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EIGHTH ANNUAL SUMMER RESEARCH SYMPOSIUM TRINITY COLLEGE

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BIOLOGY

1.

DOES A COMPOST PILE'S INVERTEBRATE COMMUNITY VARY WITH ITS KITCHEN SCRAP CONTENT?

Sadichhya Adhikari '14, Bridget Tevnan '14

Faculty Sponsor: Scott Smedley

Composting is an increasingly popular, environmentally friendly means of disposing household kitchen scraps. Since 2008, we have conducted an experiment to test the claim that addition of animal-based scraps increases visitation by scavenging vertebrate wildlife. Three compost piles were set up in a woodland adjacent to homes and were remotely monitored by cameras: CON (a control pile with a core of leaf mulch covered by straw, without kitchen scraps), VEG (with the addition of vegetable scraps), and MIX (with an addition of vegetable and animal products).

Since informal field observations suggested that the number of invertebrates might vary among these treatments, a study was conducted to compare the piles' invertebrate communities. Pile material (mulch and straw separately) was sampled using Tullgren funnels to extract its invertebrate inhabitants, which were sorted into 19 taxonomic groups (e.g., earthworms, beetles, insect larvae, millipedes) and the number of individuals per group determined. The extremely minute, and very numerous, mites and springtails were not analyzed.

For these 19 taxa, a total of 25,294 individuals were censused. Collectively, there was a strong association with treatment (CON < VEG < MIX) and with substrate (mulch < straw). When analyzed separately, the eight most abundant taxa typically (seven out of the eight) showed an association with pile treatment. Five out of these seven groups displayed a pattern of density of CON < VEG < MIX. These results are consistent with the hypotheses that increased diversity of food scraps leads to a higher density of invertebrates. The MIX pile with animal and vegetable scraps likely had higher protein levels than the strictly vegetable scrap and control piles. Underlying differences in invertebrate communities, particularly for larger-bodied taxa such as earthworms, may thus in part explain variation in the visitation of facultative scavengers that may also prey on invertebrates.

2.

PHENOLOGIC SHIFT: ARE HAWKS ON THE EAST COAST ADAPTING THEIR MIGRATORY PATTERNS TO CLIMATE CHANGE?

Jason Baird '14

Faculty Sponsor: Joan Morrison

Hawks and many other species migrate up and down the east coast. Climate change, however, has begun to affect this movement in many cases, delaying fall migration, as species can safely stay in northern nesting areas for longer periods. The trigger for migration is still up for debate, however; for some species it appears to be hard-coded, unaffected by a temperature shift, while others easily shift their phenology back and forth to match the current temperatures. Hawks have been shown to migrate along the east coast; can they shift the timing of their migration to make

up for the climate shift? I investigated mean and median passage dates of four hawk species at three hawk count sites in Pennsylvania and Connecticut, over a forty- to eighty-year period. This study did not show a significant shift in median or mean arrival date among any of five hawk species at the Hawk Mountain count site in Pennsylvania, but suggested a delay in red-tail fall passage date at both the Quaker Ridge and Lighthouse Point sites in Connecticut. Due to the high degree of variability in passage date and northern breeding grounds, it is difficult to determine the causes of a delay, if any - age differences, local weather patterns, weather and conditions at nesting sites, and prey population shifts could all account for any trends noted here.

3.

CREATION OF SERRATE LIGAND GENE CONSTRUCTS FOR THE ACTIVATION AND INHIBITION OF THE NOTCH SIGNALING PATHWAY

William Blaine '15, James Curlin '15

Faculty Sponsor: Robert J. Fleming

The highly conserved Notch signaling pathway is an essential mechanism for cell differentiation in organisms ranging from fruit flies to humans. Two ligands, *Serrate* and *Delta*, interact with of the Notch receptor to regulate the activation and inhibition of the pathway. The *Serrate* ligand can function to either activate or inhibit the Notch receptor depending on its cellular location relative to *Notch*. When present on the same cellular membrane as *Notch*, *Serrate* inhibits the receptor (called *cis*-inhibition); contrastingly, *Serrate* ligand located on opposing cell membranes functions to activate *Notch*. Previous experiments show that the capacity to inhibit *Notch* is conserved in select EGF repeats, while the remaining EGF-like repeats appear to either activate *Notch* or play no role in either function. A *Serrate minigene* construct, containing only the N-terminal EGF repeats and sequences had been generated earlier that failed to activate but retained the ability to inhibit *Notch*. We generated a slightly larger version of this minigene to test the importance of *Serrate* sequences close to the transmembrane region of the molecule. This version, called "*Serrate minigene plus*" contains an extra 103 amino acids of extracellular sequence. Comparisons of the properties of the *Serrate minigene plus* with the original *Serrate minigene* are presented herein.

Previous studies have shown that when deleted individually from *Serrate*, EGF-like repeats 4, 5 or 6, result in the loss of the *cis*-inhibition property of the *Serrate* ligand To determine if this quality of these EGF like repeats is cumulative and results when all three repeats are removed, some *Drosophila* were injected with a lab-created construct lacking EGF repeats 4-6 (Del 4-6). An absence of a phenotype in the fruit flies expressing this construct led to the finding that the construct had been inserted in the vector in the wrong orientation. To create a functional, viable gene construct, the Del 4-6 DNA segment was isolated and re-inserted in the correct orientation. This has since been injected into flies to generate stable, transgenic lines.

4.

CROWD SOURCING: CITIZEN SCIENTISTS ANALYZE WILDLIFE MONITORING CAMERA IMAGES VIA AN ON-LINE DATABASE

Daniel J. Carlozzi '13

Faculty Sponsors: Scott R. Smedley, Kent I. Patashnick, David Tatem, Jean-Pierre A. Haeberly

Background/Questions/Methods

Remote wildlife monitoring cameras are increasingly common in ecological research. These tools frequently yield such large sets of images that researchers face tremendous challenges to analyze them. While investigating the behavior of scavengers in an environment under considerable human influence, we developed a crowd-sourcing approach to categorize the content of images. Participants initially used an on-line field guide to learn how to identify mammalian and avian visitors to compost piles. After demonstrating proficiency via an on-line test, participants were able to view and categorize actual images using the study's on-line database. Each image was served to five independent viewers.

Results/Conclusions

In a pilot study, with 56 participants, primarily high school students, nearly 700 images reached the level of five views. A threshold of 80% agreement among the independent viewers' categorization of a particular image was met or exceeded for 85% of these images. For such "agreed upon" images, the accuracy of the citizen scientists' identifications was 94%, based on concurrence with the consensus reached considering six independent views of each focal image by researchers in our lab. Citizen science thus has promise for assessing the multitude of camera trap images generated in ecological studies.

5.

NOTES ON THE MARINE ALGAE OF THE BERMUDAS. 13. *HELMINTHOCLADIA KEMPPII* SP. NOV. (NEMALIALES, LIAGORACEAE) BASED UPON *H. CALVADOSII* SENSU AUCT. FROM THE WESTERN ATLANTIC

Tayoot Chengsupanimit '14, Thea R. Papolizio, Christopher E. Lane, Craig W. Schneider

Faculty Sponsors: Craig W. Schneider, Christopher E. Lane

Since the initial western Atlantic collections in the Florida Keys and Bermuda during the mid-1800s, *Helminthocladia calvadosii* sensu auct. (type locality: Calvados, France) has also been identified from the Caribbean Sea and as far south as northern Brazil. Prior to this study, collections from the eastern and western Atlantic had not been compared using molecular-assisted alpha taxonomy. Recent winter-spring collections of *H. calvadosii* from Bermuda display an overall habit that is distinct from eastern Atlantic plants of the same species, appearing more similar to *H. reyesii* (type locality: Canary Islands). Using markers for the mitochondrial COI-5P and the plastid-encoded *rbcL*, we have elucidated the relationships between Bermudian isolates and *H. calvadosii* from near the type locality, verifying their generic placement within the Liagoraceae and demonstrating their distinctiveness. Using vegetative and reproductive characteristics, this study concludes that specimens historically identified as *H. calvadosii* from Bermuda represent a novel species, and we propose *Helminthocladia kempii* Papolizio, C.W. Schneid. et Chengsupanimit sp. nov. for them.

