Abstracts

Astronomy & Astrophysics

A-01: Villanova's Astrophysics Department Archive
Author: Giannina Guzmán, Briana Dalton, Kyle Conroy, Andrej Prsa
Advisor: Andrej Prsa

Villanova University's Department of Astrophysics and Planetary Science has years of hand-written archival data at its disposal. This archive was established when computer-based database infrastructure was not as accessible as it is today. The objective of this project is to digitize the archive and create a fully functional online catalog that presents the information collected. During Summer 2017, our group worked with Django and Python to build a database that was in accordance to the data that is meant to be collected, and also worked and finished the data entry interface. In the Fall 2017 semester, our group will build a web-based searchable catalog as a frontend interface to the database. This interface will be available to astronomers worldwide, and it will provide access to the data otherwise unavailable. This project will maintain Villanova University's prominence in the astrophysical community, and preserve the work of notable scientists, including some of our faculty.

A-02: HAWC+/SOFIA Instrumental Polarization Calibration
Author: Joseph Michail M., D. T. Chuss, J. Siah
Advisor: Dr. David T. Chuss, Dr. Javad Siah

HAWC+ is a new far-infrared polarimeter for the NASA/DLR SOFIA (Stratospheric Observatory for Infrared Astronomy) telescope. HAWC+ has the capability to measure the polarization of astronomical sources with unprecedented sensitivity and angular resolution in four bands from 50-250 microns. Using data obtained during commissioning flights, we implemented a calibration strategy that separates the astronomical polarization signal from the induced instrumental polarization. The result of this analysis is a map of the instrumental polarization as a function of position in the instrument's focal plane in each band. The results show consistency between bands, as well as with other methods used to determine preliminary instrumental polarization values.

A-03: Supernnovae Cosmology Without Spectroscopy
Author: Elizabeth Johnson, Daniel Scolnic, Eli Rykoff, Eduardo Rozo
Advisor: Daniel Scolnic

Present and future supernovae (SN) surveys face several challenges: the ability to acquire redshifts of either the SN or its host galaxy, the ability to classify a SN without a spectrum, and unknown relations between SN luminosity and host galaxy type. We present here a new approach that addresses these challenges. From the large sample of SNe discovered and measured by the Dark Energy Survey (DES), we cut the sample to only supernovae (SNe) located in luminous red galaxies (LRGs). For these galaxies, photometric redshift estimates are expected to be accurate to a standard deviation of redshift = 0.02. In addition, only Type Ia Supernovae are expected to exist in these galaxies, thereby providing a pure SNIa sample. Furthermore, we can combine this high-redshift sample with a low-redshift SN sample of only SNe located in LRGs, thereby producing a sample that is less sensitive to

host galaxy relations because the host galaxy demographic is consistent across the redshift range. We find that the current DES sample has ~250 SNe in LRGs, a similar amount to current SN samples used to measure cosmological parameters. We will use a further subset of this sample with spectroscopic redshifts from the host to confirm that the standard deviation of redshift = 0.02. It is possible to then use these redshifts to help determine distances of the SNe, and combine this information to produce a Hubble diagram and to measure cosmological parameters of dark energy. We discuss systematic uncertainties from this approach, and forecast constraints from this method for LSST, which should have a sample roughly 200 times as large.

A-04: An Orbital Period Analysis of the Hyades Eclipsing Binary V471 Tauri
Author: Lucas Marchioni, Liam Jones, Dr. Edward Guinan, Dr. Scott Engle
Advisor: Dr. Edward Guinan

We have performed an analysis of the available photometric data available on the eclipsing binary system V471 Tauri. This system resides in the Hyades star cluster located approximately 153 light years from Earth. The system is comprised of a star of spectral type K2 V accompanied by a smaller white dwarf star. These stars form the eclipsing binary system of V471 Tauri, and they have been studied extensively as an example of common envelope theory. This means the entire orbiting system is contained within an envelope of gas that serves to reduce the distance between the binary stars due to drag until the stars merge. The system has been the subject of analysis regarding the orbital period of the eclipsing binary, and from this analysis many postulate the existence of a third body in the form of a brown dwarf that is varying the period. In this study we combine data from the Kepler K2 mission and after detrending and phasing the available data, we are able to compare the changing period of the eclipsing binary system against predictions on the existence of this third body.

A-05: Improving the Determination of Eastern Elongations of Planetary Satellites in the Astronomical Almanac
Author: Christopher Rura, Mark T. Stollberg
Advisor: Edward Fitzpatrick

The Astronomical Almanac is an annual publication of the US Naval Observatory (USNO) and contains a wide variety of astronomical data used by astronomers worldwide as a general reference or for planning observations. Included in this almanac are the times of greatest eastern and northern elongations of the natural satellites of the planets, accurate to 0.1 hour UT. The production code currently used to determine elongation times generates X and Y coordinates for each satellite (16 total) in 5 second intervals. This consequentially caused very large data files, and resulted in the program devoted to determining the elongation times to be computationally intensive. To make this program more efficient, we wrote a Python program to fit a cubic spline to data generated with a 6-minute time step. This resulted in elongation times that were found to agree with those determined from the 5 second data currently used in a large number of cases and was tested for 16 satellites between 2017 and 2019. The accuracy of this program is being tested for the years past 2019 and, if no problems are found, the code will be considered for production of this section of The Astronomical Almanac.

A-06: The Secret Lives of Cepheids
Author: Mary Erickson, Scott Engle, Edward Guinan, Mark Wells
Advisor: Edward Fitzpatrick

Classical Cepheids are a specific class of variable stars that are fundamentally important to Astronomy and Cosmology. These stars pulsate radially, and their pulsations can be used to determine accurate distances, both inside the Milky Way and to other galaxies throughout the Universe, via the well-studied Period-Luminosity Relationship (the Leavitt Law). This makes Cepheids "standard candles," and they are helping Astronomers refine the expansion rate and age of the Universe. Though Cepheid pulsations were long-theorized to be completely stable, we now know that they undergo small but observable changes in their pulsation periods. The rates of the period change give us invaluable information on the Cepheids themselves. Five Cepheids were used for this study – AA Gem, BB Gem, RZ Gem, AD Gem, and DX Gem. Data from this program were taken from two sources: ASAS (All-Sky Automated Survey) and the RCT (Robotically Controlled Telescope) at Kitt Peak National Observatory in Arizona, and combined with available data from the literature. Villanova University is a member of the RCT Consortium, which allows students and faculty to obtain data. ASAS is described as "a low cost project dedicated to constant photometric monitoring of the whole available sky, which is approximately 〖10〗^7 stars brighter than 14 magnitude." ASAS is incredibly useful for its time-span of observations, but the RCT is capable of much higher precision. The two instruments combined can give us an excellent look at how Cepheid pulsations are evolving over time. The pulsation behavior of the 5 Cepheids studies will be presented, along with their calculated stellar parameters.

A-07: The Death Spiral of the Hot Jupiter Exoplanet HD 189733b

Author: Liam Jones, Lucas Marchioni, Edward Guinan, Scott Engle
Advisor: Edward Guinan

HD 189733 is a quintessential example of hot Jupiter-type exoplanet systems in which a gas giant planet with a mass similar to Jupiter is orbiting extremely close to its host star. HD 189733 is the nearest and brightest hot Jupiter system discovered so far and undergoes transit eclipses. Because of this, HD 189733 is well studied across the electromagnetic spectrum. It consists of a 7.7 mag K1.5 V host star and a Jupiter-size planet orbiting with a period of P =2.22 days, only located only 0.030 AU from its host star.

About ten years ago HD 189733 system was discovered to be accompanied by gravitationally-bound red dwarf M4 V star companion (HD 189733 B). It was found previously by Guinan et al. (2017) that the age measurement (~0.7 Gyr) of the K-type star indicated by its 11.95 day rotation period and corresponding moderately high levels of coronal X-ray and chromospheric emissions do not agree with the much older age of ~6 - 9 Gyr indicated from the low X-ray activity of the dM companion star. This age discrepancy is can be resolved by assuming an increase in angular momentum or "spin-up" of the HD 189733A by its hosted planet. It is probable is that this extra angular momentum was acquired from the orbiting exoplanet from the tidal and magnetic interactions of the planet and host star.

Photometric observations of the planetary transit eclipses of HD 189733b have been carried out for over 11 years. Using new transit timings that we have obtained with the 1.3-m Robotically Controlled Telescope (RCT) when combined with numerous timings available in the literature, we have discovered a very small decrease in the orbital period of the HD 189733b. The change in period is dP/dt = 0.87 sec/100 yrs. This finding support the transfer of orbital angular momentum of the planet to the host star - thus spinning-up the host star and shrinking the orbit of the planet. At this rate of period decrease, the planet will be tidally disrupted in less than 40 million years. However, this

planetary disruption will likely occur much sooner because the decrease in the planet's orbital period is expected to speed-up as the planet gets closer to the star.

A-08: KIC 4142768: an eccentric, eclipsing binary system with Delta Scuti pulsations, Gamma Doradus pulsations and tidally induced pulsations
Author: Joseph Manuel, Kelly Hambleton
Advisor: Kelly Hambleton

Heartbeat stars are a class of variable, binary systems that have eccentric, ellipsoidal orbits caused by strong tidal forces. These tidal forces generate variations in the light curve in the form of tidally-induced pulsations which offer information about the mechanisms of the orbit. A variety of interesting effects occur due to these tidal forces: the shape of each star changes, the temperature across the stellar surfaces change, and the velocities of the stars vary. Using data from NASA's Kepler missions, we obtained photometric observations for the eclipsing, heartbeat star system KIC 4142768. Using the binary modeling software PHOEBE, we have determined the fundamental parameters for this system including masses and radii. Our data analysis for this system has also presented a multitude of interesting characteristics. Not only are tidally induced pulsations present, but also Delta Scuti and Gamma Doradus pulsations. We plan to continue this study by applying asteroseismology, the study of stellar pulsations, to KIC 4142768. Through our continued investigation, we hope to extract information about the star's internal structure and expect this will yield additional, interesting results.

Biochemistry

A-09: Determining the Nucleotide Specificity of a Thiamine Responsive Element in Candida Glabrata
Author: Alison Mody, Dennis Wykoff, Christine Iosue
Advisor: Dennis Wykoff

Thiamine (Vitamin B1) is an essential vitamin required for glycolysis and amino acid metabolism that is synthesized by most microorganisms. Yeast synthesize thiamine by upregulating biosynthesis genes. Previous work has identified an 11 bp promoter element that is essential for upregulation of the CgPMU3 promoter. I performed a next generation sequencing technique to identify nucleotide sequences in this 11 bp element (termed a TRE – for thiamine responsive element) in an unbiased manner. I performed PCR to mutagenize the TRE region, inserting random bases in the 11 bp TRE. Then, I fused the mutated TRE in the CgPMU3 promoter to ScTHI5 and YFP. Expression of ScTHI5 allows for growth in the absence of thiamine, and serves as a selective marker for promoter expression. These cells were screened for the capability to express YFP in medium lacking thiamine, and then these TRE sequences were identified using next generation DNA sequencing.

A-10: Synthesis & DNA binding of [Ru(bpy)2(6,6'bpy(OH)2)]2+
Author: Lauren Winkler
Advisor: Dr. Jared Paul

Cancer claims lives every single day and the scientific community is racing to provide new, better ways to kill the mutated cells. A recent focus has been placed on ruthenium organometallic compounds for their effectiveness in targeted cell destruction. It is widely hypothesized that the compound is able to

covalently bind to double-stranded DNA after ligand dissociation, which leads to cell death. In an attempt to understand this destruction mechanism, a series of DNA binding studies were used to support these theories. Modeled after a paper by Claudia Turro, the control was run with a similar small molecule anti-cancer drug that binds to DNA, cisplatin. Next, different concentrations of [Ru(bpy)2(6,6'bpy(OH)2)]2+ were bound to linearized plasmid and run through gel electrophoresis to show separation. Multiple factors, including concentrations, binding time, and pH, were manipulated throughout the process to best adjust the experimental design to [Ru(bpy)2(6,6'bpy(OH)2)]2+. The project has yet to be concluded, however promising data was produced this summer and is presented here. These initial studies serve as the basis for this project moving forward.

