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ELEVENTH ANNUAL SUMMER RESEARCH SYMPOSIUM TRINITY COLLEGE

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BIOLOGY

1.

NOTCH INHIBITION AND ACTIVATION RESULTING FROM MODIFICATION OF THE INHIBITORY REGION IN SERRATE

Scott J. Buchanan '17

Faculty Sponsor: Robert Fleming

In *Drosophila*, the ligand Serrate encodes a single protein with 14 EGF-like repeats (ELRs) extracellularly. Through the function of these ELRs, Serrate is able to either inhibit or activate the Notch receptor. Removing ELRs 4-6 causes Serrate to lose its ability to inhibit Notch, whilst conserving its ability to activate it. Relocating ELRs 4-6 to a position following ELR 11 fails to restore the ability to inhibit Notch. This suggests that the location of the inhibitory ELRs 4-6 is critical for their function. A construct was built in order to test whether this inability to inhibit Notch is simply due to distance from the activation region (N-terminus through ELR 3). ELR 7 was removed from its normal position between ELRs 6 and 8, and placed between ELRs 3 and 4. Two halves of the construct were created: the 5' piece which consisted of ELRs 1, 2, 3, 7, 4, 5, and 6, and the 3' piece which consisted of ELRs 8, 9,10,11,12,13,14. Preliminary ligations of these two pieces in a pUAST vector during the summer failed due to problems with the Antarctic Phosphatase used in the construction process. This problem has since been corrected and the effects of this construct will be observable soon.

2.

VISUALIZING SEGMENTATION-RELATED GENE EXPRESSION IN THE POSTERIOR GROWTH ZONE OF THE FAIRY SHRIMP, *THAMNACEPHALUS PLATYRUS*

Khaoula Ben Haj Frej '18

Faculty Sponsor: Terri A. Williams, National Science Foundation

Segmentation is widespread across metazoans, found among organisms in three major taxa, including arthropods. Until recently, most of the data regarding segmentation has been accumulated from studies on *Drosophila*. However, their mode of segmentation is not typical, so they cannot serve as a model for all other arthropods (Peel et al., 2005), making the use of new models necessary. The purpose of this lab's research is to study typical and thus, potentially important pancrustaceans (insects and crustaceans). However, these animals are currently less understood than other models. This study focuses on the fairy shrimp, *Thamnocephalus platyurus*, particularly the posterior region of the developing animal, called the growth zone. Among the main mechanisms studied deal with cellular methods of elongation along with complex regulatory gene networks in arthropod posteriors, all of which are united in the region known as the "growth zone." In terms of the gene regulatory network, the interplay between genes can be viewed indirectly through the double label *in situ* hybridizations, which combine two single label *in situ* hybridization. Double labels are good inferential tools which allow one to view the expression of two genes at the same time, in a single animal. Multiple double labels together can be used to then piece together a gene map depicting the influence of all the major genes involved in segmentation, providing one way to infer the operation of the regulatory gene

network controlling segmentation. The double label has yet to be perfected for *Thamnocephalus*, but has successfully been used in other arthropods such as the Pueyo and Chesebro studies on *Periplaneta americana*, the cockroach. Ensuring a successful double label involved multiple steps, beginning with optimizing the tyramide 488 in terms of cuticular staining and primary and secondary antibody concentrations. Chitinase and chymotrypsin tests were performed for the former, concentration variations for the latter. The same was performed for the tyramide 555, which failed. Thus, the double label could not be performed within the allotted time, but continues to be a potential short term goal. Once it is optimized, studying the *Thamnocephalus* gene network will help one understand how segmentation, and more specifically, the gene regulatory network, evolved in these pancrustaceans. *Thamnocephalus* is only one arthropod, but understanding undersampled pancrustaceans phylogenetic roles together would allow for a specific comparison of segmentation between arthropods and the more well-studied vertebrates. One such example is *Tribolium castaneum*, the flour beetle, which has also been studied in this lab.

3.

THE ROLE OF STONE WALLS IN THE BEHAVIORAL ECOLOGY OF WILDLIFE IN A NEW ENGLAND FOREST HABITAT

Jessica Chotiner '17

Faculty Sponsor: Scott R. Smedley

Hundreds of thousands of kilometers of stone walls span New England and eastern New York, making these man-made structures a significant feature of the landscape. Anecdotal accounts suggest that animals use the stone walls as byways in the forest, but until now there have been no controlled experiments to confirm this phenomenon. In a hardwood forest in eastern Connecticut, we used camera traps to record mammalian and avian use of stone walls and two control conditions, a wooden substrate wall, and a patch of unobstructed forest floor. Two sets of camera positions, Far and Near from the target, were used to record large and small animals, respectively. These experimental conditions and camera positions were replicated in a dry North microhabitat and a wet, low-lying South microhabitat. Data in this current analysis were collected from June 2013 to September 2014. Separate Goodness-of-Fit tests performed on the total encounters for the North Far and South Near conditions we found that in the North Far condition significantly more animals were encountered on the stone wall than on the wooden substrate or blank controls, while in the South Near condition significantly more animals were encountered in the blank control than on the stone wall or wooden substrate. We then used Goodness-of-Fit tests to analyze the encounters of the top five most abundant species for both the North Far (i.e., gray squirrel, white-tailed deer, Eastern chipmunk, fisher, and opossum, respectively) and the South Near (i.e., white-footed mouse, gray squirrel, Eastern chipmunk, vole sp., and shrew sp., respectively). The results from these tests showed that in the North Far condition, the gray squirrel, Eastern Chipmunk, fisher, and opossum were encountered with significantly greater frequency on the stone walls, and in the South Near the Eastern chipmunk, vole sp., and the shrew sp. were encountered with significantly greater frequency on the stone walls. When considered with our earlier analysis of the North Near and South Far conditions, three of these four blocks show a significant preference for the stone wall versus the wooden substrate or blank control. The fewer overall encounters at South Near wall may reflect that the

two dominant visitors (white-footed mouse and gray squirrel) tend to concentrate their activity higher up the wall, while in this case the camera monitored the wall's base.

4. **IN VITRO MODELING AND ANALYSIS OF CHROMOSOME 8P ARM-LEVEL DELETION USING CRISPR-CAS9**

Michael S. Cuoco '16

Faculty Sponsors: Robert Fleming, Dr. Alison Taylor, Dana-Farber Cancer Institute

In tumor development, types of acquired genetic changes include single nucleotide polymorphisms (mutations), translocations, and copy number alterations. Somatic copy number alterations (SCNAs) are thought to drive tumorigenesis by the amplification or deletion of different sized regions across the genome. One type of somatic copy number alteration, arm-level SCNAs, include the amplification and deletion of entire chromosomes or chromosome arms. Chromosome arm 8p deletion has been reported as enriched in epithelial cancer types including breast, hepatocellular, lung, prostate, renal, and esophageal adenocarcinomas. Arm-level SCNAs have never been modeled in isolation and an effective model of an arm-level SCNA would provide a new path to discovery in cancer research. Here I describe my ongoing thesis project, which involves a unique approach to remove chromosome arm 8p *in vitro* with a novel genome editing tool. If successful, this method will generate a stable and testable model of 8p arm loss in cancer. To accomplish 8p removal, we have developed two plasmids to operate in conjunction to cut chromosome arm 8p and replace it with an artificial telomere. We performed transfection into the HEK (human embryonic kidney) 293T cell line and amazingly, stable bulk populations were retrieved. In result, *every* population tested positive for the presence of the artificial telomere on chromosome arm 8p from polymerase chain reaction (PCR) tests. At least four of the clonal populations have demonstrated consistent and significant low chromosome arm 8p levels relative to 8q in quantitative PCR (qPCR) tests. Three of the four clonal populations showed robust growth patterns in CellTiter-Glo® cell proliferation curves. Decisively, the collective data from the three clonal populations strongly supports their loss of chromosome arm 8p. Furthermore, more qPCR tests are being done to uncover additional possible 8p-loss clones. Our upcoming research includes entering these candidate clones into whole genome and whole transcriptome sequencing. My thesis research at Trinity is centered on in depth *in silico* algorithmic processing and analysis of these genome and transcriptome sequencing data. The methods of my research will provide conclusive data on 8p arm loss and the possible adverse genetic, genomic and expression-level effects of the arm loss.

5. **USING 24-HOUR WEIGHT AS REFERENCE FOR PERCENTAGE WEIGHT LOSS CALCULATION TO PROMOTE BREASTFEEDING**

Xiaomeng Deng '16

Faculty Sponsors: Alison Draper, Maryann McGuire, Margaret McLaren, MD; Mary Marshall-Crim, APRN; Sandra Motta, MD, Connecticut Children's Medical Center

Background: Exclusive breastfeeding in the newborn nursery is strongly recommended for infant health. It is common practice to interpret a weight loss of $\geq 10\%$ of birth weight as

evidence of dehydration and to initiate supplements. Evidence is growing that transplacental transfer of intravenous fluids given to a mother during C-section may inflate the infant's birth weight. Studies suggest that the 24-hour weight is a preferred reference for weight loss calculation after the diuresis of this excess fluid. Hartford Hospital implemented the intervention of using 24-hour weight as opposed to birth weight as weight loss percentage calculation reference for infants whose mother received fluid during delivery.

Objective: To evaluate the efficacy and safety of this clinical intervention to decrease supplementation.

Methods: We performed a retrospective chart review of 667 healthy, term, appropriate for gestational age newborns, delivered by C-section to mothers planning to breastfeed. We performed independent sample t-tests to compare overall supplementation rate, maximum weight loss, length of stay, and maximum transcutaneous bilirubin between infants from two study periods: 12 months pre-intervention (n=404) and 12 months post-intervention (n=263).

Results: Overall supplementation rate decreased from 43.6% to 27.4% due to the intervention; the decrease was especially dramatic among first-time mothers (51.9% to 31.0%). There was no increase in maximum percentage weight loss, length of stay, or maximum transcutaneous bilirubin level.

Conclusion: Adopting the 24-hour infant weight as the routine reference for weight loss calculation was safe and effective in reducing supplementation and promote exclusive breastfeeding.

6.