6.

CONSTRUCTING A DATABASE OF TRFLP PROFILES FOR USE IN ANALYSIS OF OROPHARYNGEAL BACTERIA

Stephanie Garcia '15, Sara Khalil '15

Faculty Sponsor: Lisa-Anne Foster

Bacteria have been characterized as harmful and pathogenic, yet many species are necessary to the human body. The body harbors many protective bacteria, which serve as a line of defense against pathogens. Protective bacteria thrive in the upper respiratory tract, specifically the oropharynx. In this project, a database of known bacteria was expanded and will eventually be used as a reference to analyze and compare the oropharyngeal bacterial present in different populations. The bacterial species studied include *Streptococcus pyogenes*, *Streptococcus pneumoniae*, *Streptococcus salivarius*, *Streptococcus sanguinis*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Proteus vulgaris*, *Micrococcus luteus*, and non-typeable *Haemophilus influenzae*. Terminal Restriction Fragment Length Polymorphism (tRFLP) profiles, graphs that create several series of peaks unique to different species, help identify protective bacterial species and quantify populations. The 16s rRNA gene, a gene universal to all bacteria, facilitates the analysis of and differentiation between the known bacterial species used to build the database. One approach for the analysis of the bacteria was an in-silico approach, which used 16s rRNA sequences obtained from the Ribosomal Database Project website. Terminal fragment lengths were determined for several strains of each bacterial species when cut with different restriction enzymes. This was verified in the lab by creating peaks based on their fluorescently labeled terminal fragments of their 16s rRNA gene. The information obtained by in-silico and from the chromatograms will later be used for comparison with profiles of unknown bacterial samples in order to identify and quantify their populations.

7.

ROLE OF CELL DYNAMICS IN SEGMENT FORMATION IN *TRIBOLIUM CASTANEUM*

Sarah So Young Kim '14

Faculty Sponsors: Terri Williams, Lisa Nagy, Ayaki Nakamoto

Arthropods, the most abundant animals on earth, are built as series of repeated units, or segments, the driving force behind the evolutionary success of this phylum. The development of segments is well studied in the model system, *Drosophila*, which makes all its segments simultaneously. By contrast, the majority of arthropods form segments sequentially from a growth zone, a process that is relatively unknown. In particular, we know little about the cell behaviors involved in segmentation: cell proliferation, cell division, or some combination of both. Current models of gene regulation hypothesize that cells divide in the posterior region in the growth zone, thereby providing new cells for the sequential addition of segments. We examined the size of the segmenting region in the beetle, *Tribolium castaneum*, and measured changes in the size and shape to estimate cell number during development. We found that the overall area of the segmenting region does not change drastically during development and approximately 60% of cells need divide to form the elongation of the growth zone. We used immunohistochemistry and exposure to the nucleotide analog (EdU) to map cell divisions,

although this analysis was hampered by the complex layers and morphogenetic movements of the embryo. To better understand and identify any distinctive characteristics of cells of different layers, 3D images of *Tribolium* with the cell membrane and nuclei labeled were constructed from confocal images. Analysis showed discrete cell shapes and layers. Further analysis is required for accurate identification of the dividing cells of embryonic layers. The visualization and recognition of cells will help us answer the question of sequential segmentation process in the most successful species.

8.

FETAL MEMBRANE MORPHOGENESIS OF CORN SNAKE EGGS THROUGHOUT DEVELOPMENT

Weston Klimas '13

Faculty Sponsors: Daniel Blackburn, Ann Lehman

While snakes exhibit a range of reproductive diversity, most reproduce through oviparity (egg laying). My research concerned the species *Pantherophis guttatus* (known commonly as the Corn Snake), in which I examined the fetal membranes of eggs sacrificed at different developmental stages. Fetal membranes are involved in sustaining the developing embryo by providing a means of respiration via the chorioallantois, and water uptake from the environment presumably via a derivative of the yolk sac. Using light microscopy, I have observed change in both of these membranes over the developmental period. Future work will involve the use of a transmission electron microscope to observe the ultrastructure of the membranes we have seen thus far.

9.

NORMAL DEVELOPMENT OF FAIRY SHRIMP, *THAMNOCEPHALUS PLATYRUS*

Niranjana Pokharel '15

Faculty Sponsor: Terri A. Williams

Arthropods are the largest phylum of animals and segmentation has been key to the evolutionary radiation of arthropods. In order to understand how this phylum evolved it is necessary to understand normal development of their segments. *Drosophila* is the only arthropod whose mechanisms of segmentation are well studied. However, since *Drosophila* forms all its segments at once, it fails to explain the mechanisms of the majority of arthropods which form their segments one by one from a posterior growth zone. In order to gain a better understanding of evolution of arthropods, we have tried to study segmentation examining cell division pattern and gene expression in the posterior region. One critical question is, what cellular behaviors produce elongation in the growth zone? Here I describe the fairy shrimp, *Thamnocephalus platyrus*. According to the current theoretical model of the growth zone, signaling at the very posterior signals the cells in the growth zone to divide. In order to test the proposed model, I measured cell division as well as cellular dimensions of the growth zone. The pattern of mitosis was visualized by exposing living animals to a nucleotide analog that is incorporated into actively dividing cells. Results show that the growth zone of *Thamnocephalus* decreases as the larvae grows older and adds more segments. Moreover, there are three cells in between every last two segments and the preexisting cells in the growth zone are not sufficient to form the new segments. I have found

actively dividing cells in the growth zone, although the patterns of division vary from specimen to specimen. I am currently analyzing whether they are, on average, restricted to the posterior and support the hypothesis of posteriorly restricted mitosis.

CHEMISTRY

10.

SYNTHESIS OF γ -CARBOXYGLUTAMIC ACID

Lauren Aber '13

Faculty Sponsor: Richard Prigodich

The focus of this project is to find a new method of synthesizing a modified amino acid, γ -carboxyglutamic acid. There are three published methods. We are trying to develop a more efficient synthesis. The first step of this synthesis is to produce di-tert-butyl-allyl malonate. In this first reaction different bases and solvents were used along with varying molar equivalences of reagents and bases. The goal of this investigation was to optimize the formation of the desired product without producing a side product. The reaction that produced the most product used sodium hydride in THF to react with di-tert-butyl malonate. Allyl bromide was added after a specified amount of time. This method was found to react a greater amount of the starting reagent and was optimized at a 1:1 mmol equivalent NaH to di-tert-butyl malonate. The reaction is monitored by GC-MS and ¹H NMR. The second step was to oxidize the di-tert-butylallyl malonate to an aldehyde with the reaction of ruthenium(III) chloride and sodium periodate to produce 2-methylenecarbaldehyde di-tert-butyl malonate. Once presence of this aldehyde was confirmed using proton NMR the third step is to react the aldehyde in benzene with aminodiphenylmethane and sodium sulfate. This reaction is currently being optimized and proton NMR is being used to monitor this reaction.

11.

INVESTIGATING METHODS FOR ACYLATING ALKYNILANILINES

Shawna M. Berk '13

Faculty Sponsor: Timothy P. Curran

Previous work by Adam Boynton has shown that peptide derivatives of 2-amino-2'-carboxydiphenylacetylene will coordinate to tungsten via the alkyne, and that the resulting species adopt a β -sheet conformation. The current synthesis of 2-amino-2'-carboxydiphenylacetylene involves the coupling of an acylated derivative of 2-iodobenzoic acid with an acylated derivative of 2-ethynylaniline using a Sonogashira reaction. This synthesis is hampered by low yields of the acylated derivatives of 2-ethynylaniline. We have explored alternate routes for preparing 2-amino-2'-carboxydiphenylacetylene. In one investigation we probed whether 2-iodoaniline could be acylated, then coupled with 2-ethynylbenzoic acid to yield the desired diphenylacetylene. In another investigation we investigated a range of synthetic methods for acylating alkynylanilines. The results from these studies will be presented.