A-11: The Effect of Substrate Deubiquitinases on Substrate Degradation
Author: Jeremy Wong, Daniel Kraut
Advisor: Daniel Kraut

The Ubiquitin-Proteasome System (UPS) is the primary cellular pathway for degrading and breaking down proteins. Ubiquitin chains attached to substrates are crucial for proteasomal degradation. Our research and previous studies have shown that the type of ubiquitin chain, K48/mixed-linkage or K63 linked chain, is significant in substrate degradation. We used two types of deubiquitinases (DUBs), AMSH and oTUB1, to cleave the ubiquitin chains on the substrate containing mixed-linkage chains. AMSH cleaves K63 linked ubiquitin and oTUB1 cleaves K48 linked ubiquitin. Degradation assays were then conducted to determine the proteasome's unfolding ability on this altered substrate. First, DUBs were added into the substrate-proteasome mixture, but no clear and significant results were obtained so the substrate was instead treated with DUBs during the ubiquitination process. Both of the DUBs, however, do not appear to be greatly affecting the unfolding ability of the proteasome even though the substrate has mixed K48 and K63 chains. Further assays will be conducted to verify this conclusion.

A-12: The Effect of Lignin Degradation by Fungi on Heavy Metal Sorption Capacity
Author: Savannah Haas, Vanessa Boschi, Amanda Grannas
Advisor: Vanessa Boschi and Amanda Grannas

Sorption of metal species to a solid material has been found to be a cheap, simple, and effective method of removing toxic metals from soils and water. The effectiveness of heavy metal (As, Be, Cd, Cr, Cu, Pb, and Zn) sorption to fresh, mildly degraded, and highly degraded lignin that was modified by brown rot fungi to create catechol groups was analyzed in this study. As a preliminary measure, the metal concentration and pH at which metal hydroxides form were determined. Based on a review of previous sorption studies, results often do not fully account for the formation of hydroxides, therefore inaccurately attributing the removal of metal hydroxides during filtration to sorption, a major oversight biasing their results. Conditions that prevented metal hydroxide precipitation were determined to be a metal concentration of 0.1 mg/L, a pH range of 4 to 6, and an ionic strength of 0.05 M. Applying these conditions to our lignin sorption experiment, we determined the highly degraded lignin was found to be the most effective sorbent material as it had the highest removal rates of heavy metals and is expected to have the greatest amount of catechol functional groups which are excellent metal chelators. The mildly degraded lignin had intermediate removal rates, and the fresh lignin had the lowest removal rates.

A-13: Synthesis of a cyclopropyl glycosyl donor and an acceptor for lipid A disaccharide
Author: Noa Kopplin, Jeffrey Hupf
Advisor: Dr. Giuliano

Lipid A is the innermost of the three regions of the lipopolysaccharide molecule that is responsible for the toxicity of gram-negative bacteria. It is also responsible for adjuvant activity toward protein and carbohydrate antigens. Although its toxic effects can be harmful, it is also believed to be a major component of stimulating the immune system in response to Gram- negative infections; it presents itself as an area of interest for potential use in antibiotics. The core structure of lipid A consists of two β-linked glucosamines with attached acyl chains. Our approach to the synthesis of the lipid A disaccharide is based on the coupling of a cyclopropyl
glycoside donor and a diol acceptor. Past obstacles of our pathway included the failure of the glycosides to couple due to the inability of the glycoside acceptor to withstand the reaction conditions. If the coupling is successful, it will contribute to existing methodologies for the synthesis of Lipid A.

A-14: Synthesis and Physical Organic Analysis of Analogs of Helminthosporol
Author: Nicholas Forelli
Advisor: Dr. Casillas

In the synthesis of deoxyprehelminthosporol, an analog of the sesquiterpenoid phytotoxin from Helminthosporium sativum, an unusual physical-organic observation was made. The bicyclo[3.2.1]octan-6-one structure contains a ethyl ester and a bridged ketone which are targets towards alkylation. Kinetic studies show that ketones undergo alkylation with alkyllithium reagents more favorably than esters, however this system undergoes ester double addition while the ketone is left untransformed. Our project is to investigate the reasoning for this occurrence, and to perform structural analysis on these cornerstone natural products. We have formulated two hypotheses to test explain this phenomenon. First, that it is steric hindrance of the ring substituents that block the necessary Bürgi-Dunitz angle towards ketone alkylation. Second, that irreversible enolate formation occurs which deactivates the ketone towards alkylation. A number of analogs are being synthesized and alkylated to discern between the two hypotheses.

A-15: A Glass a Day Keeps the Doctor Away: Examining Oxidation of Quercetin from Red Wine in Cell Culture Conditions
Author: Mykal Gerald, Aimee Eggler
Advisor: Dr. Eggler

Quercetin is the most abundant dietary bioflavanoid, and is found in high concentrations in red wine, apples and dark berries/cherries. It is the subject of 50 clinical trials due in part to its presumed activation of the Nrf2 protein and the antioxidant response element (ARE) pathway, and thus its effects on chronic illnesses such as cancer, Alzheimer's and diabetes. Nrf2 is a transcription factor that binds to the ARE promoter region of DNA, which is upstream of genes that mitigate oxidative stress in cells, as well as those with other cytoprotective functions such as detoxification and repair. Quercetin is a part of a large class of Nrf2 activators called oxidizable phenols, whose oxidation results in an electrophilic form, and produces reactive oxygen species (ROS), both of which may be important in the activation of Nrf2/ARE pathway. An understudied aspect of Nrf2/ARE activation by oxidizable phenols is the extent of oxidation to the quinone form and other forms, chemical lability, and ROS production in cell culture media, and how this affects ARE activation. My project aims to

identify the various species of quercetin found after it has been introduced to media commonly used in treating human cell lines, using UV-Vis and LC-MS, and to determine under what cell culture conditions quercetin will activate the pathway. Major findings include that, unexpectedly, quercetin is rapidly oxidized in phosphate buffer at pH 7.5, and that the rate of oxidation is significantly increased by the inclusion of 100 mM NaCl, commonly used when treating cells in cell culture. The reductant ascorbic acid prevented this oxidation. As expected, rapid quercetin oxidation was also observed in cell culture media (DMEM), and this was only partly slowed by the inclusion of 10% FBS. We find only 2-fold activation of an ARE reporter by 50 uM quercetin in DMEM with 10% FBS. However, inclusion of ascorbic acid increased this to 5-fold activation, suggesting that maintaining quercetin is the reduced form is important for this activation. Initial results with LC-MS are also presented.

Biology

A-16: The Family Experience of Siblings of Children with Cancer: A Comparison of Sibling and Parent Reports

Author: Kripalani Simran, Alison Taggi Pinto, M.Ed., Melissa Alderfer, Ph.D.,
Advisor: Robert Curry

When a child is diagnosed with cancer, their entire family is affected. The diagnosis is emotionally intense, and, to meet the demands of treatment, family members often alter routines and spend time apart. Siblings of the child with cancer may have difficulty adjusting to these changes. It is unclear whether parents are aware of siblings' experience of cancer. The purpose of this study was to examine the family experience of siblings of children with cancer and to determine if parent-reports accurately represent what siblings report. A total of 29 sibling-parent dyads from families of children with cancer completed a series of measures assessing sibling cancer-related traumatic stress symptoms (Child PTSD Symptom Scale; Psychosocial Assessment Tool), family functioning (Family Assessment Device; Multidimensional Scale of Perceived Social Support), and the ability of parents to attend to the needs of the sibling (Perceived Filial Self Efficacy Scale; Perceived Parent Self Efficacy Scale). Many siblings reported experiencing cancer-related traumatic stress symptoms. Most (86%) reported high levels of family support but about one third reported "unhealthy" family functioning (36%) and difficulty getting their parents to attend to them (30%). In comparison, only 7% of parents reported difficulty attending to siblings. Parent-reported family functioning was not statistically different from sibling reports. 59% of parents reported being "very aware" and 38% reported being "somewhat aware" of how the sibling was doing. However, only 23% of parents accurately reported their child was experiencing intrusive thoughts about cancer. Even smaller percentages accurately reported when siblings were experiencing symptoms of avoidance and feeling jumpy or easily startled. While low statistical power precluded finding reliable statistical effects, descriptive statistics suggest that parents' reports may not always accurately capture the impact that cancer has on siblings. It is worthwhile to continue to gather both parent and sibling perspectives.

A-17: Investigating DNA Damage Repair Regulation as a Potential Mechanism for the *iprA* gene

Author: Vaishnavi Warrier
Advisor: Dr. James W Wilson

The iprA gene is a highly conserved gene that regulates oxidative stress survival across the Gram negative Enterobacteriaceae family. The Wilson lab published that ΔiprA mutants increase

oxidative stress resistance several log-fold in S. Typhimurium, Escherichia coli, and Enterobacter cloacae species. This data is intriguing because iprA is a novel example of a gene that represses stress repair, in its wild type (WT) form. Though the IprA protein is predicted to encode a DNA-binding protein, we don't know how the gene functions to negatively regulate oxidative stress. Since that paper, Dr. Wilson has found suggestive results that show that ΔiprA mutants, compared to wild type, survive better under harmful UV exposure and that more ΔiprA mutant colonies, compared to wild type, produce spontaneous mutations when passaged for a several generations. The oxidative stress results and these new results point to DNA damage repair mechanisms as a component in how the iprA gene operates. This summer, I conducted two experiments in relation to iprA and DNA damage repair. First, I tested the effects of various chemical DNA damaging reagents on S. Typhimurium and E. coli strains that lack the iprA gene and found that under certain conditions, cells lacking the iprA gene were more resistant to DNA damaging agents such as Mitomycin C, Polymyxin B, Hydroxyurea, and Perborate. Secondly, because the spontaneous mutations results were suggestive, I started a controlled experiment to sequence wild type and ΔiprA genomes using Next Generation Sequencing in order to quantify and locate these spontaneous genomic mutations. So far, I have constructed and screened the mutant and wild type strains and will be creating libraries and sequencing them in the following weeks.

A-18: Phylogeny, Function and Structural Constraint: Using Computed Tomography (CT) to Digitally Dissect the Factors Influencing the Morphology of the Gecko Humerus Bones
Author:Zachary Davis
Advisor: Dr. Aaron Bauer

Skeletal morphotypes within even a single lineage of organism can vary greatly. The morphology expressed by an organism is the result of three factors: phylogeny, function, and structural (meaning developmental or physical) constraints. However, the exact degree which each of these factors influences the morphologies of different species is unknown. By studying the morphology of the humeri of geckos of the genus Pachydactylus, which have many species with well-documented sizes, habitats, and phylogenetic relationships, the effect of each factor on the adult morphology can be estimated. Approximately 110 specimens of Pachydactylus, representing 22 species were borrowed from museum collections and scanned with a microCT (Computed Tomography) scanner at the Friday Harbor Laboratory of the University of Washington. Avizo 9.3.1 software was used to "digitally dissect" the post-cranial skeleton, isolating both humeri of each specimen. Although all humeri are generally similar, there are differences in proportion due to scaling, differences between taxa using different substrates, suggesting functional modifications, and differences associated with phylogenetic relationships. All of these factors interact with one another, but structural differences are the most significant. Geometric morphometric approaches and Principal Component Analysis will be used going forward to quantify differences across all taxa and to factor out size so that functional and phylogenetic patterns can be investigated in greater detail.

A-19: From genes to neural circuits to behavior: How the retained gene regulates Drosophila female courtship behavior
Author: Mary Metkus
Advisor: Troy Shirangi

How do genes build neural circuits, and how do these circuits control behavior? I am studying these questions using the courtship behaviors of the model genetic organism, Drosophila. The retained gene in Drosophila encodes a developmental transcription factor that affects female behavior. Retained is expressed in sparse subsets of neurons in the female brain, but which neurons are important for behavior, and what retained is doing in those neurons is not understood. I used the innovative genome-editing tool CRISPR-Cas9 to build a strain of flies that will allow me to answer these questions. This tool will be used in future experiments to identify the cells that express retained, determine which neurons are important for behavior, and determine how the retained gene affects neuronal development.