A MAAT STUDY OF THE GENUS *CHAMPIA* (RHODYMENIALES, RHODOPHYTA) IN BERMUDA AND SOUTHERN NEW ENGLAND IDENTIFIES FOUR NOVEL SPECIES

Maura Griffith '17

Faculty Sponsor: Craig Schneider

Champia parvula is a marine red alga that is presently the most widespread species in the genus, what is considered a pan-oceanic species. In the past decade, however, three new species were segregated from *C. parvula* in Puerto Rico and Japan. The present molecular-assisted alpha taxonomic (MAAT) study involves specimens of *C. cfr. parvula* collected in Bermuda and southern New England, each places with only *C. parvula* listed as present in the flora for the genus. Some of the eight samples were identified as known western Atlantic species *C. harveyana* and *C. taironensis*. The remaining isolates were found to represent three novel species from Bermuda in morphological and phylogenetic analysis using the *rbcL* gene, and one new species from southern New England. These four new species, in addition to others recently segregated out of *C. parvula* indicate that this species may not be as biogeographically as widespread as previously believed, yet more generically diverse than previously known.

7.

TWO NEW SPECIES OF WRANGELIA (CERAMIALES, WRANGELIACEAE) FROM WARM WATERS OF THE WESTERN ATLANTIC

Walter Jongbloed '16

Faculty Sponsor: Craig Schneider

Currently there are 20 accepted species in the genus *Wrangelia* from warm parts of the world's oceans with 4 known from the western Atlantic: *W. argus*, *W. bicuspidata*, *W. gordoniae* and *W. penicillata*. Growth forms in the genus range from mat-like turfs to erect and feathery stalks present from the intertidal zone to more than 50 m in tropical regions. Actually, it was a recent molecular and morphological investigation that separated *W. gordoniae*, (type locality, Puerto Rico) from what it had been called *W. penicillata* (type locality, Mediterranean Sea), and we report this species for the first time out of the Caribbean Sea. Lack of complete rhizoidal cortication in *W. argus* and *W. bicuspidata* distinctly separate the other four genetic species all of which had been called *W. penicillata* until now. Preliminary phylogenetic and barcode analysis (SSU rDNA) of *Wrangelia* from Bermuda indicate the presence of six species in the genus, two of which appear to be novel species in the *W. penicillata* complex. Morphological characters, as well as their gene sequences, distinguish the two new species from *W. penicillata*, and a key to the western Atlantic species of *Wrangelia* is provided.

8.

SIMULATED PREDATION, NEUROGENESIS, AND BEHAVIOR IN WEAKLY ELECTRIC FISH

Geoffrey Keane '16, Hannah Adams '17

Faculty Sponsor: Kent Dunlap

Predation in the natural environment significantly affects the brain and behavior of their prey. Previous field studies on Panamanian electric fish *Brachyhypopomus occidentalis* demonstrated a negative correlation between predation pressure and brain cell proliferation in the forebrain. However, it is unclear if the increased predation threat causes the reduction in brain cell proliferation as there is a myriad of possible contributing factors present in the Panamanian rivers. We conducted simulated predation studies in the laboratory to determine if experimental predator stimuli would cause similar changes in brain cell proliferation as was observed in the field study. *Brachyhypopomus gauderio* and *Apteronotus leptohynchus*, were touched on the tail with a Plexiglas rod three times per day for 7 days to simulate predation pressure. Electric organ discharges (EOD) were measured, and the brains were collected. To identify the density of newborn cells, the forebrains were labeled for proliferating cell nuclear antigen (PCNA) using immunohistochemistry. Fish exposed to simulated predation had lower levels of cell proliferation compared to undisturbed isolated or paired fish and showed steady EOD reactivity to the simulated predation stimuli for the duration of the experiment. These results are consistent with predation effects on proliferation seen in the Panamanian study. Additionally, we examined the effect of simulated predation of spatial learning behavior. By utilizing the simulated predation methods and timed trials of movement through a tank, we collected initial data suggesting that spatial learning behavior may be enhanced by the presence of simulated predation.

9.

ULTRASTRUCTURE OF THE FETAL MEMBRANES OF THE OVIPAROUS KINGSLAKE, *LAMPROPELTIS GETULA* (COLUBRIDAE) AS REVEALED BY SCANNING ELECTRON MICROSCOPY

Young K. Kim '17

Faculty Sponsors: Daniel G. Blackburn, Yunming Hu, EM Facility Lab Manager

One of vertebrates' most remarkable innovations was the evolution of the terrestrial egg which allowed organisms to successfully reproduce on land. The specializations of such eggs and their fetal membranes which sustain the developing embryo can illuminate important evolutionary trends. However, a scarcity of morphological studies that highlight unique physiological and functional attributes hinders a deeper understanding of these patterns. Our scanning electron microscopy study on kingsnakes (*Lampropeltis getula*) reveals two major fetal membranes: the chorioallantois and the yolk sac (bilaminar) omphalopleure. As the chorioallantois matures, changes in the membrane indicate a function in respiratory gas exchange. The yolk sac omphalopleure is comprised of an avascular omphalopleure, isolated yolk mass (IYM), and yolk cleft. Unlike those in typical lizards and snakes, however, the omphalopleure progressively transforms into a "secondary chorioallantois." Such changes in the fetal membranes reflect the embryo's increasing requirements for gas exchange, and surface protrusions which are abundant in early through mid-development suggest functions related to water absorption. The findings are consistent with those of a previous study on the corn snake, *Pantherophis guttatus*, but offer new observations and functional hypotheses about squamate reproductive patterns.

10.

DOES GUT FLORA CHANGE IN A MOUSE MODEL OF AUTISM SPECTRUM DISORDERS ON A KETOGENIC DIET?

Shelby Labe '16, Laura Nee '17

Faculty Sponsor: Lisa-Anne Foster

The normal bacterial flora of an organism includes the non-disease causing bacteria that inhabit the human body under normal conditions. These bacteria are important for numerous reasons; for example, they excrete vitamins and prevent colonization by pathogens. Autism spectrum disorders (ASD) are neurodevelopmental disorders that can start as early as infancy. They are characterized by difficulties in communication and social interaction, and gastrointestinal (GI) issues are common. One popular way to attempt to alleviate the symptoms of ASD is maintaining a ketogenic diet, which is seventy-five percent fat. Such a diet induces ketosis, a metabolic state when ketone bodies, not glucose, are used as the primary fuel. This study analyzes how the ketogenic diet affects the GI flora in a mouse model of ASD and aims to determine if the benefits of a ketogenic diet are correlated with changes in the gut flora. In order to determine the types of bacteria present, the 16s rRNA gene was amplified from the fecal samples of mice in treatment groups. The amplified DNA was then digested with restriction enzymes (HaeIII) and terminal Restriction Fragment Length Polymorphism (tRFLP) electropherograms were generated. Analyses of the electropherograms suggest there is no significant difference in number of species present or abundance of bacteria between any pre and post diet conditions. Additionally, there are 28 unidentified bacterial species that are common between two or more of the four experimental groups.

11.

REPTILIAN YOLK ULTRASTRUCTURE AND MECHANISM OF NUTRIENT UPTAKE

Kathryn Powers '17

Faculty Sponsors: Daniel G. Blackburn, Yunming Hu, EM Facility Lab Manager

Representing a generalized condition with respect to their fetal membrane structures and function, corn snakes (*Pantherophis guttatus*) serve as valuable models for studies of the embryonic development of scaled reptiles. Unlike birds which transport yolk nutrients via a well-vascularized yolk sac, corn snakes utilize a network of blood vessels that penetrate into the yolk mass and become encased in endodermal cells filled with yolk droplets. In this study, we have used scanning electron microscopy (SEM) to image yolk samples gathered from eggs of mid to late developmental stages. These yolk samples were gathered primarily from corn snake eggs; however samples were also taken from king snakes (*Lampropeltis getula*) and pueblan milk snakes (*Lampropeltis triangulum*), as well as one turtle species, snapping turtles (*Chelydra serpentina*).

12.

ESCAPE INTO WINTER; COULD A PHENOLOGICAL SHIFT BY A FIREFLY (*ELLYCHNIA CORRUSCA*) SHIELD IT FROM A SPECIALIST PREDATOR (*PHOTURIS* SP.)?

Riley G. Risteen '17, Stephen T. Deyrup, Zenab B. Ahmed, Brian T. Christofel, Nicole R. Howells

Faculty Sponsor: Scott R. Smedley

Females of the firefly genus *Photuris* mimic the flash signal of female fireflies of the genus *Photinus*, and thus lure unwitting male *Photinus* that are then eaten by these *femmes fatales*. The female *Photuris* consequently obtain the defensive steroids, lucibufagins (LBGs), of *Photinus*. We recently determined that *Ellychnia corrusca*, a very unusual firefly since as an adult it is active during the winter, also contain LBGs. Given the strong predation pressure of female *Photuris* on *Photinus* during the summer to obtain their LBGs, one wonders if *E. corrusca* may have shifted its activity to winter to avoid this specialist predator. A correlate to this hypothesis is that provided the opportunity, *Photuris* females could obtain *E. corrusca* LBGs. To test this, we presented field-collected *Photuris* females with *E. corrusca* (field-collected the previous winter, then frozen) as potential food items. Female *Photuris* in our control group received another beetle (*Tenebrio molitor*), one without steroidal defenses, as a food source. At the end of the experiment, the bodies of the female *Photuris* were analyzed with NMR to detect LBGs. We established a significant association between LBGs in *Photuris* females and their experimental diet; LBGs were found in all of the *Photuris* females that ate *E. corrusca*, and only found in a few of the individuals from the control group. These results support the hypothesis that *E. corrusca* may have evolved winter activity to avoid to avoid predation by *Photuris* seeking LBG. The low frequency of LBG-positive *Photuris* females in the control group likely stems from the fact that, although the field-collected females in this experiment were collected early in the summer, some may have already lured and consumed *Photinus*.

13.