12.

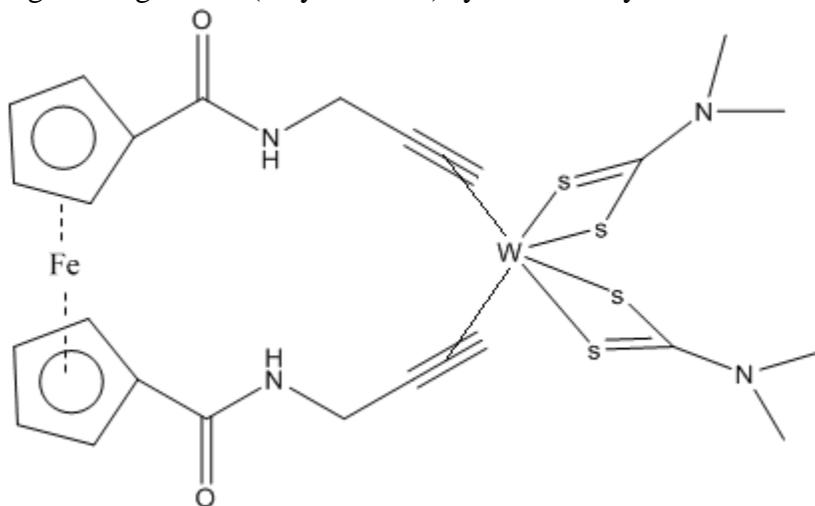
SYNTHESIS OF NOVEL, CYCLIC MOLECULES THAT INCORPORATE TUNGSTEN-(BIS) ALKYNE AND FERROCENE MOIETIES

Sebastiano Buccheri '14

Faculty Sponsor: Timothy P. Curran

Transition metal complexes have a wide array of uses in catalysis, materials synthesis, photochemistry, and biological systems making development and study of these complexes crucial. Specificity of metal-ligand conformation is often important in their application. Curran and Lawrence discovered a constrained organometallic species that includes a ferrocene component and a tungsten-bis(alkyne) complex. The molecule adopts only one conformation in solution.

Fig 1. Tungsten-bis(alkyne amide) synthesized by Curran and Lawrence (1)



We are seeking to learn if the constraint is lost within the complex if the distance between the ferrocene and the tungsten-bis(alkyne) is increased. Ferrocene compounds containing longer alkynyl side chains have been synthesized and characterized. The cyclization of these compounds by reaction with $W(CO)_3(dmtc)_2$ has been performed with some success. The resulting ferrocene coordinated tungsten-bis(alkyne) complexes have been characterized by 1H NMR and ESI-MS. In addition, the aromatic derivative 1,4-diethynylbenzene has demonstrated promise in the synthesis of other novel constrained tungsten-bis(alkyne) complexes.

13.

DESIGN AND SYNTHESIS OF CHIRAL, TETHERED, C₃-SYMMETRIC TRIARYLMETHYL CATIONS FOR USE AS CATALYTIC ELECTROPHILE ACTIVATORS

Mark Chesson '13

Faculty Sponsor: Cheyenne Brindle

In-depth research and design of effective catalytic electrophile activators has been explored extensively using both Brønsted and Lewis acid activators, including the use of chiral, C₂-symmetric activators. With this in mind, the development of chiral, C₃-symmetric electrophile

activators is a promising area of future research. Triarylmethyl cations have been explored primarily in the area of physical organic chemistry, but the synthesis and resolution of an enantiomerically pure triaryl methyl cation for use as a chiral catalyst has not yet extensively been explored. Obtaining these substances in enantiopure form for use in reactions at ambient temperature requires the barrier to racemization to be raised. One way in which this may be accomplished is to tether the aryl groups together covalently. A Kumada coupling was most effective in initial attempts at synthesizing the aryl components with attached tethers.

14. PHOTOLYSIS AT THE LIQUID-VAPOR INTERFACE OF DIHALOGENATED METHANE SOLUTIONS

Andres E. Delgadillo '13, Christina McGuire '13, Baltazar Ramos Jr '11, Edward Harrington Jr '11, William Tyler Nebel '14 (Cornell), Maria J. Krisch
Faculty Sponsor: Maria J. Krisch

Chemistry at the liquid-vapor interface of solutions can differ from that of bulk solutions. These differences were studied with droplets of chloriodomethane (CH_2ICl) and diiodomethane (CH_2I_2) solutions in water and salt water (0.5 M NaCl). Droplets were formed with a vibrating-orifice aerosol generator as well as a 6-jet collision nebulizer. The diameter of droplets ranged from 50-140 μm and $2.5 \mu\text{m} \pm 1.8 \text{ GSD}$, respectively, to change the droplets' surface area to volume ratio, thereby increasing any interfacial effects. Droplets were exposed to ultraviolet light using Pen-ray lamps (254 nm) or lasers (224 nm, 266 nm). Analysis was conducted using gas chromatography-mass spectrometry; the amount of dihalogenated methane in UV exposed samples was compared to unexposed samples. Although smaller droplets showed greater ranges of reaction than larger ones, variability in the results has rendered them inconclusive. Possible explanations for the variability in results differs for each method used to generate droplets. For droplets created via the vibrating orifice, it is possible that the size range was not sufficiently small to demonstrate interfacial chemistry. Although aerosols created with the collision nebulizer were certainly small enough, it is possible that there was insufficient UV irradiation on the droplets to cause a reaction in the chemical system. The same could also be true for the vibrating orifice generated droplets.

15. ATTEMPTS TO SYNTHESIZE MIXED TERNARY METAL HYDRIDES $\text{Ca}_2\text{Ir}_{0.5}\text{Rh}_{0.5}\text{H}_5$, $\text{Ca}_2\text{Ir}_{0.5}\text{Ru}_{0.5}\text{H}_{5.5}$, $\text{Ca}_2\text{Rh}_{0.5}\text{Ru}_{0.5}\text{H}_{5.5}$, and $\text{Ca}_2\text{Fe}_{0.5}\text{Ru}_{0.5}\text{H}_6$

Pathik A. Khatri '13 Simon Wei '14
Faculty Sponsor: Ralph O. Moyer Jr.

Based upon Vegard's Law, attempts were made to synthesize ternary metal hydrides containing combinations of two transition metals of form $\text{Ca}_2\text{X}_{0.5}\text{M}_{0.5}\text{H}_x$. The four compounds which potentially synthesized were $\text{Ca}_2\text{Ir}_{0.5}\text{Rh}_{0.5}\text{H}_5$, $\text{Ca}_2\text{Ir}_{0.5}\text{Ru}_{0.5}\text{H}_{5.5}$, $\text{Ca}_2\text{Rh}_{0.5}\text{Ru}_{0.5}\text{H}_{5.5}$, and $\text{Ca}_2\text{Fe}_{0.5}\text{Ru}_{0.5}\text{H}_6$. Based upon data obtain with powder X-ray diffraction, it was not possible to that the hydrides involving combination of Ir/Ru/Rh formed as the ionic radii of these metals are too similar. However, it was confirmed that the Ru-Fe hydride did not form.

16.

NMR EXPERIMENTS ON β -CYCLODEXTRIN AND FLUORESCCEIN

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. NMRs of different ratio combinations of β -cyclodextrin to fluorescein were studied for the analysis of chemical shift changes of the proton peaks to determine the binding constant.

17.