A-20: The Differential Impact of Medical Home on Shared Decision-Making for Caregivers of Children with Autism Compared to Children with Other Conditions

Author: Mckenzee Chiam, Thomas Mackie, PhD MPH, Erick Rojas, JD MPH
Advisor: Robert Styer

The differential impact of medical home on shared decision-making for caregivers of children with autism compared to children with other emotional, developmental, or behavioral conditions and those of children with other special health care needs. Using cross-sectional dataset from the 2009-2010 National Survey of Children with Special Health Care Needs, we conducted binary logistic regression models to examine whether medical home was strongly associated with the attainment of shared decision-making for each of the three health condition groups, while accounting for covariates. Results indicated that caregivers of children of autism with medical homes had higher odds of attaining shared decision-making that caregivers of children with autism without medical homes. Results, also, suggested that having a medical home may attenuate the disparity in attaining shared decision-making for caregivers of children with autism as compared to caregivers of children with other emotional, developmental, or behavioral conditions and caregivers of children with other special health care needs. Policies should support children with autism in accessing a medical home in order to facilitate shared decision-making implementation in their care. Lastly, the healthcare delivery system characteristic, such as medical home, should be included in the conceptual framework of future studies of shared decision-making.

B-21: Effects of TBB on Localization of ZC3H8 and PML Viewed Through Confocal Microscopy

Author: Tyler Doan, Dr. John Schmidt, Dr. Janice Knepper
Advisor: Dr. John Schmidt

Fliz 1, a zinc finger protein encoded by the ZC3H8 gene, has been shown to be upregulated in cancerous adult tissues by approximately 2-6%. 4,5,6,7-tetrabromobenzotriazole (TBB) is an inhibitor of casein kinase 2 (CK2). Protein kinase inhibitors, like TBB, are often used in treatments of diseases with hyperactive kinase activity, which leads to hyper-phosphorylation of proteins. Many diseases such as forms of cancer are driven by excessive phosphorylation that eventually leads to disrupted cellular functions. Localization behavior of ZC3H8 is dependent on the phosphorylated state of the protein. If CK2 is present, the ZC3H8 protein is phosphorylated and localized within PML bodies (promyelocytic leukemia protein) in the nucleus. These PML bodies are associated with high levels of transcription and may be hints to the specific function of the ZC3H8 protein. However, upon treatment of the cells with TBB, these PML bodies along with Fliz 1, co-localize into much fewer and more dispersed nuclear foci. The TBB treatment also seems to affect the localization of ZC3H8 and

PML individually in the sense that there are images where ZC3H8 seems to localize without PML at all, as opposed to the ordinary co-localization of the two together. Here we are presenting confocal microscopy images and analysis of both ZC3H8 and PML immunofluorescence localization in a variety of assays conducted including altering concentrations of TBB added, duration of TBB treatments, and various recovery conditions. Understanding the various step-wise effects of TBB on localization of ZC3H8 and PML will help us getter a better idea of the actual mechanism of the changes in localization.

B-22: Family Medical History Project at Mount Zion Baptist Church
Author: Christie Cannarozzi, Madona Farag, Nicole Blekhter, Michael Medina
Advisor: Dr. Roy Wade

The purpose of this study is to create a codebook through analyzing several semi-structured interviews of families at Mount Zion Baptist Church. These interviews were conducted by Dr. Roy Wade with a grounded theory analysis technique and focused on examining family medical history. As a team of research assistants, we were responsible for breaking down each interview in order to examine the common themes among the interviews of these African American families. Once we decided upon a set of themes, we established definitions and examples of variables that may play a role in family health among African Americans. This qualitative coding helped to improve reliability and create a structure and agreement about important definitions, constructs, and themes that were found throughout the multiple interviews. The codebook that we created included evidence of environmental, cultural, and community factors that affected the health of an individual within an African American family in the region of Philadelphia. It can serve as a resource that can be used to further examine the outcomes of the everyday exposures we discovered and their relation to health barriers within a family.

B-23: Self Medication in Long-Tailed Macaques to treat Plasmodium Infection
Author: Mitsy Wedderburn, Benjamin Gombash, Justin Wilcox, Hope Hollocher
Advisor: Hope Hollocher

Malaria is the deadliest parasitic disease of humans, killing more than half a million people annually. The evolution of drug resistance by its causative agents, Plasmodium spp., has hindered control of this disease, and created a need for new anti-malarial drugs capable of combatting resistant malarial strains. Medicinal plants have served as a source of such drugs in the past, but the number of potential candidates make promising targets hard to find. Self-medication by non-human primates may help to highlight potential chemotherapeutic agents, however this phenomenon is poorly understood. While non-human primates have been shown to consume a range of plants with pharmacological activity, the relationships between these behaviors and actual disease state remain unexplored. Long-tailed macaques (Macaca fascicularis) are infected by a wide range of Plasmodium spp., some of which zoonotically infect humans. Here, we utilize a series of molecular approaches to examine the relationships between Plasmodium spp. infections and medicinal plant consumption in long-tailed macaques. Macaque diet and Plasmodium infection status were assessed using data from an 18S amplicon on DNA from macaque feces. A thorough review of literature on medicinal plants of Southeast Asia led us to identify four botanical genera of interest in these data: Artemisia, Diospyros, Panari, and Psychotria. We found that Parinari spp. were significantly positively associated with Plasmodium spp. read count. To facilitate further exploration of this relationship, we began the process of developing diagnostic primers for the presence of this plant and Plasmodium spp.

infections. If effective, our methods may provide a low-cost tool for the study of self-medication in macaques and other non-human primates.

B-24: A Tale of Two Cities: The Relationship of Density and Morphology Varies Among Populations of the Maritime Earwig

Author: Alissa Coonfield, Vikram Iyengar
Advisor: Vikram Iyengar

For organisms that live in groups, the spatial distribution of individuals according to size and sex can provide insight into social interactions, including aggression (intrasexual selection for armaments) and mating preferences (intersexual selection for ornaments). To gain insight into how group dynamics may influence the mating system, we investigated the relationship of density and morphology in the maritime earwig, Anisolabis maritima, an insect found in high densities beneath pieces of driftwood above the high-tide line in coastal ecosystems throughout the world. There are fundamental differences in the behavior and morphology between the sexes. Males and females differ fundamentally in their aggression during agonistic encounters with conspecifics; males more readily cohabitate with conspecifics and resolve their disputes non-lethally whereas females often kill conspecifics in close proximity as they vigorously guard their offspring. Males also differ markedly from females in both body size (males are more variable in size, and sometimes substantially larger, than females) and weaponry (males possess asymmetrical, curved forceps whereas females have straight forceps). Given previously observed variation in both body size and forceps asymmetry, we investigated the possible correlation between population density and morphology of individuals in two populations on San Juan Island, WA to determine whether these parameters affect group dynamics and social interactions. Specifically, we lifted 10-15 logs at two sites (False Bay and Cattle Point) at two different times during the breeding season (June and July) and determined the overall density, average body size and average forceps asymmetry for individuals under each log. Comparing the area occupied to the body size and forceps asymmetry of individuals, we found that the relationship between body size and population density varied both by site and by the period in the breeding cycle. Additionally, we found a greater, more morphologically diverse population of males at False Bay, a site with lower tidal action and more predictable habitat availability. We posit, therefore, that the breeding cycle varies from site to site based on the stability of the environment, and that a more turbulent environment, as seen at Cattle Point, can disrupt the population and delay the breeding cycle, leading to a less diverse, more unstable population. Our results also suggest that larger individuals are more likely to live in higher densities before the breeding cycle, possibly due to their increased fighting ability and willingness to compete with others for mates, and at lower densities early in the breeding cycle due to their increased conspecific aggression during courtship and nesting. This research lays the foundation for future studies regarding the social dynamics of this species where we can monitor individual interactions and group distributions in a more controlled laboratory setting.

B-25: Does extra-pair paternity confound analysis of hatching success in hybridizing songbirds?

Author: Emily Burton, Dr. Robert L. Curry
Advisor: Dr. Curry

Climate change has resulted in shifts in bringing closely related species into reproductive contact with each other, resulting in hybridization. Hybrid zones that move as a result of climate change allow us to explore many interesting things because the dynamic nature of the system allows for certain analysis

not applicable to static systems. A zone of hybridization between two species of chickadee, Black-capped (Poecile atricapillus) and Carolina (P. carolinensis), in southeastern Pennsylvania has been moving steadily northward in response to climate change. Many studies have been done on this hybrid zone. One recent study in particular related hatching success to the levels of hybridization of the parents, finding that increased parental hybridization decreased hatching success. Though this study had significant results, there is the potential that the results could have been affected by extra-pair copulations, where the male parent of the offspring is not the same male associated with the nest. This has been found to occur in chickadee hybrid zones, and could lead to imprecise parentage analyses. An examination of extra pair paternity necessitates comparing the genotypes of nestlings to the parents associated with their nests, and looking for potential mismatches. McQuillen et al. recently developed 10 single nucleotide polymorphism (SNP; locations in the species' DNA that differs by only one base, e.g., A instead of G) markers representing alleles that differ between Black-capped and Carolina chickadees and can be used to analyze the levels of hybridization. I used these markers to genotype nestlings at Hawk Mountain Sanctuary, a known hybrid zone, in order to compare the nestling genotype to the genotypes of the adult birds associated with the nest. I was able to use 8 of the 10 SNP markers using PCR's followed by enzyme digests. I imaged the final product on agarose gels stained with gel red, then calculated the hybridization index of each individual based upon those results. Unexpected differences in the genotype of the nestlings compared to the adults (for example, if pure Black-capped chickadees had nestlings with Carolina genes) can be used to determine if extra-pair copulations occurred. An advantage of this plan is that it also allows for the analysis of selection between generations, meaning I can analyze whether or not the genotypes of hybrid offspring are non-random, influencing the hybrid zone's rate of movement. This has been found in other populations and would offer another view of the dynamics of the population genetics within the hybrid zone.

B-26: Phosphatases regulated by phosphate and thiamine starvation have arisen repeatedly in Ascomycetes

Author: John Nahas
Advisor: Dr. Dennis Wykoff

Convergence is thought to be a consequence of a selective pressure generating a similar phenotype, with some notable exceptions caused by constraints and not selection. We observe a convergent phenotype related to phosphatase evolution in a spectrum of Ascomycete yeasts, including Saccharomyces cerevisiae, Candida glabrata, and Schizosaccharomyces pombe. The convergent phenotype is a recent duplication of a phosphatase resulting in two (or more) phosphatases that are regulated by two different nutrient conditions – thiamine and phosphate availability. We observe evidence of both subfunctionalization and neofunctionalization. In C. glabrata, the phosphatase proteins have novel enzymatic functions relative to one another; whereas in S. cerevisiae the two phosphatases appear to be transcriptionally regulated under different conditions, but maintain similar enzyme specificity at the level of the protein. In most cases, the duplications of the phosphatases are after the split of Genera, and therefore, relatively recent. Because these convergent phenotypes are a consequence of two different families of histidine phosphatases (the PHO5 and PMU1 gene families), the convergence indicates that there must have been similar selective pressures on multiple yeast species to recycle both thiamine and phosphate, that this convergence is unlikely a consequence of a constraint, and that there must have been periods (over evolutionary timescales) where this selection strength varied.

B-27: Case Study: Bilateral Complete Visual Loss in Chiari I Malformation
Author: Larissa M Pastore, Domenic J Pastore MD, Samantha Pastore
Advisor: Dr. Jackman

Chiari malformation type I is a developmental disorder which features herniation of brain tissue into the spinal canal. Due to its origin as a progressive ailment, chief complaints leading to a Chari malformation type I diagnosis typically presents later on in adulthood and is diagnosed through the use of an imaging test. Although often times asymptomatic, Chiari I malformations can commonly induce painful and debilitating onsets of headaches, neck soreness, and numbness in extremities. This case study demonstrates that incidental Chiari I malformation findings may also be pertinent to symptoms of bilateral vision loss. In addition, a patient complaint of bilateral vision should be followed up with an MRI and consult with a radiologist and neurologist with Chiari I malformation being included as a relevant differential diagnosis.

