neurochemical changes that occurred as a result of this diet, specifically in context with pain perception brain structures. Brain tissue samples from the somatosensory cortex, hippocampus, periaquaductal grey (PAG), cerebellum, and thalamus were analyzed for purine content using high-performance liquid chromatography (HPLC). Peak assignments for hypoxanthine, xanthine, inosine, and adenosine were verified based on UV spectra, retention time, and metabolic enzyme experiments. Diode array UV spectra analysis identified an incorrect peak assignment for uric acid. The identity of this peak is currently under investigation. Regional distribution of adenosine and its metabolites are reported.

41.

THE EFFECT OF NEONATAL ISOLATION TREATMENT ON LONG-TERM POTENTIATION IN RATS

Nay Oo Shein ‘12, Georgia McAdams ‘14
Faculty Sponsor: Harry Blaise

In the brain, the dentate gyrus (DG) is a subfield of the hippocampus that is concerned with learning and memory. Thus, the region is significant because stress can affect learning and memory. Neonatal isolation is known to be an early life stressor that causes changes in long-term potentiation (LTP), an indicator of learning, as recorded in the perforant pathway (PP) between the DG and entorhinal cortex. Previous studies have only shown the results of rats isolated for 1 hour periods from days 2-9 after birth. Currently, we are conducting experiments to determine if the results are the same when rats are isolated for 2 hour periods from days 2-5 versus 1 hour periods from days 2-9. After maturing, these rats are implanted with electrodes in the PP and DG through stereotaxic surgery and allowed to recover for a week; they then have LTP induced.

This is a continuing project from last year when two seniors studied induced LTP in rats with 4-day stress. This summer, studies were conducted upon on non-handled rats, which did not go through neonatal isolation, for control purposes. Although the study of 4-day stress and non-handled groups has been finished, the experiment needs to be continued on rats with 8-day stress to prove whether these two methods of isolation produce similar or different results. This study will be continued next year to collect more data to determine the effectiveness of the 4-day stress protocol.

42.

PROSPECTIVE AND RETROSPECTIVE STUDIES OF THE EFFECTS OF THE KETOGENIC DIET ON BEHAVIOR

Rebecca Williams ‘12
Faculty Sponsors: Susan Masino, David Ruskin, Julia Svedova ‘11, Francis DiMario, MD (Connecticut Children’s Medical Center, Department of Neurology)

The ketogenic diet is a high-fat, low-carbohydrate diet that changes the body’s metabolism to break down ketones instead of glucose for energy. The diet has been successfully used as a treatment for seizures, as well as autism in children. The goal of this study is to determine the effects of the KD on behavior in children before and during or after diet treatment in a prospective study, and during or after the treatment in a retrospective study. We hypothesized that in addition to its benefits in reducing seizures, the ketogenic diet would improve aspects of behavior in children with epilepsy, autism, and epilepsy and autism. For the retrospective and prospective components of this research we are including children who already started or are already pre-qualified and planning to start the diet. Parents or guardians are sent surveys to quantify clinical criteria and behavior in the children. Retrospective study participants will be identified at the University of Calgary, and potentially other sites, and include English-speaking parents of living epileptic minors who will have initiated the ketogenic diet at least six months prior. Children who (1) are still on the diet or (2) have been off the diet for more than two months will be included in the retrospective study. Parents of participants in the prospective study will be given a set of surveys (1) prior to initiating the diet and (2) six months later. The lab is currently waiting for the first set of surveys to be returned for the prospective study, and for IRB approval to move forward with the retrospective study.

PHYSICS

43.
DEVELOPMENT OF NOVEL ULTRAFAST ELECTRON SOURCES
Jonathan Handali ‘13, Erik Quinonez ‘14
Faculty Sponsor: Brett Barwick

Testing quantum mechanics through experiment is essential to extend the understanding of physical phenomena from the atomic to astronomical scales. Recently, femtosecond lasers have been combined with electron sources to create ultrashort duration electron packets, which have successfully been used to image ultrafast dynamics at the nanometer/femtosecond scales and to test fundamental quantum mechanics problems. Here at Trinity College, in Prof. Barwick's lab we plan to develop experiments that use these ultrashort packets of electrons to both test the Pauli Exclusion Principle, which is a fundamental tenant of quantum mechanics, and to construct a table top ultrafast electron microscope that will be used to study the dynamics of ultrafast process in nanoscale material systems. We have made significant progress towards these goals over this last summer by pursuing two different projects: the first was to develop fabrication techniques to construct novel ultrafast electron sources from different materials and the second was to experimentally realize femtosecond optical vortex beams in the lab here at Trinity.