THE EFFECT OF ALTERING JUXTAMEMBRANE REGIONS OF SERRATE ON NOTCH SIGNALING

Kathy Rodogiannis '17

Faculty Sponsor: Robert Fleming

Notch signaling is an evolutionarily conserved developmental pathway that regulates several cellular processes in a wide range of organisms. In *Drosophila melanogaster*, the Notch ligands Delta and Serrate regulate the pathway through (1) trans-activation when the Notch receptor and ligand are present on adjacent cells and (2) cis-inhibition when the Notch receptor and ligand are located on the same cell. Cleavage of the Notch protein by metalloproteases has been found to be crucial for receptor activation but the function of similar cleavages in the ligands is less well defined. Previous studies altered the transmembrane region of Serrate by removing the normal cleavage site and found that this form does not activate Notch. Putting back 65 amino acids from Serrate that are adjacent to the cleavage site restored the ability of this ligand to activate Notch. In the present study, the critical 65 amino acids of Serrate were replaced with a similarly located 65 amino acid segment of the human Discoidin Domain Receptor 2 to determine the function of this region.

14.

THE USE OF CRISPR/Cas9 TRANSDUCED JLat CELLS AS A WAY TO CONFIRM THAT TNF- α AND BRYOSTATIN ARE TRANSCRIPTIONAL ACTIVATORS

Jessica Stowell '17, Natalie Sooksatan '17

Faculty Sponsors: Michael O'Donnell, Alexandra Howell

One popular idea of how to cure the Human Immunodeficiency Virus (HIV), the “kick and kill” method, involves first activating or awakening HIV replication in dormant infected cells. If the virus in these “hidden” previously infected cells can be awakened, there is a chance that various drugs would then be able to kill all of the virus within the body. In our experiment, we tested compounds in hopes of finding a substance that would be able to awaken the HIV in infected cells to serve as the “kick” portion of the “kick and kill” method. To do this, our lab developed an indicator cell line called JLat cells that are stably transduced with a newly developed cleaving system called CRISPR/Cas9. CRISPR/Cas9 is used in our JLat system to cleave the HIV provirus that is engineered into the JLat cells. Our JLat system was used to help us screen TNF- α , bryostatin, and turmeric to see if they could activate HIV transcription within the cells. Since TNF- α is a known transcriptional activator, we compared the results of turmeric and bryostatin from the p24 ELISA assay and FACScan data to those of TNF- α to test if they could turn on transcription as well. We found that bryostatin could be used a transcriptional activator while turmeric could not. The most important finding of this experiment is that the CRISPR/Cas9 transduced JLat cell lines reliably screen compounds to see if they can activate transcription of the HIV provirus. This may be useful for future studies because if other transcriptional activators are discovered, it may spark further research on the “kick and kill” method.

15.

CHARACTERIZATION OF MYCOBACTERIOPHAGE FUNSTON

Fabiola Yun '18, Melindy Dorcin '17

Faculty Sponsor: Kathleen Archer

A bacteriophage is a type virus that infects and reproduces inside of and parasitizes a bacterium. Furthermore, Mycobacteriophage is a group of bacteriophages that specifically target *Mycobacterium* as their hosts. The intention of this study was to characterize the Mycobacteriophage Funston by observing the life cycle of the phage, and performing the lysogeny experiments on the phage. Facilitating the process of counting *M.smegmatis* cells was also achieved during the course of this study.

Lysogeny experiments, however, test the ability of bacteriophages to form lysogens. A lysogen is a bacterium containing the phage genome and bacteriophages that possess the ability to form lysogens are called temperate phage. The lysogeny experiments conducted in this study tested Funston's efficiency of lysogeny, superinfection immunity, and tendency switch to lytic growth in response to an environmental cue. The efficiency of lysogeny is the frequency under given conditions with which Funston enters the temperate cycle instead of the lytic cycle. The superinfection immunity refers to the immunity of lysogens to the infection of other bacteriophages. Lastly, the exposure to UV light was used as an artificial environmental cue in order to determine if the cue can trigger a switch the lysogens to lytic growth.

During the course of this study, it was discovered that spectrophotometric analysis may be used to count the number of bacterial cells in an *M.smegmatis* culture, thusly facilitating the process of counting bacteria. The facilitation of this process was an important part of this study since counting *M.smegmatis* cells will most likely be necessary in future studies concerning Funston. As a result of the observation the life cycle of the phage it was determined that Funston is capable of temperate growth and forming lysogens. Based on the results of the lysogeny experiments carried out in this study, it was determined that Funston's lysogeny efficiency was low compared to that of other bacteriophages. It was also found that Funston lysogens have superinfection immunity which applies to other A4 phages. Finally, it was found that UV light does not trigger a switch from lysogenic to lytic growth in Funston. These conclusions are significant because the phenotypic properties of Funston observed here may be referred to in future experimentation in which the functions of unknown genes are determined. Therefore, these phenotypic characteristics of the wild-type phage may be used in order to detect any genetic alterations in a mutant phage.

CHEMISTRY

16.

PHOTOCHEMISTRY AT THE LIQUID VAPOR INTERFACE

Julia Clapis '18, Sahng Hyo Michael Yoon '17, Jefferson Pruyne '14

Faculty Sponsor: Maria Krisch

Anywhere liquids and gases meet there is a liquid-vapor interface. Chemistry at this interface is unique due to a reduced solvent cage and the different surface propensities of chemicals. These effects are especially visible in atmospheric aerosols due to their large surface area to volume ratio. Some chemicals relevant to atmospheric chemistry have high surface propensities and when involved in reactions at the liquid vapor interface, often give very high quantum yields. These chemicals, for example bromine, play important roles in atmospheric chemistry, and are involved in some negative atmospheric processes. Complete understanding of these reactions is essential to our understanding of atmospheric chemistry.

A droplet train is used to mimic these atmospheric aerosols by using a vibrating piezoelectric disk to make stable droplets from a jet of solution. By changing orifice size, different sized drops are created. The drops are exposed to ultraviolet lamps of 254, 302, or 365 nm. Gas phase products are then analyzed using a mass spectrometer.

17.

INVESTIGATING THE IMPACT OF INTRA-MEMBRANE INTERACTIONS AND DIVALENT BUFFER CATIONS ON THE DURABILITY OF A SUPPORTED PHOSPHOLIPID BILAYER COATING FOR MICROCHIP ELECTROPHORESIS

Zachary Garber '16

Faculty Sponsor: Michelle Kovarik

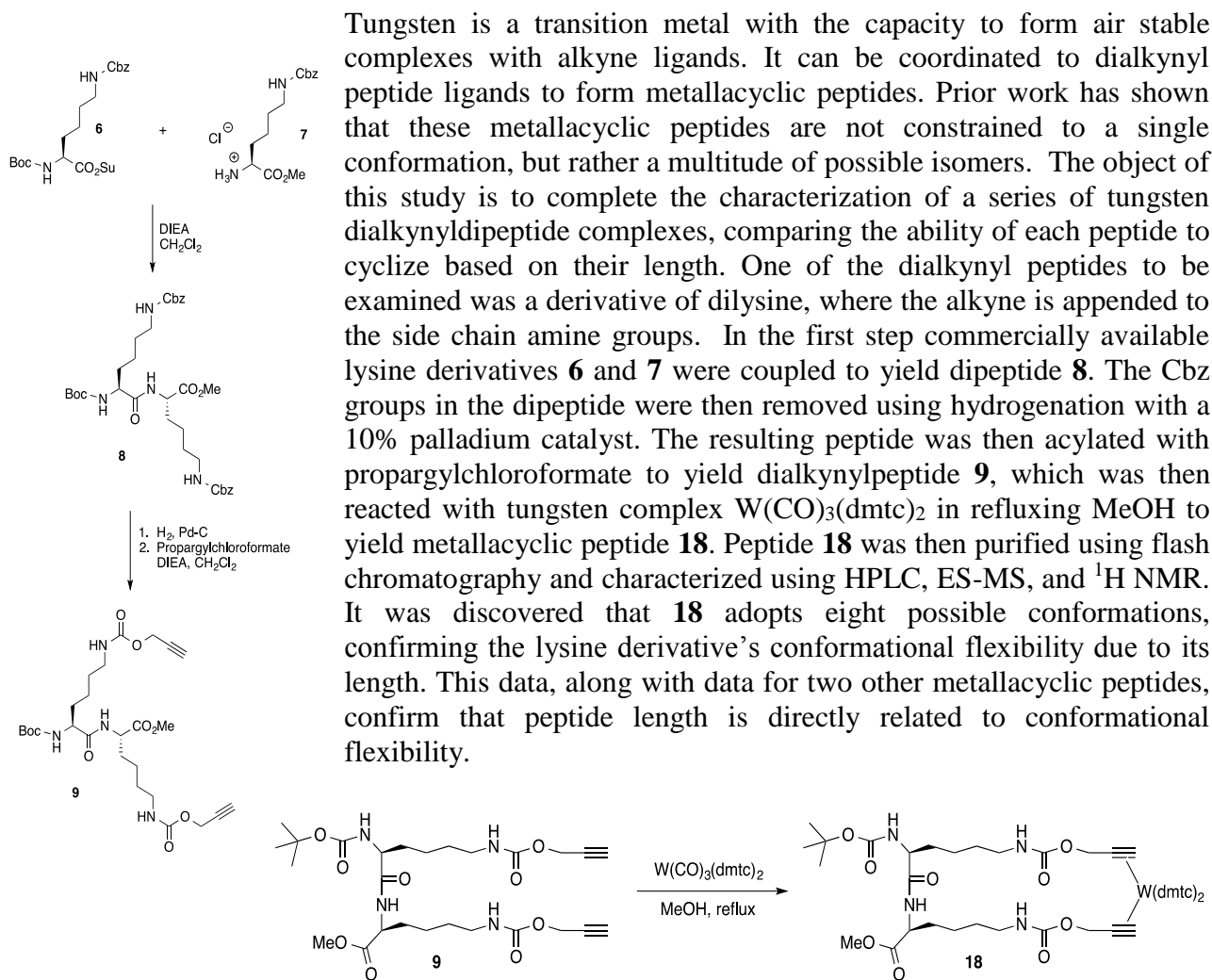
Wall coatings for microchip electrophoresis are necessary to prevent non-specific adsorption of analyte molecules to the capillary wall. Supported lipid bilayers are well established as semi-permanent coatings for microchip electrophoresis. Two factors affecting the durability of a supported phospholipid bilayer used as a coating for microchip electrophoresis were tested. Durability of the coating was assessed based on peak migration times for a mixture of two fluorescent dyes. To test the importance of hydrophobic interactions within the coating, chips coated with 1-palmitoyl-2-oleoyl-*sn*-glycerol-3-phosphocholine (POPC) and its naturally occurring forms found in eggs (egg PC) were compared. POPC-coated chips gave an average run time of 290 ± 123 minutes while egg PC chips gave an average run time of 198 ± 102 minutes across five chips of each type, suggesting better performance from the POPC coating. Additionally, the use of a divalent cation in the preparation of the coating was investigated. Egg PC coatings prepared with 10 mM pH 7.4 Tris-HCl buffer with the addition of either 150 mM NaCl or 20mM CaCl₂ were compared. Coatings prepared with NaCl gave an average run time of 149 ± 36 minutes while those prepared in CaCl₂ had an average run time of 138 ± 36 minutes, leading to the conclusion that using a divalent cation in coating preparation has no impact on the long-term durability of the coating.