B-28: Social Network Analysis, Dominance, and Parentage in Carolina Chickadees
Author: Matt Dula, Rebecca Garlinger, Robert Curry
Advisor: Robert Curry

Social interactions, such as dominance and social networks, have been shown to affect fitness in many animals, and may cause increases in hybrid zone movements. I have begun to examine the link between these interactions and fitness in Carolina chickadees (Poecile carolinensis) by testing the relationship of dominance and social networks with frequency of extrapair copulation. This spring and summer I collected blood samples and banded parents and offspring in the field for parentage analysis. I will determine paternity of nestlings using microsatellite analysis and measure the frequency of extrapair copulation and compare to social interactions. I will test dominance interactions and social networking in the fall and winter while the birds live in flocks and interact with one another. My study aims to find a novel relationship in Carolina chickadees which will help understand the effects of social interactions in animals and the mechanisms behind moving hybrid zones.

B-29: Parental effects in mangroves: endophytic fungi in response to nutrient addition
Author: Andrew Freed
Advisor: Samantha Chapman

Endophytic fungi that live in the leaves of mangrove trees have the potential to affect the growth and fitness of the mangrove. These organisms form close symbiotic relationships that can help plants tolerate stress. As more countries around the globe restore coastal wetlands, it is crucial to understand which populations of plants will provide the greatest chance of successful growth. Therefore, we must consider the factors that affect the endophyte communities in mangroves. We grew Avicennia germinans (black mangroves) from different populations in the greenhouse. The populations had been treated to nutrient addition in the field in the form of carbon, nitrogen, or phosphorus. Propagules from these nutrient-treated mangroves were then grown inside and analyzed for endophytic fungi. Progeny whose parents were treated with any type of nutrient addition had a significantly higher number of species of endophytic fungi than the plants whose parents were not treated. These plant populations also enjoyed higher endophyte diversity than their control counterparts. These results indicate that the environment of parent plants may play a role in determining which mangroves are more likely to survive and protect precious coastlines. Soil composition of the parent mangrove tree, for instance, could have a significant effect on the ability of the offspring to survive in stressful conditions.

B-30: I**nvestigation of DAF-18/PTEN and its role in regulating the age-dependent increase of DAF-16-mediated immunity in Caenorhabditis elegans**

Author: Kali Carrasco
Advisor: Matthew Youngman, Ph.D

Differential expression of critical genes is known to alter important processes such as lifespan, aging and stress resistance. Insulin signaling has profound power to control the expression of genes that have critical functions in aging and stress resistance. In the roundworm Caenorhabditis elegans, the fundamental mechanism that alters gene expression during aging involves a target of an insulin signaling pathway: DAF-16, a FOXO transcription factor. DAF-16 had been thought to only become activated in the presence of stress, but data from our lab indicate that DAF-16 activity increases in an age-dependent manner in the absence of acute stress, suggesting that the inhibitory effects of the insulin-signaling pathway are somehow assuaged with age. One factor which may be critical in this mitigation may be the lipid phosphatase DAF-18, an orthologue of the human suppressor PTEN. Critical in early steps of the ins-1/IGF insulin-signaling pathway, DAF-18 dephosphorylates the lipid PIP3 which prevents inhibitory phosphorylation of DAF-16, allowing it to enter the nucleus and regulate its target genes. Therefore, we sought to investigate the role of DAF-18 in regulation of age-dependent, DAF-16-initiated processes. Using an in vivo GFP reporter of DAF-16 transcriptional activity, our data indicate that DAF-18 is required for the age-dependent increase in expression of DAF-16 targets, including those that play a role in host defense. Accordingly, we find that DAF-16-mediated immunity is compromised in both daf-18 RNAi knockdowns and mutants, leading to a reduced capacity to resist bacterial infection in adult but not larval stage animals. Our findings have exciting implications in the possibility of increasing stress resistance and extending lifespan through FOXO-mediated changes in gene expression. Moreover, we anticipate that our studies will contribute to the understanding of the role PTEN in tumor suppression and aging.

B-31: Investigating the Origin and Function of Lipid Droplets Present in Mice Thymi

Author: Sarah Humrich, Anil K Bamezai
Advisor: Anil K Bamezai

Lipid droplets (LDs) are vesicles present inside adipocytes and play a vital role in storing neutral lipids as a source for nutrients. The presence of LDs is reported in the mouse thymus as well. The cellular origins of LDs and the functions they serve in the thymus remain unknown. My experiments sought to investigate the cellular source and nature of lipid vesicles in the thymus and the proteins they express. I also sought to examine a possible antigen presenting function these lipid droplets may serve. I developed a method to isolate and quantify LDs from the thymus using flow cytometry. I also visualized these lipid vesicles by light microscopy after staining with oil stain scarlet 6G, a dye that binds lipids. Based on the size distribution, and staining with anti-CD63 antibodies, followed by flow cytometry, we conclude that these lipid vesicles are, in fact, lipid droplets and not another type of CD63 protein-expressing lipid vesicles known as exosomes. By tagging the lipid droplets with fluorescent antibodies specific to various immune molecules, I show that the LDs from the thymus do express some immune molecules on their membranes. I was able to isolate and characterize LDs from the thymus of Recombination-Activation Gene 1(RAG-1) deficient mice, these mice lack 90-95% of T lymphocytes in the thymus. These data suggest that cells other than T lymphocytes in the thymus generate LDs, if not exclusively. I am currently carrying out functional experiments to test antigen presenting capacity of LDs to T lymphocytes. These experiments are done by combining mature CD4+T-cells with the specific antigen, and LDs to assess antigen-specific clonal expiation of

CD4+ T cells in 24 -72 hours' time frame. Based on my experiments, so far, I conclude that lipid vesicles found in the thymus are lipid droplets and not exosomes. These lipid droplets express immune molecules on their membrane, and potentially generated from a different cell source, other than thymic T cells.

B-32: The role of SMK-1 as a key repressor of oxidative stress resistance in adult Caenorhabditis elegans

Author: Patrick Mitrano-Towers
Advisor: Dr. Matthew Youngman

Aging is characterized by the accumulation of damage at the cellular and molecular levels. Oxidative stress elevates levels of reactive oxygen species, causing damage to DNA and proteins, as well as lipid oxidation. The ability to respond to a variety of stresses is conserved among evolutionarily diverse organisms. The insulin-signaling pathway is one of the most important responses to stress. In Caenorhabditis elegans the downstream target of this pathway is DAF-16. Larval, unstressed C. elegans have low DAF-16 activity that increases in an age-dependent manner, with an apparent maximum level of activity around D6 of adulthood. Previous studies in our lab indicate that SMK-1, an evolutionarily conserved regulatory subunit of the Protein Phosphatase 4 complex, is required for the age-dependent increase in DAF-16 transcriptional activity. The first question this project addressed is the role of SMK-1 as a regulator of DAF-16 in response to oxidative stress. Animals were treated with RNAi to knock down smk-1 and then exposed to lethal levels of hydrogen peroxide or paraquat at the L4 larval stage and at Day 6 of adulthood. We found that adult smk-1 knockdown animals had a longer LT50 than wild type animals when exposed to chemical agents that cause oxidative stress. Therefore, knockdown of smk-1 with RNAi in adults causes resistance of the animals to the chemical stress. This suggests that in adult animals, SMK-1 represses the ability of DAF-16 to respond to oxidative stress. The second aim of the project was to identify SMK-1-regulated genes that may be responsible for conferring resistance to oxidative stress in adult C. elegans. RNA libraries were generated from adult worms treated with RNAi to knock down smk-1 prior to exposure to hydrogen peroxide. We expect that RNAseq analysis of these libraries will reveal a host of genes that function to detoxify the animals. This project may uncover new gene targets in human cells to counter the effects of stress.

B-33: Investigating Endogenous siRNA Involvement in the Nonstop Decay Pathway in C. elegans

Author: Evana Mortezavi Elaine Youngman
Advisor: Elaine Youngman

Endogenous small interfering RNAs (endo-siRNAs) are vital in guiding modulation of gene expression. In complex with Argonaute proteins, they act by binding complementary sequences in mRNA and modulating the expression of a targeted gene. In the model roundworm Caenorhabditis elegans, endo-siRNAs known as 22G RNAs regulate expression of thousands of protein coding transcripts in developing sperm and egg cells, and their loss leads to infertility. Similarly, endo-siRNAs play important roles in proper development of germ cells in many other animals, and a mutation in one Argonaute protein (PIWI) is associated with human male infertility. While the biological roles of these small RNAs are becoming more well understood, we are working to understand the factors that control which genes are targeted for regulation by 22G RNAs. Previous research in the Youngman lab identified a gene of unknown function (F43E2.6, termed F43) that is targeted by 22G RNAs only in polymorphic wild strains of worms that have the stop codon. Conversely, when the stop codon is

present, there is low 22G RNA production. It has been previously reported that mRNAs without a stop codon enter a nonstop decay pathway that acts as a mechanism of mRNA surveillance to destroy the faulty mRNA. My project aims to investigate whether the loss of a stop codon alone is sufficient to target an mRNA for silencing by 22G RNAs. In addition to 22G RNAs, F43 is targeted by a Dicer product, and RDE-1-bound Dicer products can trigger 22G RNA synthesis in the classical exogenous RNAi pathway triggered by double-stranded RNA. This leads to two alternative hypotheses to explain the biogenesis of 22G RNAs at F43: the loss of the stop codon, or the targeting by the Dicer product in complex with RDE-1. To determine if production of 22G RNAs at the F43 locus is independent of the Dicer product, I first generated rde-1/F43nonstop homozygotes using standard worm genetic methods. This mutant strain lacks a functional Dicer pathway, but still contain the nonstop polymorphism. Therefore, any changes in the concentration of 22G RNAs would be solely dependent on the nonstop polymorphism. To determine if there is an increase in the production of 22G RNAs in the presence of a nonstop codon, we are currently isolating RNA from the rde-1/nonstop strain for qPCR and deep sequencing to assess 22G RNA levels targeting F43. In addition, CRISPR will be utilized to further demonstrate that the presence of the nonstop codon at the F43 locus is sufficient for increased synthesis of 22G RNAs. This work would represent the first known connection between endo siRNAs and mRNA surveillance pathways in any animal, providing new insight into the mechanisms that protect eukaryotes from potentially harmful aberrant transcripts.

B-34: Potential genetic influence on personality traits of black-capped and Carolina chickadees: testing connections with DRD4

Author: Taylor Heuermann, Robert Curry
Advisor: Robert Curry

The underlying genetics that drive different expressions of personality in animals is a great topic of interest in behavioral ecology. Research has linked the dopamine receptor four (DRD4) gene to personality in several different vertebrate species, including the great tit. The chickadee is a close relative of the great tit, and both black-capped and Carolina chickadees show SNP variation in DRD4. The purpose of this project was to see if boldness and exploratory behavior, components of personality, correlated with different DRD4 genotypes in the chickadees. My study sites were the Great Marsh nature preserve and Tuscarora State Park. I obtained boldness scores for chickadee pairs at nest sites by observing responses to a woodpecker decoy – specifically, how much time the pair spent within five meters of the decoy during the five minute testing period, as well as how many alarm calls were made and to what level of alarm. Graduate student Sarah Polekoff obtained exploratory scores by following a strict observational protocol of chickadees released into a specially designed box. Exploratory test results have shown a significant difference in personality between both chickadee species, as well as variation within species. Boldness tests have shown variation within species, and preliminary data suggests difference between species as well. Correlation between personality scores and genotypes for DRD4 are pending completion of laboratory testing.

B-35: Identification of putative regulators of the age-dependent transcriptional activity of DAF-16 in Caenorhabditis elegans

Author: Julia Morris, Kali Carrasco
Advisor: Matthew Youngman

The insulin/IGF-1(IIS) signaling pathway confers stress-resistance and longevity in C. elegans by regulating the DAF-16/FOXO transcription factor, which in turn modulates the expression of immunity, detoxification, and repair genes, among others. Inside the nucleus, DAF-16 cooperates with

other proteins to specify its transcriptional output. One of the most critical co-regulators of DAF-16 is SMK-1, which may be the regulatory subunit of the Protein Phosphatase 4 complex. We find that DAF-16 activity increases not only in instances of stress but also in an age-dependent manner. In particular, our data suggest that SMK-1 is required for DAF-16- mediated innate immunity in adult C. elegans. To identify other genes that may be required for the age-dependent increase in DAF-16 transcriptional activity, we took an RNAi-based reverse genetics approach to test the function of candidate genes identified as potential subunits of the SMK-1/PPH- 4.1 complex or its putative substrates. Our initial screen revealed an age-dependent increase in plys-7::gfp expression, an in vivo reporter of DAF-16 transcriptional activity, and yielded several positive hits. Four of these candidate genes encode orthologs of subunits of the mammalian protein phosphatase 4 complex and were selected for functional validation in a bacterial infection assay. In this secondary test, we found that knockdown of pph-4.1, pph-4.2, and ppfr-2 result in an increased susceptibility to infection at Day 6 of adulthood, suggesting these genes are potential regulators of DAF-16 in adult C. elegans. Our results indicate that, as it does in developing embryos, SMK-1 may cooperate with PPH-4.1 and other PP4 complex members in adult worms, and both proteins appear to regulate DAF-16 later in life.