AN ALTERNATIVE SYNTHESIS OF 2-CARBOXY-2'-AMINODIPHENYLACETYLENE

Varun Konanki '15

Faculty Sponsor: Timothy P. Curran

2-carboxy-2'-aminodiphenylacetylene is a molecule that mimics a β -turn. It has been used to generate antiparallel β -sheets. The current synthetic method used to make the molecule has some problems, so an alternate route was explored. To do this, a derivative of 2-iodoaniline was needed, as well as a derivative of 2-ethynylbenzoic acid. Reactions intended to make these molecules were tried, and the results will be discussed.

18.

CMNB-CAGED FLUORESCCEIN AND ITS USE IN LIGHT DETECTION FOR A DROPLET TRAIN

David Mallick '14, Shawna Berk '13

Faculty Sponsor: Maria J. Krisch

The droplet train is a useful instrument in the study of liquid-vapor interfaces, as it produces micrometer-sized droplets of various liquids that simulate aerosols in the atmosphere. Results from previous photochemical studies of aqueous CH_2ICl solutions in the droplet train were inconclusive due to an unknown cause. One possibility is that too little light entered the droplet train to cause the CH_2ICl to react measurably. In order to test the problem, carboxymethoxynitrobenzyl (CMNB)-caged fluorescein in DMSO was run through the droplet

train in similar manner to that of CH₂ICl. Since CMNB-caged fluorescein is light sensitive, it could identify whether small amounts of light were entering the droplet chamber by using a fluorimeter to detect fluorescein. As a calibration, various concentrations of CMNB-caged fluorescein were exposed to an ultraviolet pen-ray lamp at 356 nm and scanned using a fluorescence spectrometer to determine which concentration would best detect small amounts of light through the most linear fit. The best concentration was then run through the droplet train with 30 and 75 μm orifices with and without exposure to 356 nm UV light. Results show a promising trend where an increase in fluorescein signal corresponds to an increase in light. For future work, a 50 μm orifice will be used to examine a possible trend between orifice size and signal changes.

19.

IMPROVED METHODOLOGY FOR REMOVING DIHALOMETHANE CARRYOVER FROM SPME FIBERS

Christina M. McGuire '13, Edward Harrington Jr. '11

Faculty Sponsor: Maria J. Krisch

Solid phase microextraction (SPME) in conjunction with gas chromatography-mass spectrometry (GC-MS) is a simple and effective way to sample analytes. Typically during desorption in the GC the coated fiber is automatically rid of most compounds, allowing for the analysis of a new sample. This study indicates that simple desorption is not enough to thoroughly clean a Carboxen PDMS 75μm fiber from dihalomethanes, resulting in carryover of the analyte between samples. Our data suggests that heating the fiber in a separate injection port between each run prevents carryover from sample to sample. Calibration curves indicate that heating between samples significantly improves the linearity of the peak area vs. concentration relationship.

20.

ALTERNATIVE AND EFFICIENT PHOSPHONAMIDITE SYNTHESIS AS A PRECURSOR TO SOLID-PHASE OLIGONUCLEOTIDE SYNTHESIS

Alex Plochocki '14

Faculty Sponsor: Richard Prigodich

The synthesis of phosphonamidites through a new and efficient pathway is being employed in order to achieve automated solid-state synthesis of phosphono-linked oligonucleotides. Oligonucleotides can be synthesized to contain a single phosphonate nucleotide, which can then be used to elucidate the nature of nucleic acid-metal ion bonds; this is accomplished by a phosphonate's unique ³¹P-NMR chemical shift. The pathway of phosphonamidite synthesis uses thymidine, an easily available reactant, as a starting substrate. Using thin-layer chromatography and ¹H-NMR spectroscopy as confirmation, the fifth intermediate in the synthetic scheme has been synthesized. With the completed synthesis of the phosphonamidite, experimentation with the automated and efficient solid-phase oligonucleotide synthesis will begin.

21.

SURFACE CONCENTRATION OF FORMIC ACID IN SALT/WATER SOLUTIONS

Jeff Pruyne '15

Faculty Sponsor: Maria J. Krisch

The concentration of organic molecules near the surface of the liquid-vapor interface is affected by the presence of ionic salts in solution. The interface is a thin layer of molecules with different thermodynamics and concentrations compared to the phases (liquid or vapor) on either side. To gain an understanding of the interface, surface tension, a measurement of intermolecular forces at the interface, is examined. From the change in surface tension for a change in concentration, an equation for surface excess can be determined. Using formic acid we looked at the effect salt had on formic acid's excess in the interface. We looked at three different systems, formic acid and water, 0.05 M sodium chloride with formic acid and water, and 0.5 M sodium chloride with formic acid and water. Based on these three systems, we think that sodium chloride has a very weak salting in effect on formic acid. This has implication for atmospheric chemistry, where surface chemistry on aerosols plays a big role.

22.

ISOLATION, PURIFICATION, AND CRYSTALLIZATION OF MAL 3 PROTEIN

John Stiller '14

Faculty Sponsor: Richard Prigodich

E.coli cells transformed with a plasmid containing the gene for the Mal 3 protein with a six-histidine residue N-terminal tag were used for the synthesis of Mal 3 protein. Via incubation of the E-coli cells, activation of the lac-operon with IPTG, and isolation of the protein via centrifugation, sonication and a histidine trap column, Mal 3 protein was isolated and purified. Concentration of the extracted protein, SDS-PAGE and UV absorbance measurements proved that the protein was pure and available in high enough concentrations for a crystallization attempt via the hanging drop method from solutions of 1 M MgCl₂ and 50% PEG. Crystals were obtained.

23.

SEM-EDS ANALYSIS OF METALLIC ARTIFACTS

Lan Anh Tran '13

Faculty Sponsors: Ann Lehman, Maria Parr

In July 2011, several artifacts were discovered during a construction project along Davenport Avenue in New Haven, Connecticut. The artifacts, which date to the mid nineteenth century, are metal plate fragments, a nail, a shroud pin, a small medallion and textile fragments. Due to the fragile nature of the artifacts, they were carefully mounted on SEM stubs and not coated prior to analysis. The samples were analyzed using the new Zeiss EVO LS-15 scanning electron microscope (SEM) equipped with an energy-dispersive x-ray spectrometer (EDS). The EDS function of the SEM was employed to determine the elemental composition of each artifact. Various areas of each sample were imaged and analyzed. The metal plate fragments show

extensive corrosion and are most likely composed of an iron-tin alloy or tin plate. Small areas in plate fragments A and B also contain manganese. The metal nail is comprised of iron. The shroud pin composition is based on a tin-plated brass alloy (copper-zinc), while the medallion is composed of brass containing small amounts of lead. The textile fragments exhibit a plain simple weave pattern. The elemental compositions are consistent with literature reports of similar artifacts of that time period.

COMPUTER SCIENCE

24.

MONIKER: A MOBILE-BASED IMAGE CLASSIFICATION SYSTEM FOR FIELD CAMERA TRAPS

Jason Baird '14, Megan Chiu '14

Faculty Sponsors: Ralph Morelli, Jim Sanderson, Trishan de Lanerolle, US Fish & Wildlife Service

In New Mexico and Arizona, there are over sixteen sites containing many camera traps that take over three million photos of the wildlife in a natural setting. These camera traps are triggered by a motion or infrared sensor. The US Fish & Wildlife Service uses these camera trap photos to study wildlife patterns of animals, where human interference is not evident. However, inefficiency becomes an obstacle when researchers deal with millions of unsorted animals.

We introduce Moniker as a mobile application developed for the Android phone. When using the application, a user is able to download unsorted photos from a server and classify the photos according to the animal species and number of animals in the photo. The data can then be sent back to the server, where it will place the sorted photos into the appropriate animal folders.

25.