PSYCHOLOGY

44.
PERCEPTION OF NATURAL SPEED OF BIOLOGICAL MOTION
Asiqur Anik ‘12
Faculty Sponsor: William Mace

The objective of this experiment was to determine if the orientation of biological motion can influence the perception of the natural speed of the motion due to the seemingly alternation of gravity. “Natural speed” is the normal speed in which an action is performed. It is influenced by the earth’s gravitational force. For the experiment three sets of 40 biological motion videos were shown to 30 observers. The videos contained an individual, represented by dots on his head and major body joints, walking across the screen. Each set had the biological motion in a different orientation and each video in a given set had 8 subsets. Each subset had a different speed. The observers were asked to rank the speed of the biological motion. The results showed that the orientation of the biological motion did not influence the perception of natural speed. We concluded that the observers were determining the speed of the biological motion with the video’s duration time. For future studies, a video of an individual performing a motion that remains in the center, such as running on a treadmill, will be used. The video will be in a loop, thus eliminating the ability to judge the speed from the video’s duration time.

45.
T**HE RECREATION OF WAVES THROUGH POINT-LIGHT DISPLAY**
Ewen Kronemeyer ‘14

Faculty Sponsor: William Mace

Point-light displays are video representations of motion depicted through a series of moving dots. They have traditionally been created by placing dots on key areas of the human body, such as the hands, head, and feet. A human model is then filmed performing a specific action. When the motion of the dots against a blank background is shown to participants, they have consistently perceived a number of properties of the action being filmed. However, little research has been done into non-biological point-light display, specifically display involving very fluid motion. Through the creation and manipulation of a typical wave, a better understanding of the rather unexplored motion of waves was acquired. The goal of this research was to explore the possibilities of fluid point-light motion and to create the best possible point-light display of a wave for future experiments. A point-light display video was created depicting a side-view of a wave of water vacillating within a container; the x-coordinates of each point in the point-light display were then rearranged in various ways to discover if the original motion of the wave would remain identifiable or become unrecognizable. The wave motion was created by first filling a four-foot-long by two-foot-high clear, plastic container with water. Six ping-pong balls were strung together with string across the surface of the water and connected perpendicularly to the edges of the container through a small hole in each end. This modification of the container allowed the ping-pong balls to move freely in a vertical path with the wave while maintaining their horizontal position. A dot was then placed in the center of each ping-pong ball to later mark the placement of points within the point-light video. A video camera was placed on an even surface with the container. The right side of the container was then lifted about four inches above the surface and quickly lowered back down, relying on the effects of gravity to force the water into the motion of a wave.

46.

NATURAL APPLAUSE IN INDIVIDUALS AND GROUPS

Spencer McCauley ‘13
Faculty Sponsor: William Mace

The purpose of this experiment was to explore the fundamental aspects of natural applause, such as duration and frequency, in individuals and groups. Ten participants from Trinity College were recruited and participated in two applause exercises, one in which they clapped in anticipation of a performance, and the other in which they applauded enthusiastically after a performance. The results showed that there are fundamental attributes to clapping across individuals such as slowing down at the end of enthusiastic clapping and a consistently shorter duration observed for enthusiastic applause as compared to anticipatory applause (which was true for group applause as well.)

47.

GENDER DIFFERENCES IN ACADEMIC HELP-SEEKING AND THEIR RELATION TO ACADEMIC PERFORMANCE AND ADJUSTMENT IN FIRST-YEAR COLLEGE STUDENTS

Jasmine Owarish-Gross ‘12
Faculty Sponsor: Laura Holt

Previous research has examined whether there are gender differences among college students when it comes to general attitudes about help-seeking. Less is known, however, about the nature and extent of gender differences across different types of academic help-seeking and whether differences in help-seeking predict academic outcomes. Accordingly, the main purposes of this study were to investigate if there were gender differences in different types of academic help-seeking among first-year college students and to see if gender and/or attitudes about help-seeking predicted academic adjustment and GPA. Measures included a 10-item Academic Help-seeking scale, the 24-item Academic Adjustment subscale of the Student Adaptation to College Questionnaire, and GPA. These measures were part of a larger survey of first-year student adjustment. First-year students received e-mail invitations at the beginning of the semester to participate voluntarily in this web-based study. Ninety-four participants completed a survey at both the beginning and end of the semester and thus were included in the current analyses. Results showed that when faced with academic difficulty, males were more likely to endorse threat associated with help-seeking and were more likely to avoid seeking help, while females were more likely to endorse proactive help-seeking behaviors. Also students who engaged in proactive help-seeking behaviors experienced better initial academic adjustment in college while those who endorsed avoidant strategies showed poorer adjustment. Moreover, reluctance to seek out academic help was associated with a lower GPA. These findings suggest that it may be especially important to encourage and de-stigmatize academic help-seeking among males and that students who show avoidant behaviors might need to be targeted by faculty and teaching assistants, since they are prone to poorer adjustment and lower levels of achievement.