B-36: The Effects of Mutating ZC3H8 Zinc Fingers on Nuclear Localization
Author: Emily Harris
Advisor: Janice Knepper

ZC3H8, a zinc finger protein with a three zinc finger structure, also known as FLIZ, has been found to be overexpressed in multiple mouse and human breast cancer cell lines and leads to an increase in invasiveness, motility, proliferation, and tumorigenesis. FLIZ is generally associated with nucleic acid binding, therefore it is important to determine which of the three zinc fingers is most important to this function. The Knepper Lab has previously found FLIZ to be localized mainly within PML bodies, a type of nuclear body. The intent of this project was to create mutations of the different zinc fingers in order to determine if localization of the FLIZ changed in any of the mutations, possibly indicating the importance of a particular finger over the others. In order to do this, the zinc finger gene was first mutated as to knock out each finger individually, in combination, and for a complete knockout. These mutations were cloned into a GFP vector in order to visualize the localization on a confocal microscope so comparisons of the mutants could be made. The main control for the project was SynFLIZ, a synonymous mutation of FLIZ with a different codon sequence coding for the same amino acids, also cloned in to GFP vector in order to compare to the mutations in terms of localization. The findings of the project could indicate an importance of a specific zinc finger to the localization, which could potentially indicate a therapeutic target.

Business

B-37: The Identification of Trends in Cryptocurrency Markets and Arbitrage Opportunities
Author:Michael Morrow
Advisor : John Sedunov

Cryptocurrencies are a relatively new part of the world of finance, and scholars have been trying to assess their feasibility as a global solution to many of the world's banking problems. However, research in the cryptocurrency markets are largely incomplete, specifically in relation to exchange rate arbitrage and mispricings in the various online marketplaces. Through a variety of well-established economists

have touched on the process of cryptocurrency generation, valuation, and trade, there is a lack of conclusive research on the interactions of cryptocurrencies.

Chemistry

B-38: Controlling Wettability of 2-D Materials Through Lateral Hydrogen Bonding Networks in Noncovalent Monolayers
Author: Arcidiacono Ashley, Ashlin Porter, Shelley Claridge
Advisor: Dr. Jared Paul

We propose a strategy for creating sub-10-nm chemical patterns that leverages the hydrophilic-hydrophobic orthogonality intrinsic to the cell membrane. Such patterning abilities serve important synthetic material applications including nanoelectronics and organic photovoltaics. For nanoelectronic applications specifically, the capability to interface with metals is necessary, as well as the ability to control monolayer patterning. The structural cues for metal binding and for directional shifts will need to come from the molecules in the monolayer. To this end, we have developed new headgroup architectures that can be used for these goals, as well as to increase overall monolayer robustness. Drawing on the structural stability of sphingolipids, which contain both hydrogen bond donors and acceptors in the same region, enabling formation of a network of hydrogen bonds at the periphery of the polar region, we have designed and investigated four simple single-chain model systems that begin to incorporate both lateral and inter-lamellar hydrogen bonding in the X-Y plane, which we can ultimately incorporate into dual-chain phospholipid architectures.

C-39: Steps Towards the Total Synthesis of the Spongidine Family
Author: Ryan Allen, Florian Bartels
Advisor: Dr. Kevin Minbiole

Several approaches were taken to improve and complete the previously devised synthetic path to create the potent class of anti-inflammatory agents known as Spongidines. An optimization of a Wittig-type rearrangement was first undertaken to improve the yield of the reaction, which would have led to an improved yield for the entire process. The tested substrates did not lead to an improved yield over the previously reported 2-methylbenzyl substrate. Two different reactions were tested to synthesize 1-chloro-2-iodopyridine, of which the aqueous reaction provided a better yield over the organic phase reaction. Two different zinc-sulphinate reagents were then synthesized to determine their efficacy in functionalizing a C-H bond on a substituted pyridine ring. Both reactions were found to produce little to no yield of the desired product.

B-40: Amphibian Chemical Ecology: Method Development in Natural Product Identification
Author: Anthony Poltronetti, Emily Doe, Kevin Minbiole
Advisor: Kevin Minbiole

Our research group has investigated natural products within the amphibian skin ecosystem for over a decade. Amphibians worldwide are at risk of extinction due to a lethal fungus, Batrachochytrium dendrobatidis (Bd); we continue to develop methods to identify Bd metabolites, as well as bioactive compounds produced by amphibians as well as their cutaneous bacteria. We have made advances in the ability to use non-invasive swabs to extract and subsequently isolate natural products, as well as using culture-based methods to grow cutaneous skin bacteria. We extract and identify metabolites from the cultures, at times using a process of derivatization. LCMS was used as the primary analytical method to confirm the identity of natural products.

B-41: The Creation and Effects of Multiple Mutations in Rpt Subunits of the 26S Proteasome
Author: Mariah Cruse
Advisor: Daniel Kraut

The 26S proteasome is a multi-protein complex used by eukaryotic cells to regulate degradation of proteins. It is composed of multiple subunits including the 20S core particle and 19S regulatory cap containing base and lid subcomplexes. The base contains six Rpt subunits, each of which contains a loop of amino acids with a central tyrosine residue, known as the aromatic paddle, as they "paddle" the substrate proteins into the core of the proteasome to be degraded. Six single mutants were previously created by mutating tyrosine to alanine in the six Rpt subunits. This research now aims to create and characterize 26S proteasome mutants that have multiple mutations to the aromatic paddles of Rpt subunits. This was done by reconstituting the proteasome, where the different components of the 26S proteasome were purified separately, including a double mutant base, and then combined and tested for activity. By creating mutations in multiple Rpt subunits of a single proteasome, further insight can be gained regarding the link between the aromatic paddles and protein degradation efficiency and processivity.

C-42: Electronic and Spectroscopic Properties of [Ru(tpy)(tphoxy)][PF6]2 and [Ru(tphoxy)2][PF6]2 (tpy=2,2':6',2''-terpyridine; tphoxy= 4'-(4-hydroxyphenyl)-2, 2':6', 2''-terpyridine)
Author: Charlotte Montgomery, Claire Teahan, Jared J Paul
Advisor: Jared J Paul

Numerous fundamental chemistry studies have been carried out within The Paul Laboratory centered around ruthenium complexes bonded to hydroxyl substituted terpyridyl ligands such as toxy (4'-hydroxy-2,2':6',2''-terpyridine). The purpose of these fundamental studies is to learn how slight manipulations of structure result in changes in the electronic properties of these complexes. Our previous findings have led to further advancements in water oxidation catalysis and anti-cancer research. The purpose of our summer research project was to analyze the effects of a new ligand in our lab, tphoxy (4'-(4-hydroxyphenyl)-2, 2':6', 2''-terpyridine). Throughout the summer we were able to synthesize and characterize two different ruthenium complexes, [Ru(toxy)(tphoxy)][PF6]2 and [Ru(tphoxy)2][PF6]2. These complexes were analyzed using various characterization methods including infrared spectroscopy, NMR spectroscopy, ultraviolet/visible absorbance spectroscopy, and

electrochemistry. These studies provided insight into the complexes, particularly their electronic properties. For future studies, it is our goal to grow crystals of both complexes for X-ray crystallography. Following this we will convert the complexes to chloride salts in order to study both complexes' stability in water and at various pH values.

C-43: Characterization of Nannochloris eucaryotum algal lipids using gas chromatography
Author: Emily Legaard, Dr. Bryan Eigenbrodt
Advisor: Dr. Bryan Eigenbrodt

As concerns about fossil fuel use continue to rise, so does the importance of studying alternative fuel sources such as algal lipids. In this study, gas chromatography/mass spectrometry was used to quantify the success of acid-catalyzed triacylglyceride transesterification reactions and then applied to quantify the effect of nitrogen-deprivation on lipid production in Nannochloris eucaryotum algal systems.

C-44: Hybrid Quaternary Ammonium Amphiphiles
Author: Stephanie Schallenhammer, Brian Bentley
Advisor: Kevin Minbiole

Quaternary ammonium compounds (QACs) are a historically prominent class of surface disinfecting agents. Taking inspiration from commercial disinfectants and antimicrobial natural products, we have derivatized a structurally diverse array of tertiary amines to generate several different classes of QACs with multiple cationic groups (multiQACs). We have synthesized over 400 novel QAC structures to date, many of which exhibit potent antibacterial and antibiofilm activity. Analysis of the structure-activity relationship of these amphiphiles has led to the facile production of QACs that display micromolar to (more recently) sub-micromolar MIC values against a suite of bacteria, and furthermore do not appear to trigger bacterial resistance systems in methicillin-resistant Staphylococcus aureus (MRSA). Antibiofilm activity is amongst the best reported to date.

C-45: Synthesis of Trifluoromethyl Isogemichalcone B Analog
Author: Andrew Yun, Dr. Eduard Casillas
Advisor: Eduard Casillas

Aromatase inhibitors are a potential therapeutic solution in regulating the overproduction of estrogens, linked to breast cancer in post-menopausal women. Analogs of isogemichalcone, a natural product that is itself an aromatase inhibitor, are being developed. The target analog of this research consists of a bis-substituted trifluoromethyl isogemichalcone. Key coupling steps such as a Stille coupling and a Claisen-Schmidt condensations have been achieved. Emphasis is now being placed on optimizing the synthetic steps in preparation for a hallmark Mitsunobu coupling.

C-46: Synthesis of Isotopically Labeled Precursors for the Characterization of the Halonium Ions
Author: Henry Sise
Advisor: Dr. Ohta

The Halonium ion is characterized as being a closed bridged structure. It has been hypothesized that this is not the case but in a rapid shifting equilibrium. In order to determine this the intermediate Halonium Ion will be disturbed by using the isotopic perturbation of equilibrium, IPE, to characterize the spectra. This is done by selectively placing deuterium onto a molecule in order to create chemical shift within certain spectra. The deuterated spectra of a rapid shifting equilibrium will appear qualitatively different than that of a bridged or open structure and therefore will be discernibly different to characterize the structure of the intermediate.

C-47: Investigation of the Photochemical Degradation of Triclosan
Author: Opeyemi Famakinwa, Dr. Vanessa Boschi, Dr. Amanda Grannas,
Advisor: Dr. Vanessa Boschi, Dr. Amanda Grannas

Triclosan (TCS), an antimicrobial agent used in many pharmaceutical and personal care products, can be found in surface waters. TCS is photochemically labile and can break down into carcinogenic compounds that pose a risk to humans and the environment. Previous work has shown faster photochemical degradation of TCS occurring at high salt concentrations (NaCl) and with no salt present at all. In order to determine whether TCS photochemistry was dependent on the presence of chloride or due to changes in ionic strength, a different salt was implemented. In this study, TCS and NaBr solutions were prepared and analyzed in order to determine the effect of NaBr on the photochemical reactivity of TCS. In order to observe the rate of TCS degradation, NaBr concentrations were varied from 0 - 35,000 ppm and changes in the TCS concentration were measured over time using gas chromatography-electron capture detection (GC-ECD). We compared the TCS degradation rate constants at various NaBr concentrations to determine its effect on TCS photosensitivity.