AN OUT-OF-CORE IMPLEMENTATION OF BLOCK CHOLESKY DECOMPOSITION ON A MULTI-GPU SYSTEM

Philip Cho '15, Jiajia Zhao '15

Faculty Sponsors: Peter Yoon, Lin Cheng

The Cholesky decomposition is one of the most efficient preconditioners to iterative schemes for solving linear systems such as the conjugate gradient method. In medical imaging applications, we often face situations where a linear system exceeds the capacity of existing memory. To that end, in this paper we present an out-of-core implementation of the block Cholesky decomposition on a multi-GPU system, which will be able to handle linear systems of arbitrary size. Our implementation exploits in a streamlined fashion three core memory systems: GPU memory, CPU host memory, and virtual memory space on the disk. We also demonstrate that incorporating memory traffic reduction, efficient data allocation and task overlapping is critical in optimizing performance. Our experiment shows that our implementation outperforms a serial version by at least a factor of 33. We successfully apply our work to image segmentation.

26.

INCOPORATING BARCODE SCANNER INTO POSIT-HAITI

Nyi M. Htet '13

Faculty Sponsors: Ralph Morelli, Trishan de Lanerolle, ACDI/VOCA, USAID

POSIT-Haiti is an Android-based phone application that was built for ACDI/VOCA, a humanitarian aid organization in Haiti that specializes in food security. The mobile app helps the NGO manage their 17,000 aid beneficiaries at distribution and registration events throughout the southeastern region of rural Haiti. POSIT-HAITI collects and transmits beneficiary data collected during food distribution events back to headquarter in Jacmel via cellular text message transmission (SMS), in a timely manner for evaluation and planning purposes. After a year of pilot deployment, ACDI/VOCA reported that they were getting back data inconsistencies. Investigation revealed that at each distribution event, nurses were unable to input the identification number (ID) of each beneficiary rapidly and correctly, due to the overwhelming number of aid recipients and chaotic work environment, causing erroneous data to get recorded. In order to solve this problem, a new Quick Response code (QR Code) based ID look-up system for POSIT-Haiti was developed this summer. The new bar-code system replaced the old system of typing in the ID manually to the phone which was found to be error prone and time consuming when dealing with hundreds of people. The new system was designed in a way that the staff member can just point and scan the ID of each beneficiary, and automatically bring up the data to process. The revised version of the application with the bar code system was field tested during a visit to Haiti this summer. One of the field tests finished up the registration of 220 beneficiaries in 35 minutes, a significant improvement on the speed of the distribution event.

ENGINEERING

27.

FORMATION OF CLOGS UNDER ULTRASOUND EXCITATION: A MICROFLUIDIC STUDY

Erin Barney '15

Faculty Sponsor: Emilie Dressaire

Microfluidic devices are used in a myriad of applications. When suspensions of particles flow in microchannels, clogging events can occur limiting the use of the device. Acoustic waves and more specifically ultrasound have been used in microfluidic devices to focus, separate and mix particles. Here we study the influence of ultrasound on the formation of clogs of colloidal particles in microchannels. We fabricate microfluidic devices out of polydimethylsiloxane (PDMS) and glass. The colloidal suspensions consist of deionized water, microspheres, and a small amount of surfactant. We ensure the reproducibility of the baseline experiments (ie: clogging without ultrasound excitation). We then use piezoelectric transducers to produce ultrasound waves and characterize how they affect the formation of clogs. Our first experiments focus on the role played by the frequency of the acoustic wave and the orientation of the channels in relation to the wave propagation. Our preliminary results indicate that ultrasound excitation delays the formation of clogs in the system.

28.

HELICOPTER BLADE VIBRATION ANALYSIS

Shaun Smith '15

Faculty Sponsor: Taikang Ning

Helicopters are aerial vehicles used for transportation on passengers or cargo. A major component of a helicopter are the blades, which are exposed during flight. The blades experience extreme wear and frequently need replacing. The blades go through vibrational patterns which are indicative of their condition. Oscillation increases in any case of damage and other types of malfunctions. The goal is to identify these errors through only vibrational analysis. A hoverstand is in the building process. Through construction of a functional stand, testing will exhibit status change of blades which will be used as indicating factors.

29.

DUAL-AXIS SOLAR TRACKER

Benjamin Williams '15

Faculty Sponsor: Taikang Ning

Target tracking refers to the process of locating a given signal, radar being a common example. One application of target tracking is solar tracking, which refers to the tracking of the sun. As solar panels gather more energy when pointed directly at the sun, assisting solar panels with solar tracking aids significantly in the collection of solar energy. The purpose of this research project is to develop a functioning dual-axis solar tracker. By utilizing two axes of rotation, the tracker will consistently point directly into a light source. Last summer, an apparatus was designed and partially developed and microcontroller programming began. Eventually, a solar panel may be mounted onto the apparatus in order to compare energy gathered with the aid of tracking. Future variations in blocks, motor powers, and programming may yield greater target tracking capabilities.

ENVIRONMENTAL SCIENCE

30.

INVESTIGATING THE INORGANIC CARBON CYCLE AT THREE CONNECTICUT PONDS

Erika Adams '13, Kate Furgueson '15

Faculty Sponsor: Sarah Gray

Three bodies of water, Batterson Park Pond, Mill Pond and Wethersfield Cove, were studied from May to August, 2012. The goal of the study was to investigate and compare the inorganic carbon cycling of each pond. A surface and a deep water sample were taken at each site. For every sample, the pH, salinity, dissolved oxygen, and total alkalinity (TA) were measured. Trends in pH data showed similar results at Batterson Park Pond and Wethersfield Cove. There was an increase in pH from the beginning of the summer to the end of the summer, where the pH plateaued. The pH data for Mill Pond showed weekly variability but no seasonal trend. Oxygen content was measured using three different methods: Winkler titrations, a membrane oxygen

probe, and an Onset oxygen sensor. Trends in oxygen over time for Batterson Park Pond and Wethersfield Cove showed that the oxygen concentration peaked in the middle of the summer. The oxygen data for Mill Pond showed high variability but no seasonal trends. Temperature and TA data were analyzed for trends throughout the summer, including differences between surface and deep samples. Water temperature increased throughout the summer. The average differences in temperature between surface and deep water samples at Batterson Park Pond, Mill Pond, and Wethersfield Cove were 0.4 ± 0.5 °C, 0.9 ± 1.4 °C, and 0.6 ± 0.7 °C, respectively. The average TA was stable throughout the summer for Batterson Park Pond and Wethersfield Cove. The TA at Mill Pond showed large monthly variability (up to 40 mg/L) but no clear seasonal trend. Average differences in TA from surface to deep samples for Batterson Park Pond, Mill Pond, and Wethersfield Cove were 0.2 ± 0.8 mg/L, 0.4 ± 2.2 mg/L, and 0.3 ± 1.2 mg/L respectively. No significant correlations were found between temperature and oxygen concentration, salinity and TA, or pH and oxygen concentration.

31.

SOURCE OF MERCURY CONTAMINATION IN THE MILL POND PARK OF THE PARK RIVER WATERSHED, GREATER HARTFORD, CT

Daniel Hong '15

Faculty Sponsor: Jonathan Gourley

Mercury (Hg) is a naturally occurring element in the environment in very low concentrations. However, a recent study showed that an excess amount of mercury was present in the Piper Brook sub-basin within the Park River watershed, a sub-watershed of the Lower Connecticut watershed. Because the Park River runs across the highly populated and recently industrialized city of Hartford, the high levels of impervious cover accumulate pollutants, including mercury, through aeolian deposition. Through precipitation, the deposited pollutants in the impervious cover are washed off and discharged into the Park River. However, once mercury is released and spread out in the environment, the origin of the mercury contamination becomes hard to determine. The Mill Pond Park in the Piper Brook sub-basin was reported to have the highest concentration of mercury of 298 µg/kg. To find the sources of contamination of mercury in the Mill Pond Park, 16 mud samples were first collected and analyzed for mercury concentration using a Milestone DMA-80 Total Mercury Analyzer. Similar concentrations of mercury as the study done before were found downstream of the Mill Pond rather than within the Mill Pond itself. Thus, 16 more focused samples were collected around the sample location where it showed similar results. Percentages of organic materials and carbonates were also analyzed using loss on ignition method. The locations and distribution of the samples were plotted using GIS. The goal was to determine potential sources for mercury contamination using the concentrations and distributions of mercury. A trend in the concentrations and distributions of mercury was found and the exact location of mercury discharge was where the asphalt road, which leads to the parking lot of school buses, falls into the stream. Moreover, there was a weak correlation between the percentage of organic materials and mercury and another weak one between the percentage of carbonates and mercury.