18.

CONFORMATIONAL BEHAVIOR OF A DILYSENE PEPTIDE CONSTRAINED INTO METALLACYCLIC CONFORMATIONS THROUGH TUNGSTEN COORDINATION

Paul Handali '18, Joseph Sanderson-Brown '18

Faculty Sponsor: Timothy P. Curran



19.

COMPUTER ASSISTED DRUG DESIGN: TOWARDS THE DISCOVERY OF NEW ANTIBIOTICS

Rahina Ishawu '18, Lauren Ollerhead '18

Faculty Sponsors: Vindya Thilakarathne, Amy Anderson, School of Pharmacy, University of Connecticut, Storrs

Drug resistant bacteria infections caused by species such as *Pseudomonas aeruginosa*, have become an increasing threat to recent public health. Our project aims to utilize computerized softwares to discover new drug molecules that target antibiotic resistant bacteria. Metal binding enzymes, Lpxc and DXR play pivotal roles in the formation of bacterial cell wall synthesis,

causing the two enzymes become major targets in novel antibiotic drug development. The resistance to available antibiotics creates a need for new antibiotics with activity against novel targets. The development of highly potent and specific inhibitors of LpxC and DXR will require a full understanding of the enzyme's catalytic mechanism, hence a small library of ligands (Trplones) were docked in Lpxc and DXR using the docking software AUTODOCK.

The docked inhibitor-ligand system was then examined using PYMOL to verify receptor-ligand binding interactions. PYMOL is visualization software that allows us to observe which amino acids in enzyme are interacting with the docked ligand molecule. Docking results were compared with experimental data collected at Prof. Anderson's lab and constructed a structure activity relationship for Tropolone ligands.

20.

COMPUTER AIDED OPTIMIZATION OF A CELL CULTURE IMAGE ANALYSIS MACRO

Tom Naragon '17

Faculty Sponsor: William H. Church

In cell culture image analysis, one vital step is the conversion of images to a binary form using thresholding. Due to the wide variation in image quality, variable cell brightness and spacing, finding the optimal threshold value for a given image without human input is difficult. While automatic thresholding methods exist in FIJI image-processing software, none of the methods perform consistently over the range of images typically obtained with our imaging instrumentation. Machine learning was employed to find a correlation between various data from cell images and a human determined optimal threshold value for each image. Gray-scale histogramatic data and a compressed format of each image are currently the two forms of data being used to train neural networks (NNs) to correctly predict, or at least approximate, the optimal thresholding value for any cell culture image taken under a certain set of conditions. Once a successful NN has been developed and trained, the NN algorithm will be integrated into an already existing image analysis macro, which will allow for complete automation of the image analysis process.

21.

GENE AND PROTEIN EXPRESSION OF KEY ENZYMES OF FATTY ACID BETA-OXIDATION IN PEDIATRIC IDIOPATHIC DILATED CARDIOMYOPATHY

Hieu Nguyen '17^{1,2}, Kathryn Chartfield², Brian Stauffer², Shelley Miyamoto^{2,3}. ¹*Trinity College, Hartford, CT*; ²*University of Colorado Denver School of Medicine, Aurora, CO* and ³*Children's Hospital Colorado, Aurora, CO*.

Faculty Sponsor: Michelle L. Kovarik

Purpose of Study: In heart cells, mitochondria produce energy by two main methods: glycolysis and fatty acid beta-oxidation (FAO) so that the heart can contract and pump sufficient blood through the body. In adults with heart failure (HF) and idiopathic dilated cardiomyopathy (IDC), the balance between glycolysis and FAO is shifted towards glycolysis and this imbalance is

thought to worsen the pathology. FAO enzymes have been demonstrated to be complexed with the mitochondrial electron transport chain's supercomplex, and this association is thought to be a mechanism regulating changes in this balance in children. The purpose of this study was to investigate supercomplex-related FAO enzyme expression in the myocardium of children with IDC. We hypothesized that IDC hearts will demonstrate a down-regulated pattern of FAO enzyme compared to non-failing (NF) hearts.

Methods Used: Left ventricular (LV) tissue from pediatric (age <12 years; n=41 IDC and n =24 NF) was subjected to Quantitative Real-Time Reverse Transcription PCR (qRT-PCR) in order to measure gene expression of key enzymes of FAO that are related to the supercomplex: Acyl-CoA dehydrogenases (very long chain-ACADVL, medium chain-ACADM, short chain-ACADS), 3-hydroxyacyl-coenzyme A dehydrogenase (HADHA), and electron transfer flavoprotein alpha polypeptide (ETF A). Protein expression for ACADVL and ETF A was also measured by SDS-PAGE and Western blots.

Summary of Results: In children with IDC, ETF A, HADHA, and ACADVL are upregulated transcriptionally, while ACADVL and ACADS in IDC expressed no differential regulation compared to NF. Somewhat paradoxically, both ETF A and ACADVL are down-regulated at the level of protein compared to NF.

Conclusions: In pediatric IDC, ETF A, HADHA and ACADVL may play a role in the directional shift from FAO to glycolysis as a more favorable source of energy. The difference between gene expression and protein expression of ETF A and ACADVL suggest that the shift happens translationally. Further study of these enzymes at the level of protein will provide better understanding of the mechanism underlying FAO-glycolysis unbalance in IDC and HF, and could lead to improved targeted treatment of pediatric IDC and HF.

22.

GENE EXPRESSION OF TRANSCRIPTION FACTORS IN PEDIATRIC HYPERTROPHIC CARDIOMYOPATHY AND NOONAN SYNDROME

Hieu Nguyen^{1,2}, Kathryn Chartfield², Brian Stauffer², Shelley Miyamoto^{2,3}. ¹*Trinity College, Hartford, CT*; ²*University of Colorado Denver School of Medicine, Aurora, CO* and ³*Children's Hospital Colorado, Aurora, CO*.

Faculty Sponsor: Michelle L. Kovarik

Purpose of Study: Hypertrophic cardiomyopathy (HCM) - a genetic heart disease in which the heart muscle abnormally thickens and causes difficulties for the heart to pump blood - is one common cause of heart failure (HF) and the most common cause of heart-related sudden death in people under 30 years of age. Noonan Syndrome (NS) is a genetic disease often characterized by short height, congenital heart defect, flat black-brown macules, delay in child development, and is a common cause of HCM in children. Biochemical differences between HCM patients who have NS and those who do not have NS are not well understood. The purpose of this study was to investigate gene expression of transcription factors related to cardiac development in the myocardium of HCM children who have NS and those who do not have NS. We hypothesized

that HCM hearts with NS will demonstrate an upregulated pattern of transcription factors compared to non-failing (NF) hearts and a different expression compared to non-NS hearts.

Methods Used: Left ventricular (LV) tissue from pediatric (age <12 years; n=6 HCM, n =6 NF, and n=4 NS) was subjected to Quantitative Real-Time Reverse Transcription PCR (qRT-PCR) in order to measure gene expression of: myocyte enhancer factor 2 family (MEF2-A and -C), Ca²⁺/calmodulin-dependent kinase (CAMKI and CAMKII), cAMP response element-binding protein (CREB), DNA sequence “GATA” binding factor (GATA-4 and -6), a subclass of basic Helix-Loop-Helix (bHLH) transcription factors (HAND-1 and -2), vascular smooth muscle alpha-actin, and human CAM kinase.

Summary of Results: All genes studied were upregulated in children with HCM compared to NF, especially in GATAs (21-22 folds), CAMKII, MEF2A, and CREB (8-11 folds). The transcription factors gene expression pattern in HCM hearts with NS was different than that seen in HCM hearts without NS, with GATA4, MEF2C, HAND1 being higher and GATA6, HAND2, CAMKI, CAMKII, MEF2A, and CREB being lower, while no difference was noted for the remainder of the genes studied.

Conclusions: In children with HCM, all of the above transcription factors play a role in the development of muscle thickness. The differential regulation of transcription factors between HCM with NS and HCM without NS suggest that mechanisms regulating HCM are different than those regulating HCM developed from NS. Thus, therapeutic targets tailored for HCM developed from NS are needed.

23.

SYNTHESIS AND CONFORMATIONAL ANALYSIS OF A METALLACYCLICDIPEPTIDE DERIVED FROM COORDINATION OF DIPROPARGYLCYSTEINE TO TUNGSTEN

Vu D. Nguyen '17

Faculty Sponsor: Timothy P. Curran

The objective of the experiment was to prepare a metallacyclidipeptide by reacting Boc-Prg-Prg-NHAr [Prg=Propargylcysteine] with W(CO)₃(dmtc) [dmtc = dimethyldithiocarbamate]. In the reaction the two alkynes will coordinate to the tungsten forming a bis-alkyne complex. Propargylcysteine was prepared using the method developed by Zephyr Dworsky '10 and Andy McTeague '10. The dipeptide Boc-Prg-Prg-NHAr was prepared using standard peptide coupling reactions, and it was characterized by ES-MS and ¹H NMR. The metallacyclidipeptide was prepared and purified by flash chromatography. Its identity was confirmed by ¹H NMR and ES-MS while its purity was established by HPLC. The conformation of the metallacyclidipeptide was probed by observing the alkyne hydrogen resonances using variable temperature NMR. These protons appear as singlets in the region around 11 ppm in the ¹H NMR spectrum. It was observed that there are a large number of singlets present in this region, and that they appear to coalesce to one peak as the temperature of the sample is raised to 354K. The large number of singlets in the spectrum indicates that at room temperature the metallacyclidipeptide adopts a large number of conformations. That the singlets coalesce to a single peak as the temperature is

raised indicates that the various conformers can interconvert. The data shows that this metallacyclicpeptide is flexible.