C-48: Progress towards the synthesis of novel light-absorbing copolymers and development of electron-rich ligands for iron-catalyzed ATRP
Author: Anna Shavin, Marianne R. Donley, Evan Samples, Graham E. Dobereiner, Deanna L. Zubris
Advisor: Dr. Zubris

Progress in energy production requires improved and cost-effective materials. To this end, our target copolymer containing vinyltriphenylamine and carbon monoxide (CO) potentially meets both requirements as a competent hole transporter in electric diodes and solar cells. The reaction conditions to synthesize our target copolymer need to be optimized to produce sufficient material for applications testing. Here, the co-monomer vinyltriphenylamine was synthesized in toluene solvent and under an inert argon atmosphere. The product was characterized by UV-VIS, 1HNMR, and 13CNMR. The maximum peak was measured at 324 nm and the molar absorptivity was calculated at 16,770 M-1cm-1. The 13CNMR and 1HNMR spectra both verified the presence of the product, as well. The planned polymerization of vinyltriphenylamine and CO will be run with a palladium catalyst complex and is expected to produce an alternating pattern of comonomers in the first of a new class of copolymers.

Atom Transfer Radical Polymerization (ATRP) uses a metal catalyst to mediate a controlled ("living") free-radical polymerization. The Zubris lab investigates the principles of successful iron based ATRP using unique ligands to fine tune the catalyst complex. Recent work in our lab involves the pursuit of a new ligand containing an electron donating N-heterocyclic carbene. This synthetic target serves as a model for new ligand design in our lab to prepare an (imino) pyridine ligand with an electron donating thiol substituent at the imino carbon position. We hypothesize that strategic placement of electron donating groups on new ligands will lead to improved iron based ATRP.

C-49: Synthesis and Characterization of Tris(2-pyridyl)phosphine Ruthenium(II) Complexes
Author: Lawson Wilkinson, Julia Leonard, Mark Bezpalko, Wm. Scott Kassel
Advisor: Scott Kassel

Ruthenium complexes of tris(2-pyridyl)phosphine can be used as hydroformylation and hydrogenation catalysts; however, these complexes, specifically, RuHCl(P(Py)3)3 and RuCl2(P(Py)3)3, are generally prepared indirectly by the substitution of PPh3 for P(Py)3. Given the structural similarity between PPh3 and P(Py)3, it is logical to consider if RuHCl(P(Py)3)3 and RuCl2(P(Py)3)3 can be synthesized directly. The direct synthesis of these complexes, as well as Ru complexes of the oxidized ligands: O=P(Py)3 and Se=P(Py)3, will be presented along with spectroscopic (31P NMR, infrared, and UV-Visible), and structural details (X-ray crystal structures).

C-50: A new approach to the synthesis of quaternary ammonium containing polymers
Author: Vaidehi Shastri, Zachary D. Whitermore, Stephanie M. Duggan, Megan C. Jennings, William H. Wuest, Kevin P.C. Minbiole, Deanna L. Zubris
Advisor: Dr. Deanna Zubris

Quaternary ammonium compounds have long been used in disinfectants, but the antibacterial activity of multi-cationic quaternary ammonium compounds (multi-QACs) has recently been investigated with promising results. The properties of these compounds can be employed in the underexplored area of polymer coatings for use in biofilm-resistant materials. The characterization of previously synthesized monomers and methacrylate based copolymers is described here as well as a new approach to creating these polyQACs. This new approach involves utilizing post-polymerization modification of a neutral base homopolymer of bromoundecyl methacrylate to install multiQAC functionality. The synthesis and characterization of this homopolymer is outlined here.

C-51: Phthalate Testing
Author: Vincent Nobile
Advisor: Anthony Lagalante

Phthalates, or phthalate esters, are a common plasticizer found in many household plastic products that have also been linked to carcinogenic effects. Many phthalates can be analyzed using gas chromatography and mass spectroscopy (GC-MS). Using GC-MS, a method was created to identify and quantify the surface concentration of five common phthalates in samples of plasticized polyvinyl chloride (PVC) plastic. The PVC samples were subjected to a variety of environments in order to determine their effect on phthalates leaching, as well as to create standard methods to test for phthalate leaching.

C-52: Synthesis of L -Glucose
Author: Brynne Pergolini, Alexis Short, Robert Giuliano
Advisors: Scott Kassel, Amanda Grannas

D -Glucose is a naturally abundant organic molecule. It is a product of photosynthesis and consumed during cellular respiration. Due to its availability, D -glucose is an inexpensive material, which costs $0.22 per gram. L -Glucose, the enantiomer of D -glucose, meaning that the two molecules are mirror images of each other but are not superimposable due to the molecules' hirality,

is uncommon. It must be synthesized, causing it to be fairly expensive, selling at $95 per gram. L -Glucose was required as a starting material in another project in the Giuliano lab, the synthesis of the natural product diplopyrone. L -Glucose can be synthesized from an inexpensive material, D -glycero - D - gulo -heptonic acid, in a 5-step process. We synthesized L -glucose from sodium D -glycero - D - gulo -heptonate, a material costing $0.42 per gram. Key intermediates in our route were "acetonide sugars" such as 4.

Computing Science

C-53: Electrical and Computer Engineering The Northeastern Interactive Clustering Engine
Author: Shi Dong, David Kaeli, Jorgensen Mackenzie, Jonathan Spohn
Advisor: David Kaeli

Big data applications continue to grow in number and are challenging our computing capabilities. Given the rate of data collection, which grows exponentially, we need enhanced software solutions to analyze this mountain of data. As data visualization becomes critical in analytics, we want to provide engineers and scientists with the ability to explore their datasets interactively, providing state-of-the-art machine learning analysis in a timely fashion. In this research project, we present our NICE framework, which provides interactive visualization/analytics of large datasets. The framework has been developed leveraging the best practices in software engineering standards. Our framework is composed of three parts: a computing engine in C++ and CUDA as back-end, a Python-to-C++ support end-to-end communication and zero-overhead data transfer, and a Python front-end developed for visualization. We leverage optimized software libraries for BLAS operations, Python-C++ interactions, and acceleration. We also developed several efficient machine learning algorithms to support interactive data analytics, targeting both multi-core CPUs and many-core GPUs.

C-54: Science Hierarchical Sparse Coding for Multimodal Deep Learning
Author: Darryl Hannan, Edward Kim, Garrett Kenyon
Advisor: Edward Kim

Deep feed-forward convolutional neural networks (CNNs) have become ubiquitous in virtually all machine learning and computer vision challenges; however, advancements in CNNs have arguably reached an engineering saturation point where incremental novelty results in minor performance gains. Although there is evidence that object classification has reached human levels on narrowly defined tasks, in general, the biological visual system is far superior to that of any computer. A missing component in feed-forward deep neural networks is top down feedback. Our visual cortex is working in tandem with our parietal lobe, integrating sensory information from various modalities. The brain does not work solely in a feed-forward fashion, but rather all of the neurons are in competition with each other; neurons are integrating information in a bottom up and top down fashion and incorporating expectation and feedback in the modeling process.

In our work, we sought to improve upon the standard feed-forward deep learning model by augmenting them with biologically inspired concepts of sparsity, top down feedback, and lateral inhibition. We define our model as a sparse coding problem using hierarchical layers. We use the Locally Competitive Algorithm (LCA) to solve the sparse coding problem with an additional top down feedback error driving the dynamics of the neural network. Our results demonstrate that our network mimics behaviors observed in mammalian brains such as the emergence of invariant neurons that

respond to multiple modalities. We additionally show that our sparse representation of multimodal signals is qualitatively and quantitatively superior to the standard feed-forward joint embedding in common vision and machine learning tasks.

Engineering

C-55: Biochemical analysis of wildtype and genetically modified pennycress (Thalspi arvense) seeds

Author: Ellenhorn Zachary, Kate Kuczynski, Jorg Schwender
Advisor: William Kelly

Pennycress (Thalspi arvense), a potential new seed-oil crop that has advantages over the current soybean and rapeseed crops currently used, can grow in less favorable environments and has a shorter growth cycle than other major seed-oil crops. This study explores whether wild pennycress can be improved to increase the crop's feasibility to produce seed-oil on a larger scale. The attempted improvement in this study focuses on the fatty acid composition of its oil. The FAE 1-1 enzyme is required to form 20- and 22-carbon long fatty acid chains. Its creation is prevented through genetic modification. The main goal of this project is to understand how this modification in the biosynthesis of seed oil globally affects the metabolic network. With this understanding, the metabolism can be optimized through metabolic engineering. The cellular dynamics are dependent on thousands of enzymes and metabolites reacting in a multitude of ways making the network highly complex. 13C - Metabolic Flux Analysis (13C-MFA) is used to understand the cellular system metabolism and can be used to obtain the understanding necessary for metabolic engineering. To do this, pennycress embryos were harvested and cultured in labeled glucose media and then monitored over a 10-day growth period. Afterwards, various tests, such as an amino acid assay and fatty acid profiles, were performed to gather the information necessary for 13C-MFA. Results have yet to be developed. This research is the first step towards the large-scale use of a new seed-oil crop which would make biofuels a more feasible clean energy source.

C-56: Villanova Thermodynamic Analysis of Systems

Author: John Clements,Steven Squillante
Advisor: Dr. Wemhoff

Data centers are massive facilities housing large computer systems that are critical in the modern world. However, these data centers require large amounts of power and cooling equipment to keep them functioning. Villanova Thermodynamic Analysis of Systems (VTAS) is a MATLAB-based program that models data center cooling and power system energy efficiency. These models are created through a graphical user interface (GUI) or a text-based input file. Simulations include both heating, ventilation, and air conditioning (HVAC) and electrical components commonly found in industry, including air and liquid based cooling equipment. VTAS is a powerful program, yet barriers exist in regard to its ease of use. With version 3.11 due to be released in Fall of 2017, many improvements have been made to create a more user-friendly product. These improvements are comprised of (1) creating a GUI for the electrical component layout to greatly ease the creation of

models, (2) reworking the user manual by adding a large instructional section on the GUI to keep it current with version 3.11, (3) and rigorous beta-testing on the existing version. These changes will ensure that version 3.11 is much more stable and user-friendly than previous releases.

C-57: Investigating Mathematical Models for Metabolism and Transport of Cholesterol

Author: Ryan Searcy, Derek Fake, Qian Jia, Zuyi Huang
Advisor: Dr. Huang

Cholesterol is an important molecule that is responsible for making other substances needed by the body. For example, one of main products from cholesterol is hormones that is needed for human daily life. If free cholesterol accumulates in enough amounts, however, it can begin to cause health problems. As of 2011 in the United States alone, 71 million people struggled with high cholesterol. Having high cholesterol can as much as double someone's chances of heart disease. Because of the risks associated with high cholesterol, it is imperative that studies are conducted to determine the best course of action to reduce whole body cholesterol levels. One of the ways is accomplished is by developing mathematical models. By examining these models, it can be determined where the most suitable locations for drug targeting are with the goal of lowering whole body cholesterol.
This paper examines different kinds of models that, in total, cover most of the processes involving cholesterol metabolism and transport, including the absorption of cholesterol in the intestine, the cholesterol biosynthesis in the liver, the storage and transport of cholesterol between the intestine, the liver, blood vessels, and peripheral cells, via low density lipoprotein (LDL), intermediate density lipoproteins (IDL), high density lipoproteins (HDL), and very low density lipoproteins (VLDL). The two general types of models that have been developed for cholesterol metabolism and transport are ordinary differential equation (ODE) models and linear regression models. The ODE models are useful for describing the transient dynamics of a process and evaluating the impact of individual reactions on the whole cholesterol metabolism, while the linear regression models show the correlation relationships between variables using clinical data. Each of the models presented in this paper will be summarized and analyzed both on its own and in a larger context. The findings presented in these models will be discussed to improve the understanding of cholesterol metabolism in the human body. The hope is that the models presented here can eventually be combined together to form a comprehensive model of cholesterol within the entire body, which is then taken as an in-silico patient for identifying drug targets, screening drugs, and designing intervention strategies to regulate cholesterol levels in the human body.

C-58: Zinc Oxide Nanowire Surfaces for Water Collection and Purification

Author: Andrew Lee
Advisors: David Riassetto, Gang Feng, Amy Fleischer

Bioinspired nanomaterials with alternating hydrophilic and hydrophobic patterns show promising applications in water collection and purification through passive condensation of atmospheric water. In one approach towards achieving these materials, ZnO NWs are used as a building block for their natural hydrophilicity and ability to be coated with hydrophobic hydrocarbons. A procedure for the synthesis of patterned ZnO NW growth via photocatalytic lithography was developed using two methods. Additionally, initial studies of NW length, NW patterns, presence of excess reactant and presence of filling nanoparticles on overall hydrophobicity and hydrophobicity durability after coating with hydrocarbons was performed. These insights give clear direction to future studies that optimize

hydrophobicity and nano-scale patterning capabilities of this unique and promising water collection material.