32.

SYNERGISM IN TOXICITY OF MIXTURES OF PHARMACEUTICALS TO *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 complex mixtures of chemicals. Four pharmaceuticals for human-use were chosen for this study. All are water-soluble, thus eliminating complications of solvent effects. All of the chosen pharmaceuticals are also 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 LC₅₀'s using the classic method of mixture toxicity. Again, synergism was observed. This relationship would not be anticipated 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.

33.

MAGNETIC ANALYSES OF LAKE SEDIMENT AS A POSSIBLE MEANS TO RECONSTRUCT ANADROMOUS FISH POPULATIONS IN FOUR CONNECTICUT LAKES

Sama Shrestha '14

Faculty Sponsor: Christoph Geiss

Sediment magnetic analyses can help to reconstruct past environmental conditions within a watershed. This study focused on investigating possible correlations between alewives, an anadromous fish species known for transporting large amounts of nutrients enrich in $\delta^{15}\text{N}$, and corresponding changes in sediment chemistry and magnetic parameters of the lake sediments. We hypothesized that high alewives populations leads to increased organic productivity. Strongly reducing sediment conditions due to increased organic matter result in the dissolution of magnetic minerals, which should be visible in magnetic parameters. Sediments were collected from four Connecticut lakes, two of which (Rogers and Bride) have known alewives population while the other two lakes (Linsley and Uncas) were not populated by alewives and serve as controls. The sediments were characterized in terms of abundance, composition and grain size of magnetic minerals through measurements of magnetic susceptibility (χ), isothermal remanent magnetization (IRM), anhysteretic remanent magnetization (ARM), S-ratios, organic content, magnetization ratio (M_r/M_s) and coercivity ratio (H_{cr}/H_c). Alewife abundances were estimated through measurements of Nitrogen isotopic ratios ($\delta^{15}\text{N}$). Our hypothesis predicts that high Alewife concentrations (high $\delta^{15}\text{N}$) lead to decreases in the concentration of magnetic minerals

(lower χ), a coarsening of the magnetic assemblage (decrease in ARM/IRM), and possibly a change in magnetic mineralogy (lower S-ratios). Correlations between magnetic and geochemical parameters were mixed, and our initial hypothesis could not be confirmed.

34.

MAPPING OF ARCTIC PEATLANDS USING GROUND PENETRATING RADAR

Jessica Smith '14

Faculty Sponsor: Christoph Geiss

Our study area in Northern Manitoba is located in discontinuous permafrost at the present-day taiga-tundra ecotone, which makes the region sensitive to past and future climate change. In addition, its proximity to Hudson Bay may amplify regional climate variability through changes in sea ice cover. The area contains numerous small lakes and extensive peatlands which have developed over the past 8000 years and act as a reservoir of organic carbon. Because of the nature of these reservoirs, changes in climate can greatly influence the dynamics of these peatlands, which can in turn result in changes of the amount of greenhouse gases in atmosphere. To estimate the volume of existing peat deposits, nine wetlands in Northern Manitoba (59.3°N, -97.5°W) were surveyed using ground penetrating radar (GPR). Previously acquired borehole data was used to ground-truth more than 2 km of GPR profiles. Data were taken using a SIR-3000 radar unit (Geophysical Survey Systems Incorporated) and were analyzed using ReflexW v 5.6 (Sandmeier Scientific Software). The majority of the studied wetlands is less than 1.5 m in depth and shows a regular basin shape. Therefore information from peat cores can be generalized across the watershed.

NEUROSCIENCE

35.

CATECHOLAMINES AND THE KETOGENIC DIET

Ryan Adams '13

Faculty Sponsor: William H. Church

Although the exact mechanism by which the ketogenic diet reduces epilepsy is still unknown, recent studies have implicated catecholamines in being involved in modulating seizure susceptibility. This work investigated the effects of the ketogenic diet on catecholamine concentrations in the brains of mice. Tissue homogenates of the hippocampus, motor cortex, somatosensory cortex, periaqueductal grey and caudate putamen regions were analyzed using high pressure liquid chromatography to quantitate norepinephrine, dopamine, DOPAC, 5HIAA and 5-HT. Changes in endogenous levels between mice fed a normal diet and mice fed a ketogenic diet for 3 weeks will be discussed. The results of this analysis may provide insight into the mechanism by which the ketogenic diet modulates epileptic activity.

36.

BENEFICIAL EFFECTS OF LOW-CARBOHYDRATE DIET ON SOCIAL BEHAVIOR IN A NOVEL REPEATED-MEASURES TEST OF SOCIAL BEHAVIOR IN MICE

Josh Altschuler '13, Subrina Bisnauth '15, Sierra Slade '15

Faculty Sponsors: David Ruskin, Susan Masino

Autism is a neurological disorder that includes a deficit in sociability as a defining symptom. We have hypothesized that a very-low carbohydrate diet known as the ketogenic diet (used to treat epilepsy) might improve sociability, and have found positive results in the BTBR mouse model of autism. In those experiments we used the standard 3-chamber test of sociability in rodents, in which test mice can choose to spend time in chambers with or without another mouse (or with a novel mouse or a familiar mouse). Here, in hopes of increasing test sensitivity, we characterized a novel permutation of the 3-chamber test in which the test was delivered twice: before and after three weeks of dietary intervention with an 8% ketogenic diet. The control group remained on standard diet for both the test and retest. Results show that after being on the diet, mice spent significantly more time in the chamber with the novel mouse in the second phase of the three-chamber test. This is in comparison both the initial test of the experimental group before they had been switched to the special diet and to the retest of the control group that had not switched diet. These results indicate that the ketogenic diet led to an increase in preference for social interaction in the BTBR mice. Future research could continue to explore the benefits of the ketogenic diet for autism.

37.

PROSPECTIVE MEMORY IN SCHIZOPHRENIA: RELATIONSHIP TO MEDICATION ADHERENCE, NEUROCOGNITION AND SYMPTOMS IN INDIVIDUALS WITH SCHIZOPHRENIA

David Correll '13, Marta Zamroziewicz '13, Alexandra Rogers '09

Faculty Sponsors: Sarah Raskin, Matthew Kurtz, Jacqueline Maye

Medication management is a serious concern for individuals with schizophrenia. One possible reason for poor adherence to medication is poor ability to remember future intentions. It has been demonstrated in several studies that individuals with schizophrenia do have impairments in prospective memory. However, there have been no studies, to our knowledge, examining the relationship of prospective memory to medication adherence. In this study individuals with schizophrenia and healthy adults were administered a standardized measure of prospective memory, a standardized measure of medication adherence and a computerized virtual measure of medication adherence. Individuals with schizophrenia demonstrated impairments specifically in prospective memory. Performance on the test of prospective memory was correlated with the standardized measure of medication adherence. This suggests that prospective memory should be assessed before assuming that individuals with schizophrenia will be independent in medication management. It also suggests that prospective memory intervention may be important in this population.

38.