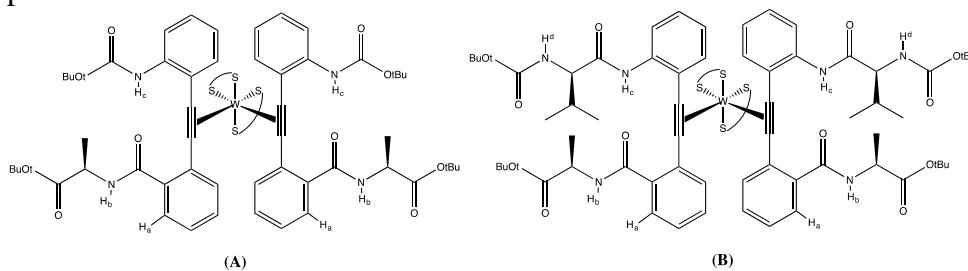
24.

SYNTHESIS OF TUNGSTEN BIS-ALKYNE COMPLEXES AND INVESTIGATION OF THE RETENTION OF PEPTIDE PORTION β -SHEET STRUCTURE AFTER COORDINATION TO TUNGSTEN

Elena-Marie Pedro '17

Faculty Sponsor: Timothy P. Curran

Neurodegenerative diseases such as Alzheimer's disease have been linked to the aggregation of β -sheet proteins¹. Therefore, investigating chemical models of β -sheet proteins may yield results that allow the behavior of these proteins to be understood. Research conducted by Kemp and Li (1995), found that peptide derivatives of 2-amino-2'-carboxydiphenylacetylene adopt an anti-parallel β -sheet conformation.² Previous research revealed that the coordination of one diphenylacetylene to the transition metal tungsten produced a mono-alkyne complex which continued to possess a β -sheet arrangement, despite being bonded to tungsten³. These findings allowed the examination of the possibility of two diphenylacetylenes coordinating to tungsten and synthesizing a tungsten bis-alkyne complex. Results indicated that a tungsten bis-alkyne complex (**A**) could in fact be synthesized. Therefore the objectives of this research are: i) to increase the yield of the tungsten bis-alkyne (**A**) and to determine if a tungsten bis-alkyne (**B**) which is comprised of a larger peptide derivative of 2-amino-2'-carboxydiphenylacetylene, could be synthesized and ii) to determine if the peptide portions of the bis-alkyne (**A**) retain its β -sheet arrangement. Additionally, if the bis-alkyne (**B**) can be synthesized, this research also aims at investigating if the peptide portion of (**B**) also retains its β -sheet arrangement. Details regarding the synthesis, purification and coordination of the peptide derivatives of 2-amino-2'-carboxydiphenylacetylene peptide to tungsten to produce tungsten bis-alkyne complexes will be presented.



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25.

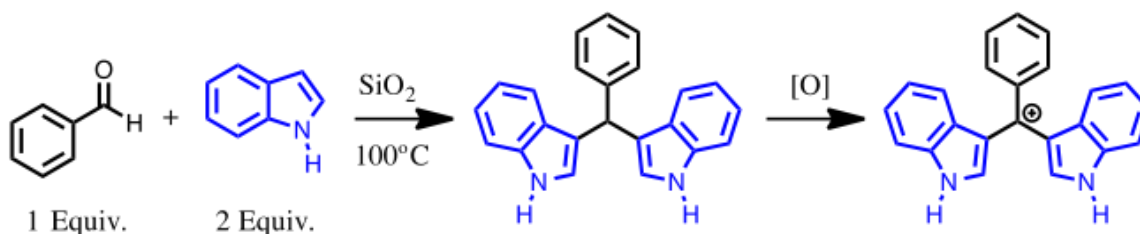
SYNTHESIS OF TURBOMYCIN B ANALOGUES FOR THE DEVELOPMENT OF PROSPECTIVE ANTIBIOTICS

Phong Quach '17

Faculty Sponsors: Cheyenne Brindle, Lisa-Anne Foster

The drastic emergence of antibiotic resistance bacteria combined with the paucity of new antimicrobial agents in recent years has made it necessary to develop novel antibiotics. Turbomycin B, which was isolated from soil microorganisms in 2004, was screened and found to have broad spectrum antibiotic effects toward both gram positive and gram negative bacteria. We hope to establish the structure-activity relationship of this promising novel antibiotics candidate via assessing the consequences of the modification of the indole and aldehyde portions of the turbomycin B on its biological activities. Thus far, we have synthesized an array of analogues to probe the steric and electronic effects of the phenyl and the indole components. The analogues were sent out for testing on a variety of bacterial strains to assess their activities.

Figure 1. General synthesis scheme of turbomycin B with indole and benzaldehyde



26.

THE APPLICATION OF ANALYTICAL TECHNIQUES IN ART CONSERVATION

Sarah Talcott '17, Jacqueline Busa '17

Faculty Sponsor: Henry DePhillips

Art conservators are able to repair original works as well as determine if a work is counterfeit through the analysis of its materials. A number of analytical techniques have been developed for the determination of resins, binders and pigments, both organic and inorganic, in easel paintings. Typically, those methods require that the sample be pretreated and, given that samples taken from easel paintings are very small, treatment usually results in loss of some of the original sample. Hence, any technique that permits direct analysis of sample components with no prior treatment is preferable. Direct Analysis in Real Time–Time of Flight Mass Spectrometry (DART-TOF-MS) is a mass spectrometric method in which samples do not require pretreatment. DART-TOF-MS was used to investigate the m/z profiles of seven different resins and four different oils as well as to identify organic pigments in paints. Six mass spectra of each resin and oil were obtained from a given sample. Two Principle Component Analysis (PCA) graphs were generated, one for resins and one for oils, using the six mass spectra for each material. It was determined that each resin yielded a separate and identifiable m/z grouping, while oils yielded very similar m/z patterns. Paints containing inorganic pigments were analyzed using Scanning

Electron Microscopy–Energy Dispersive Spectroscopy (SEM-EDS). The results of this research will help art conservators identify binders and varnishes in authentic easel paintings before they begin their restoration work.

27.

QUANTITATIVE ANALYSIS OF SYNTHETIC CATHINONES IN ORAL FLUID USING STIR BAR SORPTIVE EXTRACTION COMBINED WITH DIRECT ANALYSIS REAL TIME – TIME OF FLIGHT MASS SPECTROMETRY (DART-TOFMS)

Kathryn M. Tully '16

Faculty Sponsor: Janet F. Morrison

In the past few years, there has been an emergence of a new class of drugs called synthetic cathinones, which are marketed as “legal” alternatives to ecstasy that still produce the euphoric and stimulant-like effects. Synthetic cathinones, commonly known as “bath salts” or “plant food”, are advertised as legal highs because their warning labels commonly state that they are not for human consumption. Because cathinones are easily attainable, the popularity of these designer drugs has spread immensely over the last ten years, driving the need for the development of a reliable and quantitative analysis of cathinones in biological samples.

The current study explores the use of stir bar sorptive extraction combined with direct analysis in real time – time of flight mass spectrometry (DART-TOFMS) for the rapid detection and quantitative analysis of synthetic cathinones in oral fluids. DART-TOFMS is an attractive method of analysis for the target analytes (butylone, diethylpropion, flephedrone, mephedrone, methedrone, methylenedioxypropylone, methylone, ethylone and naphyrone) because the cathinones of interest are secondary and tertiary amines that often require derivatization for other types of mass spectrometry, such as GCMS. Stir bar sorptive extraction (SBSE) with PDMS and EG-silicone fibers was chosen because the presence of an analyte can still be confirmed at very low analyte concentration, and the different phases allows for characterization of the synthetic cathinones with varying polarities. The parameters being explored are sample pH, extraction temperature and time, automated versus manual sample acquisition on the DART-TOFMS, and different interfaces of the DART-TOFMS. Results of parameter optimization experiments designed to maximize SBSE recoveries will be presented.

28.

MEASURING PEPTIDASE ACTIVITY IN *DICTYOSTELIUM* AS A FUNCTION OF CELL LIFE CYCLE USING A PEPTIDE SUBSTRATE REPORTER

Allison Tierney '17, Kunwei Yang '17

Faculty Sponsor: Michelle L. Kovarik

Peptide substrate reporters are fluorescently labeled substrates that can be acted upon by one or more enzymes of interest. In many cases, peptide substrates are easier to work with than full-length protein substrates; however, these reporters can be degraded by peptidases. As a result, proteolysis of peptide reporters can be a problem when attempting to study enzymes in intact cells and lysates. We are adapting a peptide substrate reporter for protein kinase B (PKB) that

was developed in human cells for use in *Dictyostelium*, a social amoeba with three unique life cycle stages that is used as a common model organism. We plan to measure PKB activity in *Dictyostelium* lysates using the peptide VI-B, but first we must characterize the stability of this reporter in lysates. The results of the degradation assays are measured by capillary electrophoresis with laser-induced fluorescence (CE-LIF). This summer, we determined that VI-B undergoes minimal proteolysis in our degradation assays ($t_{1/2} = 81-93$ min) in 3-mg/mL protein lysate from both vegetative cells and developing cells. When comparing 0, 2, 4 and 6 hour time points of development, there is no significant difference in half-life. On-going work includes beginning phosphorylation experiments with various *Dictyostelium* mutants including *pkbA*-, *pkbA*-/*pkgB*-, *cAR1*-, and *pten*-mutants.

29.