C-59: Modeling Nanoindentation of Colloidal-Sphere Assembly

Author: Preston Whiteman, Dr. Gang Feng, Dr. Aaron Wemhoff
Advisor: Dr. Aaron Wemhoff

The goal of this research is to uncover how the interparticle interactions influence the colloidal film stability. Colloidal films are of interest because they can be used as non-glare, fog-resistant coatings on surfaces. A computer model of the film has been created using the principles of molecular dynamics and is used to run simulations which represent indentation forces acting on the film. The model shows how the colloidal particles interact with each other. This determines the impact of interparticle bonding forces on the mechanical properties of the film. A better understanding of these forces allows for modification of the film to enhance its material properties for specific applications."

C-60: Three-Dimensional Space-Filling Curve Antennas

Author: Christopher Israel, Dr. Ahmad Hoorfar
Advisor: Dr. Ahmad Hoorfar

"Many modern wireless and mobile communication applications require miniaturized antennas. One way of achieving miniaturization is to use conducting traces that follow fractal geometries like those offered by Hilbert and Peano curves. In this work, we have investigated the fundamental radiation characteristics of three-dimensional antennas patterned after multiple orders of 3D Hilbert and Peano curves through an extensive parametric study utilizing numerical techniques like the Finite Element Method. These techniques were used to find various antenna properties including radiation pattern, cross polarization, radiation efficiency, impedance bandwidth, and matched-feed location. It has been found that a feed located near the end of the curve produces a desirable fifty-Ohm real impedance at resonance. In addition, as in the previously studied 2D versions of these antennas, it was found that both 3D geometries, across various curve orders, exhibit typical dipolar radiation. These results indicate that this novel class of 3D antennas may be well-suited for further implementations such as in design of low-profile arrays and electrically-small top-loaded-monopoles, which are of high value to many applications where antenna miniaturization is needed. Currently, Additive Manufacturing (3D printing) techniques are being used to fabricate and measure selected prototypes to verify the simulation results.

C-61: Synthetic Production of Plasmids for Gene Therapy

Author: Adam Gabriel, Evan Kurt, Jane Liu, Gabrielle Van Der Gaag
Advisor: Dr. Jacob Elmer

The current method of making DNA plasmids of gene therapy is to use bacterial fermentation. However, in using bacteria, harmful side products are produced that make purification costly and time-consuming. As part of the Villanova Summer Innovation Incubator (VSII) program, a multidisciplinary engineering and science team investigated the synthetic production of plasmids for gene therapy applications. The scope of our project was to innovate the entire process of plasmid production.

The mechanical engineering part of the project focused on the development of a low-cost, open-source thermal heating block. An Arduino controlled Peltier system was designed and constructed to isothermally heat PCR tubes for the Gibson Assembly reaction at 50oC and Cre-mediated recombination reaction at 37oC. The system consisted of a relay setup to regulate the thermoelectric cooling unit, with a thermistor to monitor the temperature of the copper heating block and lid.

For the biology and chemical engineering part of the project, students worked on several methods for the synthetic plasmids. The first was Gibson assembly, optimizing the established single-step multi-enzyme reaction to produce circularized plasmids from PCR amplified fragments. This, however, proved to be thermodynamically infeasible due to entropic limitations, as confirmed by AFM imaging. A second method, Cre-LoxP recombination, was also assessed to produce circular product. PCR products were designed with LoxP sites, amplifying a gene expression cassette with flanking Cre sites and then running a Cre reaction to circularize it. While the 1' PCR was successful, we were unable to circularize the product with Cre recombinase. Consequently, we also investigated a third method, MIDGE (Minimalistic, Immunologically Defined Gene Expression). This reaction creates linear DNA, but with hairpins at the ends which still prevent exonuclease digestion. Confirmed by AFM imaging and transfections in PC3 cells, this method was partially successful, with at least one end of the fragment having proper hairpin formation. Further optimization of the primers and reaction is necessary to ensure all product is functional.

To optimize recovery of PCR products from a gel, we developed a novel gel extraction process: 2D gel electrophoresis. While traditional methods rely on silica spin columns to extract DNA from melted agarose, our method allows the user to electrophoretically move the desired DNA band into a liquid volume for direct extraction with a pipette. This involved an initial electrophoresis separation (the first dimension), followed by rotating the electric field perpendicular to the initial (the second dimension), and then running a second electrophoresis into a water-filled capture well. This method provided pure product but had issues of yield loss due to leakage.

At the end of the summer, the heater worked as intended. While the 2D gel was marginally successful with more work to fix leakage issues. For the reactions, we were able to produce linear DNA with all of the methods, but were unable to circularize the product. As such, MIDGE seems to be the most promising method. However, further optimization is required.

D-62: Optimization of Wetland Microbial Fuel Cells Using Novel Electrodes

Author: Brendan Gorman, Clement Ekaputra, Li Chen, Dr. Zuyi (Jacky) Huang
Advisor: Dr. Zuyi (Jacky) Huang

Wetland microbial fuel cells (wMFCs) make use of exoelectrogenic microorganisms in the soil which uptake organic compounds to produce electricity. In particular, the anode of wMFCs is buried in the soil, while the cathode is placed in water or around the roots of plants. wMFCs hold great potential to provide power for sensors used in wetlands and remove pollutants in storm water such as carbohydrates, phosphate, sulfate, and ammonia. While wMFCs have attracted attention in recent years, their applications to the wetlands in the Philadelphia area have not been well studied. In addition, wMFCs are limited by their low power density production. Designing novel electrodes is one approach to address this issue. While existing platinum-catalyzed cathodes return higher power density, they are expensive and not sustainable for practical application. In this study, novel electrodes were designed using a mixture of polyvinylidene fluoride, activated carbon, and carbon black (PVDF-AC). These electrodes are both inexpensive and relatively easy to manufacture. The constructed wMFCs were

tested using sediment retrieved from local wetlands in Villanova, PA, USA. wMFCs using the PVDF-AC electrodes were found to be able to generate 607.7 mV voltage (20000 Ω external resistance) and power per electrode surface area of 3.673 mW/m2. In combination with a proper power management system, this is sufficient to provide renewable and maintenance-free power for wetland sensors for many environmental monitoring applications. These results demonstrate that this electrode composition could potentially be a cost-effective and viable way to construct wMFCs.

D-63: The Next Generation Smartwatch

Author: Yu Zhenglin, Timothy Kubista, Benjamin Hollinger, Branden Garett
Advisor: Edmond Dougherty

Smartwatches have been gradually changing people's lifestyles in the past few years. Leading by Apple Watch, this newly boomed technology has benefited people in areas such as personal fitness, meeting courtesy, and convenience for electronics message checking. However, there is not massive amount of adapters. The primary reasons that stop people to get the smartwatches or even try to use them are, as we have surveyed over a hundred college students, are the ease of use and price. People have found controlling a smartwatch on a small touchscreen is extremely difficult, and the small font letters are very hard to see. With the price as high as an expensive traditional dress watch, the smartwatches are thought to be the things that are luxury to have rather than necessity.

A solution is created to solve both of these problems. In this summer, a prototype of a smartwatch is built that gives an intuitive sense for users to use within $100. The smartwatch is built on a Raspberry Pi development SoC (system on chip) integrated with an APDS9960 gesture sensor and Alexa voice assistant developed by Amazon, along a screen, a battery, and a case which is designed and created by ourselves. The gesture sensor expands the user interacting space from two-dimension small screen to three dimension larger space above the smartwatch. The Alexa voice assistant allows the user to interacting with the device when their hands are incapable of commanding the device. A GUI (Graphic User Interface) is created to be tested for the gesture sensor. With the 2500 mAh battery, which has as much power as a smartphone, the smartwatch will last for more than a day.

The major functions have been tested separately and proved to be working very well. A physical body of the prototype is designed and assembled. However, an integrated operating system with gesture sensor and voice command together is still not fully developed. The total cost of making this watch is $80. There is still more room to make customized circuit board, developing accommodating operating system, and design more aesthetic case for the watch, potentially lowering the cost down and making it more attractive for the buyers.

D-64: VSII Smart Baseball

Author: Bova John, Nathan Cheong, Joseph Liquori, Dan Tagliaferro
Advisor: Mark Jupina

Dangerous pitching mechanics in modern baseball can typically lead to tears of the ulnar collateral ligament, UCL, which usually results in a surgery known as Tommy John Surgery. Mechanics that lead to tears in the UCL often involve the arm slot that the ball is thrown in as well as throwing at too high a velocity at a young age. To assist pitchers in avoiding these dangerous mechanics, a Smart Baseball was designed to measure velocity, spin rate, and the hand rotation during the course of the pitch. The design incorporated an inertial measurement sensor, GPS sensor, and high speed gyroscope to quantify the velocity and spin-rate of the baseball after it is pitched as well as the pitcher's arm location over the course of a pitch. To achieve this, a baseball was embedded with a microcontroller fitted with the various sensors while also being able to wirelessly send the quantified data to a user's laptop. The

Smart Baseball was physically designed in such a way as to protect the electronic components from the subjected forces due to a high speed pitch. A final prototype of this Smart Baseball was designed and completed over the course of eight weeks through Villanova Summer Innovation Incubator.

D-65: Measurements of multicore microstructured optical fibers heated up to 100 C
Author: Gerald Wagner, Jacob Hisel
Advisor: Rosalind Wynne

As Microstructured optical fibers continue to be used in sensing applications, recent efforts have sought to implement them in optofluidics. Fibers with multiple cores are used to to enhance optical detection in submicroliter volumes of fluid using the coupling conditions between neighboring cores which are affected by external and internal low temperature thermal changes. The Laboratory for Lightwave Devices, at the Villanova University College of Engineering, performed measurements of the coupling characteristics for a 3-core microstructured optical fiber for temperatures up to 50∘C. At low temperatures less than 50∘C, coupling conditions between neighboring cores may be affected by transient external and internal thermal changes. Previous work by Villanova students demonstrated the relationship between temperature and coupling characteristics at low temperatures, however the Laboratory for Lightwave Devices observed the behavior of intensity fluctuations with time for temperatures up to 50∘C. Multicore fibers with core separations of 2.5 μm and 5 μm were investigated. Images of the mode field distribution were acquired for a range of temperatures during a 5 s period. The intensity was measured for temperatures between 25∘C and 110∘C. Significant time-dependent intercore-coupling instabilities were present for temperatures less than 22∘C. The intensity of the coupled light varied according to microchannel air-flow rates of 1-2mm/s.

D-66: BioMimic Research
Author: Nicholas Burns, Savannah Restori
Advisor: Calvin Li

The propellers on submarines generate noise reducing their capability for stealth
For a solution we decided to look to nature for inspiration. Organisms such as whales and barn owls have irregularities on their trailing edges (crenelations on theil tails and downy feathers on the wings). These features were mimicked with trailing edges on NACA0012 airfoils. They were saw toothed, brushes and fractal patterns."

The project started with research into basics of aerodynamics and previous results from trailing edge studies. The plan was to run similar tests and get data for both aerodynamic and acoustics of the different trailing edge designs. This meant that an airfoil with interchangeable trailing edges needed to be created, lift and drag data had to be collected, and then methods for analyzing the noise and visualizations were to be developed. However, there were challenges due to properties of the equipment that was being used. Some of the tests could not be run with the equipment we had and so we had to construct a secondary wind tunnel. Much of the project was spent learning in depth information about several different aspects that played a role in the project so that each obstacle could be addressed and hopefully cleared. The airfoils were creating using the Solidworks design tool which was converted into a g-code and finally 3-d printed.the wings were composed of two parts and connected through a set of female and male grooves on the pieces. Surface finishing was done to eliminate roughness on the wing. Multiple methods were tried and a combination of sanding and tape was found to give the most consistent results.

Research resulted in creating a NACA 0012 airfoil that fit into the wind tunnel and had the interchangeable trailing edges. A second smaller wind tunnel was also built to visualize the patterns of vortex shedding. Despite these advances, data for an accurate and precise baseline test has not yet been obtained. This project will continue on to establish this baseline and then get data to make conclusions on if the biomimicry trailing edges had effects on the acoustic and aerodynamic performance.