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

Amy Hackett '14, Daniel Isaman '15

Faculty Sponsor: Charles C. Swart

Neurogenesis is the proliferation of new neurons in the nervous system and is a key process in learning new information and repairing damaged neural tissue. In vertebrates neurogenesis is limited to a few discrete areas of the brain. However among invertebrates there is a great diversity of neurogenerative processes including animals that develop a set number of neurons upon maturity and exhibit no further new cell growth to those that exhibit continuous neurogenesis throughout their life span. Among the molluscs all possible strategies are thought to exist. However, those animals which exhibit a finite number of neurons at adulthood have received the most attention. There are a couple of reasons for this. First these animals tend to have a relatively small number of neurons and those neurons tend to be large in size and easily recognized across individuals. These characteristics make it possible to understand the function of complex neural circuits involved in these animals' behaviors. However, when studying neurogenesis, an animal that exhibits cell generation throughout its life would clearly be a better choice. Observations on the cerebral ganglion of the fresh water snail, *Cipangopaludina chinensis*, suggested that there were a large number of very small neurons and no large neurons. To determine what strategy of neurogenesis is exhibited by this animal we conducted a number of observational studies to determine the lifelong pattern neurogenesis in the cerebral ganglion in this animal including separate characterization of juveniles, adult males and adult females. We find that neurogenesis occurs throughout the juvenile period but stops at maturity. However the animal still increases body size as an adult and we find that while the adults do not add new neurons, the existing neurons do increase in size.

39.

ATTENUATION OF THE REGIONAL VARIATION IN GRANULE CELL PRECURSOR PROLIFERATION CONTRIBUTES TO THE ALTERED FOLIATION PATTERN IN THE *ENGRAILED* MUTANT MOUSE CEREBELLUM

Jackie L. Gottshall '13, Emilie Legué, Alexandra Joyner

Faculty Sponsors: Susan Masino, Charles C. Swart

The layered cortex of the cerebellum (Cb) is divided into complex folds (folia) along the anterior-posterior axis, allowing numerous neural circuits to fit within a compact space. Although Cb morphology and circuit allocation are highly conserved across mammals, the processes that regulate foliation are poorly understood. The distinct shape of each fold has been hypothesized to depend largely on granule cell (GC) production. Interestingly, our genetic inducible fate mapping (GIFM) analysis revealed that GC production occurs asynchronously between folia. This raised the possibility that the temporal variation of GC production between folia contributes to Cb foliation patterning. Using a mouse cerebellum foliation mutant (lacking three of the four *engrailed* (*En*) alleles) and GIFM we uncovered an attenuation of the normal temporal differences in GC production between folia that was associated with the altered foliation pattern. To further examine GC production, we assessed granule cell precursor (GCP)

proliferation using a pulse of BrdU. Preliminary analyses at postnatal day (P) 6 and P14 indicate that the normal difference in GCP proliferation seen between folia is reduced in *En* mutants. Additionally, examination of Sonic hedgehog signaling (the main proliferating signal in GCPs) at P2 suggests that normal regional differences observed in the wild-type are attenuated in the *En* mutant. These results indicate that the normal variations in the level of GCP proliferation are altered in *En* mutants, which could contribute to the attenuation of temporal differences in GC production between folia in *En* mutants compared to wild types.

40.

THE INVESTIGATION OF GLIAL-DERIVED FACTORS AFFECTING NEURONAL CELL DEATH

Alexandra Nicaise '13

Faculty Sponsors: William H. Church, Stephen Crocker; UConn Health Center

Originally astrocytes were believed to have just played a supportive role in the brain, now it has been discovered that they play very important roles, from the reuptake of neurotransmitters to signal propagation. They might also play a role in Parkinson's disease, by either alleviating dopaminergic cell death in the substantia nigra, or by causing it. In recent studies TIMPs (tissue inhibitors of metalloproteinases) have been implicated in diseases such as Parkinson's and multiple sclerosis. They are extracellular proteins that have the capability of regulating MMPs (matrix metalloproteinases), which degrade all kinds of extracellular matrix proteins. When TIMPs and MMPs are not in balance cell metabolism is at risk. A double-blind cell culture experiment was conducted using astrocytes from both wild type and TIMP-1 knock out mice.

Astrocytes were treated with MPP+, a neurotoxin commonly used to induce dopaminergic cell death. Undifferentiated and differentiated SH-SY5Y cells were treated with the glial media for 24 hours and cell viability was evaluating using the live cell/dead cell assay. Wild type glial conditioned media killed undifferentiated cells to a greater extent compared to the knock out media. Further experimentation indicated that a 50% increase of TIMP-1 concentration in the wild type glial media given no MPP+ significantly increased cell viability in undifferentiated cells. These results suggest that TIMP-1 may be modulating the activity of an apoptosis inducing factor. A proposed mechanism by which astrocytic TIMP-1 functions to control apoptosis in undifferentiated neuronal cells will be presented.

41.

IMPROVEMENT OF METHODS OF INVESTIGATION INTO THE BEHAVIORAL AND ELECTROPHYSIOLOGICAL CORRELATES OF PROSPECTIVE MEMORY (PM) IN HEALTHY ADULTS AND ADULTS WITH TRAUMATIC BRAIN INJURY (TBI).

Consuelo M.A. Pedro '15

Faculty Sponsor: Sarah Raskin

Prospective memory (PM) is the ability to remember to do something in the future. Behavioural tests developed by Raskin 2009 have successfully quantified prospective memory in adults. In addition, there has been electrophysiological inquiry into prospective memory by West 2001.

Kaur and Raskin 2012 have designed a testing system involving healthy individuals and individuals with a traumatic brain injury (TBI) using a behavioral test; the Memory for Intentions Screening Test (MIST) and electrophysiological tests. Their work has found that the TBI individuals had lower accuracy and a longer time delay in performing prospective memory tasks than did healthy individuals. Also, it was found that the TBI subjects generated smaller amplitudes during the EEG behavioural PM test and did not generate the N300 wave form; leading to questions about the correlation between prospective memory intention and that particular wave form.

The PM tests performed by Kaur and Raskin 2012, were only event based; no time based PM cues were present in the EEG test. According to West 2009, time based cues have provided a very vital method of inquiry into PM. To include a time based cue in the EEG test would provide more insight into the nature of PM deficits following TBI. In addition, the length of time and the rigours of the test especially for the TBI participants were found to be too challenging and uncomfortable, compromising the accuracy of the data.

Thus, this study aims to improve the design of the EEG-computer based test, to be shorter and less challenging. We also aim to computerize the MIST to improve the reach and efficiency of testing; making testing, less time consuming and make the test administrating process less labour intensive. In addition we will add a time based cue item to the measure.

42.

SUBSTRATE SPECIFICITY, pH RESPONSE AND INHIBITION OF THE CHOLINESTERASE IN THE CNS OF THE CHINESE MUD SNAIL, CIPANGOPALUDINA CHINENSIS

Abigail Whalen '15

Faculty Sponsor: Charles C. Swart

The purpose of this study was to describe the basic physiological activity of cholinesterase enzyme(s) in the CNS of *Cipangopaludina chinensis*. We used a spectrophotometer to measure cholinesterase activity of snail brain extracts against 3 substrates using Ellman's reagent. We tested 3 different choline substrates, acetylthiocholine iodide (ATCI), butyrylthiocholine iodide (BTCl), and propionylthiocholine iodide (PTCl) across a range of pH. We found that all cholinesterases in the brain of *B. chinensis* are membrane bound and there is no cholinesterase activity in the body muscle of this animal. Optimal activity of the enzyme occurred with a 0.1 M concentration of PTCl in a phosphate buffer solution with a pH of 8.5 and there was low or only modest inhibition of activity by both Tacrine and Iso-OMPA at concentrations of 10^{-7} and 10^{-5} . Under optimal conditions the K_{max} was calculated as 0.013mg PTCl/ml and V_{max} was 0.263mg PTCl/mg brain tissue/min. We also determined the effect of 2 cholinesterase inhibitors on activity of the snail brain extract, an AChE specific inhibitor (Tacrine) and a butyrylcholinesterase specific inhibitor (Iso-OMPA). The lack of complete inhibition of cholinesterase activity does not rule out the presence of AChE or BChE although substrate specificity supports PChE. We are currently developing a native PAGE assay to determine whether there is one or more cholinesterase enzyme present and the molecular weight of the enzyme and whether it occurs as a monomer or multiples.

43.