A PHOSPHORYLATION ASSAY FOR PKB ACTIVITY IN DICTYOSTELIUM USING A PEPTIDE REPORTER

Kunwei Yang '17, Allison Tierney '17

Faculty Sponsor: Michelle L. Kovarik

Protein kinase B (PKB) is an enzyme that assists cells in proliferating under stressful conditions. In human cells, aberrant PKB activity is implicated in many cancers, making PKB an important target for further research. We are studying PKB in *Dictyostelium*, a social amoeba that has highly conserved PKB signaling pathways similar to those in human cells. In *Dictyostelium*, PKB is activated when cells are under nutrient-poor conditions. We are measuring PKB activity in *Dictyostelium* lysates using the peptide reporter VI-B, a fluorescently labeled substrate for PKB. Vegetative cells are first lysed in lysis buffer, and the lysate is mixed with VI-B and kinase buffer that provides co-factors and inhibits proteases and phosphatases. Starved cells are developed for two hours, stimulated with cAMP pulses for another hour, lysed and studied with VI-B. The reactions are incubated for one hour and aliquots are taken out at various time points to assess phosphorylation by capillary electrophoresis with laser-induced fluorescence (CE-LIF). Based on the integration of peak areas on the electropherograms, the % area of phosphorylated VI-B is calculated as a measurement of PKB activity. In our experiment, cAMP pulsing successfully activated *Dictyostelium* PKB, which phosphorylated the reporter peptide VI-B. Though background phosphorylation of other kinases was found in vegetative cells (0.037 $\mu\text{mol pg}^{-1} \text{ s}^{-1}$, 4.1% after 60 min), the much higher phosphorylation in starved cells (0.054 $\mu\text{mol pg}^{-1} \text{ s}^{-1}$, 8.1% after 60 min) confirmed that the phosphorylation by PKB was specific to development. We also performed negative control experiments using buffers lacking ATP or Mg^{2+} , which are required for kinase activity. For future work, we will conduct more replicates to prove the reproducibility of the results and use both *pkb* null *Dictyostelium* cells and PI3 kinase inhibitors LY294002 to check for specificity of the reporter for PKB.

30.

PROPERTIES OF THE LIQUID-VAPOR INTERFACE BETWEEN AIR AND CHLOROIODOMETHANE

Tuizhi Yu '16

Faculty Sponsor: Maria Krisch

Surface tension is a physical property that has many applications in industry and atmospheric chemistry. We studied the properties of the liquid-vapor interface of aqueous chloriodomethane (CH_2I_2) solutions by measuring the surface tension of different concentrations of CH_2I_2 solutions using the Wilhelmy plate method. The experiment was performed on a tensiometer. CH_2I_2 solutions with concentrations of between 1×10^{-3} M and 6×10^{-3} M were measured. We found that 3×10^{-3} M CH_2I_2 increases the surface tension to 78.26 mN/m from 72.8 mN/m for pure water. It is unusual for organic molecules to raise the surface tension of water.

COMPUTER SCIENCE

31.

AN ACCELERATED APPROACH TO EIGENVALUE COMPUTATION USING THE FADDEEV-LEVERRIER ALGORITHM

Rahul Chandrashekhar '17

Faculty Sponsor: Peter Yoon

We present an accelerated implementation of the Faddeev-Leverrier algorithm (FLA) to solve the Eigenvalue Problem. The FLA may not be one of the most computationally suited algorithms for the Eigenvalue Problem, but it is rather preferred for its algebraic stability. It uses a series of recursive steps to calculate the coefficients of the characteristic polynomial while maintaining the original matrix at every step. The roots of the characteristic polynomial give us the eigenvalues. The recursive nature of the algorithm results in data dependency between individual steps reducing the parallelism. To this end, we present a streamlined approach which makes efficient use of the GPU memory and CPU host memory. We also use efficient methods of data allocation, task allocation and synchronization between threads to maximize the performance. Our results show that our multi-core GPU implementation outperforms the multi-core CPU version for large matrices.

32.

ACCELERATING TRIDIAGONAL MATRIX INVERSION ON THE GPU

Bemnet Demere '18, Ebenezer Hormenou '18

Faculty Sponsor: Peter Yoon

Inverting a matrix is a more computationally challenging process than solving a linear system. However, in fields such as structural engineering, dynamic systems, and cryptography, computing the inverse of a matrix is inevitable. In this poster, we present an accelerated procedure for computing the inverse of diagonally dominant tridiagonal matrices on the GPU. The algorithm is based on the recursive application of the Sherman-Morrison formula for tridiagonal matrices. The preliminary experimental results on Nvidia Tesla K20c GPUs show

that our GPU implementation of the inversion procedure outperforms the conventional CPU-based implementations with a speedup of up to 24x.

33.

GPU-ACCELERATED VLSI ROUTING USING GROUP STEINER TREES

Basileal Imana '17, Venkata Suhas Maringanti '17

Faculty Sponsor: Peter Yoon

The problem of interconnecting nets with multi-port terminals in VLSI circuits is a direct generalization of the Group Steiner Problem (GSP). The GSP is a combinatorial optimization problem which arises in the routing phase of VLSI circuit design. This problem has been intractable, making it impractical to be used in real-world VLSI applications. This poster presents our initial work on designing and implementing a parallel approximation algorithm for the GSP based off an existing heuristic on a distributed architecture. Our implementation uses a CUDA-aware MPI-based approach to compute the approximate minimum-cost Group Steiner tree for several industry-standard VLSI graphs. Our implementation achieves up to 302x speedup compared to the best known serial work for the same graph. We present the speedup results for graphs up to 3k vertices. We also investigate some performance bottleneck issues by analyzing and interpreting the program performance data.

34.

THE SPECTRAL PROPERTIES OF ZIG-ZAG PRODUCTS

Bingqing Li '17, Yicheng Shao '16

Faculty Sponsor: Takunari Miyazaki

In practice, it is often desirable to construct graphs that are highly connected and yet sparse. Such graphs allow many nodes to communicate with one another using least resources. Expander graphs are families of sparse graphs that have strong connectivity properties. In addition to networks, expander graphs are also useful in coding theory, cryptography, and complexity theory, to name a few.

The objective of this project is to study the spectral properties of particular families of expander graphs called *zig-zag products*. The notion of zig-zag products was first introduced by Reingold, Vadhan and Wigderson in their seminal paper published in 2002. It is a method to generate a large graph Z from two given base graphs X and Y , where Z 's connectivity properties are determined by those of X and Y .

In our project, we experimented with different base graphs to test the quality of zig-zag products. We examined the base graphs' different properties, such as their connectedness and randomness, and the effects on the resulting zig-zag products. Our experiments showed that the zig-zag products do not appear to be Ramanujan (a special class of expander graphs of very high quality); yet, as we increase the sizes of base graphs, the zig-zag products' spectral properties seem to approach towards desirable values.

35.

TENSOR BASED HYPERGRAPH MATCHING ON THE GPU

Minghui Liu '17

Faculty Sponsors: Lin Cheng, Peter Yoon

This research project addresses the problem of establishing correspondences between two hypergraphs. Previous methods of hypergraph matching algorithms mostly use unary or pairwise constraints. We propose an implementation of a new method that utilizes higher order graph potentials, which give our algorithm more resistance to rotation and distortion. This method also utilizes tensor to store the affinity between feature tuples of two hypergraphs. Our main contribution is speeding up this new method by creating a parallel implementation on the GPU.

36.

PARALLEL HOMOTOPY METHOD FOR SYMMETRIC EIGENVALUE PROBLEMS

Peter Reheis '16

Faculty Sponsor: Peter Yoon

The Homotopy method can be applied to solve eigenvalue-eigenvector problems for symmetric tridiagonal matrices. Often it is not of any interest to compute every eigenvalue of a matrix, rather only a select few eigenvalues are desired. Because of the order preserving property, the Homotopy method is able to compute any specific eigenvalue without the need for computing any other eigenvalues and thus the Homotopy method is a highly parallel algorithm. The Homotopy method is very efficient for eigenvalue computation, especially for graded matrices. Our implementation on the GPU exploits the inherent parallelism of the Homotopy method to reduce computation time.

37.

ENHANCING USABILITY OF APP INVENTOR'S BACKPACK FEATURE AND CLOCK COMPONENT

Grace Ryu '16

Faculty Sponsor: Ralph Morelli

This software development project addressed the design and implementation of a Backpack feature and the modification and re-implementation of the existing Clock component in the App Inventor Integrated Development Environment (IDE). App Inventor is a block-based programming language that enables users to build, design, and test Android mobile apps. The focus of the project was how to improve the user experience of App Inventor with respect to two specific features: a copy-and-paste featured called Backpack and the existing Clock component. Backpack feature was modified to make it more consistent and compatible with the rest of the App Inventor environment. The Clock component was redesigned such that date and time can be formatted according to a user's own national standard with no restriction. The changes in the Clock component were added to the recent release of the App Inventor code base , and the Backpack feature is currently in the process of code review. The full poster will describe the design process and code in details.

ENGINEERING

38.

IMPROVING A SHOCK TUBE DIAPHRAGM CUTTING SYSTEM

Tasha Adams '18, Andrew Agard '18

Faculty Sponsor: John Mertens

Diaphragms in circular shock tubes are more prone to tearing than diaphragms in contact with flat edges during shock tube experiments. In order to address this problem as economically as possible, a design process was carried out that identified and analyzed alternative solutions to the problem. An elegant solution was synthesized that consisted of a 3D printed plastic circular ring with a square opening that would fit into a facet machined into the end of the shock tube. Currently the part has been rendered in SolidWorks and 3D printed after numerous sketches and incremental prototypes. The end of the shock tube was machined and then the driver section of the shock tube was transported outside for outdoor testing of the diaphragm. Eliminating the diaphragm tearing will prevent the diaphragm from interfering with shock tube experiments. A new support structure was used to conduct outdoor shock tube experiments. An optical laser system was used to measure the speed of the shock wave and trigger a high speed camera, which provided video of the diaphragm rupture. Diaphragm tearing was effectively eliminated by the design. In a separate but related project, the chemistry of nitromethane ignition in shock tube experiments was modeled using a reaction mechanism and open source software, developing a new modeling capability at Trinity College.

39.

IMPLEMENTATION OF INTELLIGENT, REAL TIME HEART SOUND DETECTION WITH EMBEDDED SYSTEM

Dana Wensberg '18, Deven Roberts '18

Faculty Sponsor: Taikang Ning

An intelligent and robust device was created and implemented to detect the two major heart sounds: S1 and S2. S1 is produced by the closing of the mitral and tricuspid valves and S2 by the closing of the pulmonary and aortic valves in the heart. The input signal is acquired through the use of a modified stethoscope that contains a microphone embedded in a rubber tube connected to the diaphragm. The collected signal then runs through an active filter circuit to produce a stronger, cleaner waveform. This resulting waveform is then mathematically analyzed, in real time, by an Arduino Uno microcontroller, and is displayed on an LCD with the S1 and S2 moments identified and marked. The embedded program undergoes a calibration period to collect meaningful mathematical values, and then uses these values, along with other mathematical processes, to identify S1 and S2 moments visually on the LCD. Our results show a high degree of accuracy on the limited signals that we are able to play over a set of noise canceling headphones.

40.

WAVELET AND MAIN COMPONENT DETECTION DENOISING FOR POWER DELAY PROFILES

Hang Yang '16

Faculty Sponsor: Lin Cheng

Power Delay Profiles (PDP) are signals obtained by devices mounted on running cars that emit and receive signals. However, the true signal, when received, is adulterated with noise from the background. Thus in order to analyze the true signal, noise has to be removed or reduced. One of the techniques that this research uses to denoise the signal is to implement wavelet denoising to smooth out the noise in the signal in order to maximize the signal to noise ratio (SNR). Wavelet denoising has a set of parameters, including the noise threshold selection rule, the wavelet function, the decomposition level. Another technique that this research uses to denoise signals is called Main Component Detection, where a program can detect the main components from a signal by setting such parameters as observation level and thus denoise the signal.

ENVIRONMENTAL SCIENCE

41.

THE EFFECT OF CLEAR CUTTING ON SUB-ALPINE FOREST SOIL NUTRIENT CONCENTRATIONS OF ALUMINUM AND CALCIUM IN THE WHITE MOUNTAIN NATIONAL FOREST

Jack Agosta '17

Faculty Sponsors: Jonathan Gourley, Andy Coulter (US Forestry Service)

Clear-cutting is the most popular and economically profitable method of logging and has been in use for centuries to provide lumber. However, there are several negative side effects of this logging practice, including increased soil erosion and nutrient loss. Aluminum and Calcium have been found to be incredibly important factors in forest growth. Aluminum, when bound in organic material can be highly beneficial to seedling survival. However, when it is not bound to anything, aluminum on its own can be highly toxic to plant life. Calcium is a micronutrient that is essential to seedling root and shoot development and is used in plants' cell walls. This study is set up to examine these effects in two sites that have already been clear-cut. Baseline nutrient levels were taken in 2013, and then the sites were re-sampled post-cut in 2014. At the Western site, Hogsback, nutrient levels showed significant decreases. However at the Eastern site, Millstone, where slash was layed down to mitigate harmful effects, nutrient levels showed significant increases after one year.

42.

THE EFFECTS OF CLEAR CUTTING ON THE SOILS OF THE WHITE MOUNTAIN NATIONAL FOREST (WMNF), NEW HAMPSHIRE AND MAINE, USA

David Johnston '16, Lauren Tierney '16, Jack Agosta '17, Cassia Armstrong '18

Faculty Sponsors: Johnathan Gourley, USDA Forest Service

The practice of 'clear cutting' is one of the most prominent and efficient techniques used by logging companies to remove trees from forested areas. This process has been used by lumber miners for years and can have negative impacts on the soils and in turn the natural flora and fauna. The almost complete removal of vegetation cover leaves the land significantly barer than its natural appearance. This causes issues such as erosion, nutrient run-off and increases in toxic chemicals to arise. This study began in the summer of 2013 and will continue until approximately 2018. The aim is to create a baseline of nutrient concentrations of aluminum and calcium, as well as toxic concentrations of mercury in organic matter and monitor over time how each one changes. This will allow for conclusions to be draw as to what effects clear cutting has, if any, on the soil. There are three sites at which sampling techniques have been focused. The Millstone Site is located in the easternmost section of the WMNF, in Maine, the Douglass Brook Site is located more centrally in the WMNF, in New Hampshire, and the Hogsback site is located to the far west of the WMNF. All three sites have been sampled prior to clear cutting in 2013, with two new samples being taken from the Milestone and Hogback sites after the clear cutting occurred in October 2014 and August 2014 respectively. The final results will be shared with the USDA Forest Service, and help develop environmentally friendlier clearcutting methods in the future.

MATHEMATICS

43.

ATTACK OF THE TINY TITANS

Jeremy Dam '17

Faculty Sponsor: Brooks Emerick

Discrete-time models are the traditional approach for capturing population dynamics of a host-parasitoid system. Recent work has introduced a semi-discrete framework for obtaining model update functions that connect host-parasitoid population levels from year-to-year. In particular, this framework uses differential equations to describe the host-parasitoid interaction during the time of year when they come in contact, allowing specific behaviors to be mechanistically incorporated. We use the semi-discrete approach to study the effects of infected-host-feeding and parasitoid migration. We find that infected-host-feeding does stabilize the system even with a time-dependent feeding rate. Parasitoid migration, in contrast, does not stabilize the system but if combined with density dependence parasitism, it is always asymptotically stable, yielding a coexistence between hosts and parasitoids. Overall, both infected-host-feeding and parasitoid migration create an inefficiency in the parasitoid reproduction habits from year to year.

NEUROSCIENCE

44.

THE EFFECTS OF THE KETOGENIC DIET ON ESTROUS CYCLE REGULATION IN MICE

Ariana A. Adamski '17, Elizabeth M. Foley '17, Julia R. Duggan '16, Livia S. Wyss '16
Faculty Sponsors: Susan A. Masino, David N. Ruskin

Clinical use of the very low carbohydrate ketogenic diet (KD) as a treatment for epilepsy is sometimes accompanied by menstrual cycle irregularities. This experiment was performed to determine if the estrous cycle was influenced by KD feeding in female BTBR mice. 30 female mice were separated from the male litter-group when weaned. Once these mice reached an age of sexual maturity, vaginal smears were taken daily with 20uL of saline solution via a micropipette and placed on glass slides to be observed for cell types characteristic to each of the four stages--proestrus, estrus, metestrus, and diestrus. After these samples air-dried, they were treated with Schorr/hematoxylin stain and again observed under a microscope at 100X and 400X magnification for more accurate demonstration of the unique cell types. Mice were scored for four weeks on regular diet before being switched to ad libitum KD feeding for six weeks. Results revealed that when the mice were fed a strict KD (6.6:1 fat:(protein + carbohydrate), 8% protein), their estrous cycle was disrupted, characterized by a constant state of diestrus with the mice rarely or never reaching estrus; the other two stages were either skipped completely or difficult to identify. However, when fed a milder KD (3.0:1, 18% protein) it was found that all of the phases were regular and present. The effect of the strict KD is probably due to the low protein content of the diet. We plan to use the milder KD to examine interactions of estrous cycle, KD feeding, and behavior.

45.

STUDYING THE EFFECT OF AN ASTROCYTE-SECRETED FACTOR ON SH-SY5Y HUMAN NEUROBLASTOMA CELLS

Sheila Njau '17, Nathaniel Thiemann '17, Isabella Dahilig '18
Faculty Sponsor: William H. Church

Astrocytes are glial cells located in the central nervous system (CNS) that are known to secrete various neurotrophic & apoptotic factors. Experiments conducted using wild type astrocyte conditioned media (WTACM) on undifferentiated SH-SY5Y cells suggest that a neurotrophic factor present in the media protected the cells preferentially when compared to differentiated SH-SY5Y cells. It is unclear whether this factor was astrocyte-secreted or a component of fetal bovine serum (FBS), which is used to supplement the growth of the cells. To further investigate the source of these factors, undifferentiated cells were treated with media from astrocytes grown with FBS either present in or absent from the media. While FBS clearly contributed neurotrophic factors which affected the undifferentiated SH-SY5Y cells, experimental results indicated the presence of an astrocyte-secreted factor that induced cell death. Fractionation experiments were conducted to narrow down the size of the factor and the results suggest the presence of neurotrophic factors that weigh below 50kDa and between 50 and 100kDa as well as a cell-death

inducing factor that weighs between 50 and 100kDa. Future research aims to identify the nature of these astrocyte-derived neurotrophic factors and cell-death inducing factor.

46.

AN IN VIVO STUDY OF THE EFFECTS OF CHRONIC CAFFEINE CONSUMPTION ON SYNAPTIC EFFICACY IN THE HIPPOCAMPUS OF FREELY MOVING RODENTS

Jenna Park '16, Nicholas Bellas '16, Thomas Gitchell '18, Vy Phan '18

Faculty Sponsor: J. Harry Blaise

The Electrophysiology Laboratories at Trinity College currently uses the synapse from the perforant path to the dentate gyrus of the hippocampus as a cellular model system to study the effects of exposure to a host of conditions on brain function related to learning and memory. In this study, we investigated the effects of exposure to caffeine, one of the most consumed stimulants in the world today. Caffeine has long been known to benefit neurological functions, such as alertness, attention and memory. Despite its popularity, studies of the effects of caffeine on synaptic efficacy are still lacking. Long-term potentiation (LTP) is a persistent change in the strength of synaptic connections between neurons that increases the efficacy of information transmission between these neurons. LTP is widely considered a cellular mechanism underlying the processes of learning and memory. The aim of the present study is to use LTP as a model to assess the effects of caffeine consumption on learning and memory. Experimental Sprague-Dawley rats were administered caffeine daily (10 mg/kg) in their drinking water at least 3 weeks prior to collection of experimental data. At 70-120 days of ages rats under anesthesia underwent a surgical procedure to chronically implant a stimulating electrode into the perforant path—a major multimodal sensory input pathway to the hippocampus—and a recording electrode into the dentate gyrus—the first branch of the hippocampal tri-synaptic circuit. All experimental protocols were performed according to the United States Public Health Service's Guide for the Care and Use of Laboratory Animals and were approved by Trinity College Institutional Animal Care & Use Committee (IACUC). After at least 5-7 days of post-surgical recovery, population spike amplitude (PSA) measures of LTP induction were acquired in freely behaving rats using electrophysiological recording techniques. Our results indicate that rats that were exposed to caffeine (n =14) show a statistically significant ($p < 0.05$) lower level of LTP induction compared to controls (n =15). However, no statistically significant differences were found in the duration (or persistence) of LTP between controls and caffeine rats. More studies are needed to determine the exact mechanism through which caffeine alters LTP induction.

47.