EFFECTS OF DRINKING PATTERNS ON PROSPECTIVE MEMORY PERFORMANCE IN COLLEGE STUDENTS

Marta Zamroziewicz '13, David Correll '13, Sarah Isaac '14

Faculty Sponsors: Sarah Raskin, Rivkah Rosen, Howard Tennen, Carol Austad, Carolyn Fallahi, Rebecca Wood, Godfrey Pearlson

Alcohol consumption in college students is of interest due to interactions between alcohol and the developing brain and this is an important age for the development of prospective memory (PM). Thirty-one first-year college students completed the Self-Rating Effects of Alcohol (SREA), Modified Timeline Follow-back (TFLB), and Alcohol Effects Questionnaire (AEQ) and two measures of PM. The time-based PM measure required students to record the current survey question at exactly fifteen minutes during a survey questionnaire. The event-based PM measure required students to present a cash voucher when finished with a series of computerized cognitive tasks. Both measures were scored as 0 if no recognition of the task was given or if the task was partially completed or completed late, and 1 if the task was correct. The ongoing task was an online survey about drinking behavior and the JAVA NEUROPSYCHOLOGICAL TEST (JANET). At the end of the testing session, participants answered a retrospective recognition questionnaire of the PM tasks. Binge drinking was defined as consuming 5 or more drinks (male), or 4 or more drinks (female), in ~ 2 hours. Surprisingly, students performed significantly better on the time-based (mean = 0.81, s.d.=0.40) than on the event-based measure (mean=0.71, s.d.= 0.46) of prospective memory. Those who had consumed alcohol in the last 30 days performed better on the event-based measure (mean=1.00, s.d.=0.00) than teetotalers (mean=0.50, s.d.=0.53). Those who binge drank in the last 30 days performed better on the event-based measure (mean=1.00, s.d.=0.00) but worse on the time-based measure (mean=0.500, s.d.=0.55) than those who hadn't binged in the last 30 days (event-based mean=0.62, s.d.=0.51; time-based mean=0.85, s.d.=0.38). These data are consistent with some previous studies but do not match predictions. The sample size is small, thus further testing of a larger proportion of the college population may yield data with more revealing trends.

PHYSICS

44.

CREATION OF ELECTRON VORTICES USING A PULSED ELECTROMAGNETIC PHASE GRATING

Jonathan Handali '13, Abhishek Khanal '15

Faculty Sponsor: Brett Barwick

Electron vortices have successfully been produced using nano-fabricated mask gratings. The recently experimentally demonstrated Kapitza-Dirac effect of electron diffraction by a light grating presents the possibility of generating electron vortices using an electromagnetic grating. We used Matlab to model the far field disturbance of an electron beam when it interacts with an electromagnetic phase grating. The model exploits the principles of Fourier optics and correctly predicts diffraction through various apertures such as a double slit and a standing wave grating when compared to experiment. The model predicts the possibility of forming electron vortices

using an electromagnetic phase grating generated by a laser of medium power. We intend to produce the electromagnetic grating using optical vortices generated with laser-etched mirror gratings which are currently under production in the lab.

PSYCHOLOGY

45.

SENSITIVITY TO IDENTIFYING REAL VS PROGRAMMED PENDULUM MOTION USING POINT LIGHT DISPLAYS

Yasmine L. Delgado-Jimenez '14 Venus Nunez '14

Faculty Sponsor: William Mace

Individuals are especially sensitive to identifying certain patterns of motion portrayed by point light displays of human motion. (Johansson, 1973). Placing a few points of light on the surface of the object can easily identify a number of aspects of human motion. Pendulum motion is an important component of human motion. Some research argues that people are not very sensitive to acceleration, but acceleration is central to pendulum motion. Certain features of pendulum motion uniquely characterize its identity. One of its most unique features is its speed. The angular velocity of a pendulum is constantly changing as it swings from one side to the other. Therefore, its motion is not uniform. We are interested in identifying whether people can differentiate between a real pendulum and a programmed pendulum using point light displays. While the real pendulum changes angular velocity, the programmed pendulum consists of constant velocity. We had participants decide whether the presented pendulum was real. The displays varied within four conditions (nature of the pendulum, length of the pendulum, speed of the pendulum, and the number of point lights). Each condition was shown 10 times for a total of 120 displays per observer. Overall, participants were able to distinguish the real pendulum from the programmed pendulum in all conditions.

46.

LITERATURE REVIEW OF SELF-REGULATED LEARNING & METACOGNITION

Emily Howe '13

Faculty Sponsors: Dina Anselmi, David Reuman

Metacognition is a complex phenomenon critical for successful learning. Metacognition, as well as cognition and motivation, are the components necessary for self-regulated learning. Metacognition can be understood as the comprehension of and control over one's own cognitive processes. Flavell (1979) pioneered the research of metacognition and first suggested the possibility and desirability of increasing metacognition in children. Research has shown that students with higher levels of metacognition tend to be more academically successful (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). Furthermore, in a meta-analysis performed by Dignath & Buttner (2008), metacognitive interventions were shown to be highly successful at enhancing self-regulated learning in students. In light of this research, a research study has been designed to understand the role that self-regulated learning plays in academic success. The current study will evaluate the effects of a ten session metacognitive and cognitive strategy intervention on the academic performance of eighth grade social studies students. I hypothesize

that students in the treatment group will be academically more successful than students in the control group. Additionally, I hypothesize that students in the treatment group will utilize more cognitive and metacognitive strategies while learning.

47.

CULTURAL NORMS REGARDING EMOTIONAL EXPRESSION: INFLUENCES ON THE PROVISION AND RECEIPT OF SOCIAL SUPPORT

Katie Piotrowski '13

Faculty Sponsor: Janet Chang

Past studies have revealed that individuals from collectivist cultures are more likely to utilize emotional suppression, especially with respect to a stressful or unpleasant event, than those from individualistic cultures who tend to value the open expression of emotions. Although collectivist groups, such as those from Asian cultures, are less likely to seek out social support in response to a stressful event than individualistic groups, such as those from Western cultures, no studies to date have empirically examined whether collectivist or individualistic norms regarding emotional expression and suppression influence social support seeking and provisional tendencies. Furthermore, only a few past studies have examined and found that individuals from collectivist cultures prefer problem-focused support (e.g., practical advice) when seeking support, while those from individualistic cultures prefer emotion-focused support (e.g., expressing emotions). However, because these studies regarding collectivism, individualism, and support type preferences are sparse in number, further research is needed to examine both the receipt and provision of social support, thereby providing a more comprehensive understanding of social support transactions. The purpose of the present study is to examine whether cultural norms regarding emotional expression, which are shaped by either collectivist or individualistic values, influence how individuals seek out and provide social support. In this study, we will prime participants' cultural values based on adjectives, with corresponding pictures, that will represent either collectivist or individualistic values regarding emotional expression (e.g., suppression). Additionally, we will assess the preferred support type (e.g., problem-focused) between participants primed with collectivist values versus those primed with individualistic values.

48.

USING POINT-LIGHT-DISPLAYS FOR BIOLOGICAL MOTION

Edgar Soto '15

Faculty Sponsor: William Mace

Humans are known to perceive motion from the most arbitrary objects, this is most evident in simple children's animation and most studied in point light displays (Johansson, 1973). People have been able to identify exactly what someone is doing, their gender, as well as individuals in groups of people (Blake, 2007) even distinguishing two individuals dancing in unison. What has not been explored has been the coordination of two distinct individuals doing a similar action, in this case tap-dancing. Though the two individuals are linked by the tap-dancing, a study was developed to allow features of two people to be manipulated separately to determine the conditions for perceived coordination.

The work over the summer consisted of integrating the MatLab computer language into body motion study as well as using previous footage to analyze whether participants could determine the individuals in the motion with altered point-light display animations. The altered point-light display coordination was established to ascertain whether any changes in timing or alterations of the individuals affected the perceptions of the individuals as moving in unison or as two separate entities, with the ultimate goal of verifying which conditions influence how the point-light animation is discerned.