SHORTENED MEMORY FOR INTENTION SCREENING TEST

Meaghan Race '18, Erin Aisenberg '16

Faculty Sponsor: Sarah Raskin

The Memory for Intention Screening Test (MIST) is a measure of prospective memory. Prospective memory (PM) is the ability to form and recognize intentions after delay period (Einstein & McDaniel, 1990). The MIST was designed to be a brief standardized clinical

measure of PM in clinical populations using event-based and time-based cues (Raskin, 2009). However, in clinical practice, the MIST can be cumbersome as it requires approximately 30 minutes. This study was conducted to modify the original MIST for ease of administration in a standard battery. Using tasks from the original test the MIST was revised to allow for the use of other standard clinical measures as the ongoing task. In addition, a series of prospective memory tasks and retrospective recognition recall questions were removed. The administration time was cut from 35 minutes to 18 minutes. After pilot studies using a variety of tests as the ongoing task (Boston Naming Test, Wisconsin Card Sorting Test, WAS-IV) these measures were all found to be problematic due to the need to interrupt the delay period of the MIST to give instructions. In the current study, background information questionnaires were used instead and this appears to be both sufficiently attention demanding but also does not require interruption by the experimenter. Data are presented to support the psychometric properties of the shortened measure.

Resources

- Einstein, G. O., & Mc Daniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 717-726.
- Raskin, S. A. (2009). Memory for intentions screening test: Psychometric properties and clinical evidence. *Brain Impairment*, 10(1), 23-33.

48.

SOCIALLY CONDITIONED PLACE PREFERENCE IN RODENT AUTISM STUDIES

Hannah R. Reichert '18

Faculty Sponsors: David N. Ruskin, Susan A. Masino

Autism is a hereditary disorder that is characterized by social impairments; specifically, patients avoid interacting with others, perform repetitive actions, and show a lack of social motivation. Because certain strains of mice exhibit similar behavior, they have served as animal models in recent experiments that studied conditioning and the ketogenic diet, two methods that may improve autistic behavior. Before applying the diet, a three-chamber apparatus that had different patterned walls and floors was used to test C57BL (wild type) mice to determine an ideal setup for conditioning. For the first experiment, the test mouse was placed in one side of the apparatus with a corral that either contained a stranger mouse or was empty. The next day, that same mouse was paired with the other side with a corral that contained a stranger mouse or was empty (the opposite of the first day). The test mice alternated between chambers for 15 minutes each day for two weeks. The second experiment resembled the first one, except that the test mice were housed individually throughout the procedure to promote sociability. In the third experiment, conditioning occurred in housing situations for 24 hours with either aspen or paper bedding as the social cue. For two weeks, the test mice were alternately housed with their siblings with one bedding on one day and then housed alone with the other bedding the following day. Both the time the test mice spent in each chamber and, if applicable, the time they spent touching the corrals were recorded for the experiments. At the end of all paradigms, test mice were observed for the presence of a conditioned place preference. Overall, none of the experiments clearly resulted in the presence of a socially conditioned place preference. Future research will focus on improving the current protocols to produce a stronger, more reliable socially conditioned place

preference in the test mice. Ultimately, the ketogenic diet will be incorporated and the findings may be applied to humans to improve autistic behavior more effectively.

49.

THE KETOGENIC DIET DOES NOT ALTER TISSUE PURINE LEVELS IN MOUSE BRAIN

Jacob G. Rubin '15, Michelle Dyer, Emory Payne '18
Faculty Sponsor: William H. Church

Adenosine has been implicated in the therapeutic effect of the ketogenic diet. It is also known to modulate dopaminergic activity. We previously showed that the ketogenic diet increased cortical dopamine activity. This study evaluated whether the ketogenic diet produced changes in brain adenosine levels and purine activity. Samples from the previous study were analyzed for purines using a high performance liquid chromatography method for the quantification of adenosine, hypoxanthine, xanthine, and inosine. No alteration in tissue levels of purinergic compounds was found in the ketogenic diet treatment group when compared to the control diet group. A negative correlation between dopaminergic activity and adenosine tissue levels was found in the cortex of the control diet group but was absent in samples from the ketogenic diet group. These findings support previous literature regarding interaction between the dopaminergic and purinergic neuronal systems and suggest a possible ketogenic diet-induced change in the purinergic modulation of cortical dopaminergic activity in mice.

50.

REVIVAL OF CRYOPRESERVED HUMAN PERIPHERAL BLOOD MONONUCLEAR CELLS AND CHARACTERIZATION OF LYMPHOCYTE ACTIVATION GENE-3 AND OTHER IMMUNE CELL SURFACE MARKERS BY FLOW CYTOMETRY

Jasmin Williams '17

Faculty Sponsors: Alison Draper, Sunitha Sura, Annabelle Rodriguez-Oquendo, UCONN Health Center

Cryopreservation of isolated peripheral blood mononuclear cells (PBMC's) is considered a standard procedure to store human blood samples and optimizes the use of available resources. However, the effect of cryopreserved PBMC's may not present the same response as a freshly obtained sample. In this study, we investigated the viability of live cells and the expression of cell surface markers after cryopreservation. Flow cytometry was used to assess the amount of live cells that are present in the sample as well as characterize cell surface marker such as the immune checkpoint inhibitor lymphocyte activation gene-3 (LAG-3). Data for several cell surface markers yielded similar results compared to previous subjects obtained from fresh samples. We thus concluded that efficient recovery of cryopreserved PBMC's suggests that flow cytometry can be performed on selected, prospectively stored samples once clinical endpoints have been achieved and produced a good yield of live cells to be analyzed.

PHYSICS

51.

CAN ELECTRONS DIFFRACT FROM LASER INDUCED PLASMONIC NEAR-FIELDS?

Prawesh Dahal '18, Akrit Mudvari '18

Faculty Sponsor: Brett Barwick

Electron diffraction is a common technique used in microscopy to study crystals, protein structures and other periodic material structures. Electrons can also diffract from standing waves of light, which was first predicted in the 1930's and experimentally demonstrated in 2001. We propose a new variation on electron diffraction and ask the question: Can electrons diffract from a periodic near field? When an electromagnetic wave impinge on metallic surfaces, the free electrons in the metal experience a force. This optic electric force on the electrons causes them to move together. This collective electron oscillation is known as a plasmonic near-field. We simulate these plasmonic near field patterns using COMSOL, which acts as a finite element method differential equation solver, and then we simulate electron diffraction patterns that would result when electrons travel through the plasmonic near-field.

SOCIAL SCIENCES

52.

PERCEPTUAL LEARNING AND TOPIC MANIPULATION

Nicholas Celestin '16, Ted Ballenger '17

Faculty Sponsor: Elizabeth Casserly

Those with hearing impairments will often attempt to shift conversation to a particular topic area in order to minimize the relevant lexical options (citation?). However, standard auditory training methods do not typically focus on any specific topic area, and do not allow participants to manipulate the topic as they would in a real conversation. When a person does successfully narrow down their lexical options (perceptual space) through subject knowledge or manipulation, it allows that person to engage in top-down predictive speech processing, rather than relying purely on real-time speech data in order to garner meaning. This study will examine the potential of training which allows the participants moderate control over the subject matter. Normal-hearing participants listening to noise-vocoded speech simulating the processing of an eight channel cochlear implant will be assigned to either a control or test condition. In both cases, participants will complete two pre-tests, one hour of training, and five post-tests to assess perceptual learning. This poster presents the planning, stimulus design, and computer programming that occurred over the summer session to make this work possible. The experiment is currently ready to begin recruitment.

53.**EXTERNAL FORCES, INTERNAL RESPONSES: LOCAL GOVERNMENT POLICIES TOWARD IMMIGRANTS OVER TIME**

Nour Chamseddine '16, Kaitlyn Sprague '16

Faculty Sponsor: Abigail Fisher Williams

In 2006-2007, nearly one hundred US towns considered or passed ordinances that aimed to restrict the presence of unauthorized immigrants, while a similar number passed ordinances to accommodate immigrants. Restrictive ordinances have received considerable attention from the media and from scholars, who have used consideration of restrictive ordinances as a measure of local anti-immigration policymaking. Case studies of immigrant destinations, however, suggest that local restriction is not widespread, and where it does occur, it is usually fleeting. Concerns about fiscal or reputational costs of immigration enforcement appear to rein in municipal restriction. To test this hypothesis, four undergraduate coders reviewed court and legal documents to determine the current status of the 2006-2007 restrictive ordinances. We found that many ordinances had indeed been reined in over time. We then compared these findings to surveys of current local officials in 28 of these “restrictive” towns. Despite evidence that these municipalities considered or passed ordinances, local officials do not report these activities consistently when surveyed. On the whole, however, towns that introduced restrictive ordinances do report implementing more restrictive practices toward immigrants, while towns that considered or passed accommodating ordinances report greater accommodating activity.

54.**DESIGNING ON-LINE ASSESSMENTS FOR METACOGNITION**

Bettina Gonzalez '16, Lauren Thomann '16, Evan Scollard '17

Faculty Sponsors: Dina Anselmi, David Reuman, HMTCA Middle School

In the continuation of an eight-year study, we will be examining metacognition in 8th grade (13-14 years old) social studies students. Specifically, we will introduce the experimental group to metacognitive strategies through instructional interventions and will assess their subsequent performance for evidence of metacognitive skill through qualitative and quantitative self-report assessments that we have developed. In the upcoming study we will use two games – “Frog Escape” and “Oregon Trail” – to serve as an assessment and an intervention, respectively. We will use the pre-intervention and post-intervention scores on “Frog Escape” (a strategy game that requires metacognitive skill) to track metacognitive development, as well as assess initial abilities between the control and experimental groups. “Oregon Trail”, on the other hand, will serve to foster metacognitive growth as the students navigate a fictional family through a journey to the West Coast in 1830s America, supplemented by think-aloud assessments in a subset of participants. The introduction of these two games marks a transition to on-line measures, which are performance evaluations conducted during the task, whereas off-line measures are self-reported after the task. The literature (Veenman, 2011) suggests that on-line measures offer greater validity and accuracy, which we intend to supplement with the introspective elements of the off-line measures. Results will determine whether or not metacognitive intervention in 8th grade social studies classes will elevate metacognitive strategy use and skill.