English

D-67: Secrets to Success: A Study of Successful Student Voice Initiatives in High Schools
Author: Elizabeth Eby
Advisor: Jerusha Conner

The concept of "student voice" emerged in the 1990s and has grown increasingly popular ever since. Student voice initiatives give students an active role in educational decision making and planning. Numerous studies suggest that student voice efforts lead to successful changes and improvements in schools, but there is a need for further research about the specific factors, conditions, and experiences that make these initiatives effective. Through interviews with principals, teachers, and students from one urban, one rural, and one suburban high school where student voice programs have led to changes in school practice or policy, this comparative case study explores the conditions necessary to the success of student voice initiatives. Analysis followed an iterative coding process and included open and axial coding and the writing of descriptive and analytic memos. Preliminary findings reveal the crucial role of school administrators in ensuring two key conditions for success: (1) a supportive and approachable administration, and (2) a culture of care and mutual respect. The results of this study add to the existing knowledge base, fill a gap in student voice research, and raise implications for practitioners, policymakers, and researchers who seek to give students a greater stake in their own education

D-68: The Problem of Home in the Work of African-American Novelist Toni Morrison
Author: Emilia Scalaro
Advisor: Dr. Ian Clausen

The concept of home is a central theme of the Augustine & Culture Seminar (ACS). In Confessions, Augustine reveals that in returning to one's origins, one can reconcile and confront the sins of the past. Other works, such as Mary Shelley's Frankenstein and the book of Genesis, explore the importance of acceptance to seeking the solace of home. These works, however, only begin to scratch the surface of the complexity of home for displaced individuals. This summer, I sought to examine this complexity more deeply through the stories and testimonies of African American authors. While numerous American authors have grappled with race, few have so powerfully conveyed and complicated this subject as the esteemed African American novelist
and literary critic Toni Morrison. By mapping the complex landscapes of home for African Americans, Morrison not only captures the African American experience but also probes its possibilities in the light of its history – a history marked by beauty as well as brutality.

In ACS, students encounter a diverse range of literature that challenges their sense of where they are in the world. My class provided me the necessary foundation to grapple with the issue of race in America, exposing it as a systematic and intensely personal problem. However, it was Toni Morrison who heightened my awareness of how racial injustice prevents communities from flourishing; and how storytelling has the power to confront human ignorance while reclaiming the true beauty and power of one's history.

Environmental Science

D-69: A 25-Year Time Series Analysis of Juvenile Blue Crabs in Southern New Jersey.
Author: Schneider Alexandra, Paola Lopez-Duarte, Ken Able
Advisor: Melanie Vile

Blue crabs (Callinectes sapidus) are a key estuarine species because of their value to fisheries and important ecological role. Understanding the distribution and abundance of the juvenile blue crabs is necessary to understand their recruitment processes and advise management of the species. In this study, individuals measuring <80mm carapace width (CW) were considered juveniles. In similar studies, 0+ age class blue crabs were found to grow to 70-100+ mm CW in the first warm season, with some reaching sexual maturity at 90mm CW (Hines et al. 1987). In this study, we (1) compare the long-term data sets (1991-2015) of wire mesh traps and plankton nets to evaluate the seasonality and abundance of juvenile blue crabs in the Mullica River-Great Bay (MRGB) estuary, (2) describe the temporal shifts in seasonality and size classes over time, and (3) evaluate the effects of environmental factors on the recruitment (summer storms) and overwintering (winter temperatures) of juvenile blue crabs. Samples were collected through two Rutgers University Marine Field Station (RUMFS) long-term surveys (1991-2015). Most (97%) blue crabs caught in the plankton net were small juveniles <30mm CW, and most (78%) medium-sized juveniles (20-60mm CW) were caught with the wire mesh traps. Small juveniles were most abundant in the fall, with peaks in October and November. The medium juveniles were prevalent throughout the year with peaks in June and July. The abundances of small juveniles in the fall was positively correlated to storm days in NJ that were associated with northeastern winds. The abundance of medium-size juveniles in the summer was positively associated with warmer than average temperatures in the previous winter. These results have important implications in regards to climate change because the frequency and strength of storms, as well as the incidence of warmer winters, are expected to increase.

D-70: Creating Digital Elevation Models and Vegetation Classification Systems to Determine Marsh Response to Sea Level Rise in Plum Island, MA
Author: Lampasona Diana
Advisor: Nathaniel Weston

Climate change is causing drastic changes in Earth's ecosystems. Rising temperatures contribute to thermal expansion and melting of glaciers, two of many processes that are causing sea levels to rise. Salt marshes are one ecosystem that are vulnerable to sea level rise, and have already faced significant changes due to climate change and land use change. In Plum Island Sound, Massachusetts, high-elevation and low-elevation marsh have been studied over time to analyze alterations caused by rising sea levels by the Long Term Ecological Research Network funded by the National Science Foundation. Current methodologies for determining marsh response are not proper for studying

changes on a yearly basis. This research project's aim is to use unmanned aerial photography and Real Time Kinematic GPS to create high-resolution digital elevation models and a vegetation classification system to model four creek-sheds of interest in Plum Island, Massachusetts. These tools are invaluable in helping to determine future change, and to determine rates of ecosystem processes. In order to complete this, an unmanned aerial vehicle, Real Time Kinematic GPS, and on-the-ground vegetation classification were used at four creek-sheds in Plum Island. Relative elevation data collected by the unmanned aerial vehicle was compared to the sub-centimeter accuracy of the Real Time Kinematic GPS. Using these corrected values, accurate elevation data was mapped on Geographic Information Systems software. Models obtained from Pix4DMapper Pro software are currently being used to aid in watershed delineation and other processing. Vegetation identification was completed using aerial photographs and on-the-ground quadrat analyses. Using ArcMap software, models for vegetation classification are being created. Final products created would include three dimensional elevation and vegetation maps, high-resolution imagery, and an anticipated publishing on the methodology used.

D-71: Air quality patterns in Northern Philadelphia during summer
Author: Meghan McMahon, Dr. Kabindra Shakya, Dr. Peleg Kremer, Kate Henderson, Sam Bromberg, Dr. Nathaniel Weston
Advisor: Dr. Kabindra Shakya

Air quality is a public health issue of utmost concern due to its omnipresence in everyone's lives. The city of Philadelphia, which houses a population of 1.5 million people and counting, has a history of poor air quality, thereby negatively impacting the health of all of its inhabitants. Particulate matter that is less than 2.5 micrometers in diameter (PM2.5) is associated with negative human health impacts, primarily being known to cause or worsen lung conditions, among many other health conditions. Examining air pollution levels and speciation is the first step to identifying possible sources of pollution. Literature has shown that particulate matter pollution is heavily associated with vehicular emissions in Philadelphia. Identifying areas in which particulate matter pollution is high shows areas in which better practices can be employed in order to reduce pollution, thereby improving air quality. This study focused on Northern Philadelphia where a stationary E-sampler air monitor was employed to measure PM2.5 levels in five-minute increments from June 6 until July 13, 2017 (excluding June 16 -19 due to mechanical errors). Daily particulate matter readings for the 34-day long study averaged at 4.74 $\pm$2.9 μg/m3. Levels of particulate matter were also analyzed on a weekly and hourly basis to examine any correlations between either day of the week or time of day and air pollution. Since particulate matter levels is often correlated with traffic and vehicular usage, this data serves as a proxy for traffic levels on both a weekly and hourly basis. More research is necessary to capture the entire scope of local air pollution and its many causes, including but not limited to land use practices, temperature, relative humidity, and precipitation patterns. Identifying and understanding the multiple causes of air pollution is key in identifying practices that will better our air and, subsequently, our health.

D-72: Fine-Scale Spatial Analysis of Air Pollution in Philadelphia, Pennsylvania
Author: Kate Henderson, Peleg Kremer, Meghan McMahon, Kabindra Shakya
Advisor: Dr. Kabindra Shakya

Exposure to air pollution has a variety of negative health effects, and can be of particular concern in urban areas with heavy vehicular traffic. Most studies focus on large-scale pollution patterns based on samples collected at a few fixed points; however, recent research has shown that air pollution can

vary significantly on fine scales within a city. We measured local air quality in four Philadelphia neighborhoods--Chestnut Hill, Mill Creek, Northern Liberties, and Tioga--all of which have different demographics, income levels, and land covers. We used mobile monitoring equipment to detect fine-scale variations in black carbon, PM2.5 particles, and noise as we walked five-kilometer paths in each neighborhood at different times of day over a month-long period. We stopped every 500 meters for five minutes to produce a more accurate sample and to record traffic density. We detected differences in pollution levels on both spatial and temporal scales, which may be partially explained by traffic intensity and land use, although factors such as weather may have also played a role in influencing our results. We detected average PM 2.5 values of 13.48 micrograms per cubic meter (ug/m3) in Chestnut Hill, 4.03 ug/m3 in Mill Creek, 7.28 ug/m3 in Northern Liberties, and 9.58 ug/m3 in Tioga. Northern Liberties was of particular interest since there were major differences in PM2.5 and black carbon levels throughout the day, with high values during the morning commute and low values during the early afternoon.

D-73: Spatial Analysis of Microplastics in the Delaware River
Author: Madisen Dimacale
Advisor: Dr. Nathaniel Weston

An emerging issue in aquatic systems and their surrounding land areas is the prevalence of microplastics. These plastics pose a problem to humans and the environment because they do not degrade naturally and can affect organisms at higher trophic levels due to bioaccumulation. In this study, we determined the quantity of microplastics in the water at sites along the Delaware River to compare if microplastics are more abundant upstream or closer to the Atlantic Ocean. We collected water samples at nine different sites in the Delaware River starting to the North of Philadelphia and going South to Cape May, New Jersey to be able to have an adequate spatial analysis. Each sample was taken by dragging a plankton net in the water and then analyzed in the laboratory to find the quantity of microplastics in the sample. We expect there to be a higher quantity of microplastics upstream in the Delaware River because of the high population in and around Philadelphia that use products such as body washes, facial cleansers, and other consumer products which are sources of microplastics that can enter the local waterways and even larger plastic products that end up in the water and break down into microplastics.

D-74: Plant Endemism and Diversity of the Guiana Shield
Author: Elizabeth O'Brien
Advisor: Dr. Vicki Funk

My summer research focused on the spatial and genetic diversity of the Guiana Shield, a widely unexplored region spanning across parts of Venezuela, Brazil, Colombia, Guyana, French Guiana, and Surinam. The Shield is one of the most biologically diverse places in the world. To categorize the genetic diversity within this region, we aligned DNA sequences and generated phylogenies. These phylogenies reveal high confidence in the relationships between taxa. We cleaned spatial data (coordinates of samples) using a custom R-based spatial data cleaning pipeline, OpenRefine and Excel, then analyzed using ArcGIS and Biodiverse. We analyzed the patterns of weighted endemism and species richness at different resolutions of grid cell size. Initial data analysis shows some correlation between the number of samples and richness at 100 km2, R2= 0.64. There is a tradeoff between cell size and distribution: higher resolution is more precise but loses the broader scope of diversity data. Lower resolution can skew data, and is especially prone to sampling bias. We will continue this

research by concatenating "fast genes" (ITS) with current alignments to explore how richness and endemism are concentrated in the Guiana Shield.

History

D-75: Enlightenment Thought, Economics, and Racism in the 18th Century
Author: Andrew Deshler
Advisor: Marc Gallicchio

In the 18th century, modern racism was solidified and expanded alongside the trans-Atlantic slave trade. Looking at the work of Enlightenment thinkers, political debates of the time, and scholarly works studying the period, the aim of this project is to analyze the racism of the 18th century; specifically, how the colonial economic system was intertwined with, and a driving factor in the rise of racism. I examined scholarship on the Enlightenment, and added to that a detailed look at the works of two Enlightenment thinkers in particular: Montesquieu and Thomas Jefferson. Juxtaposing that analysis with the historical context of the era, the deep link between economics and racism became crystal clear. However, not only were they connected, but one was driving the other. Through my analysis, I explored the way in which the slave economy, rather than being made possible by racist attitudes, instead may have created those attitudes. I examined the historical framework for later racist attitudes towards Africans, such as European ideas about climate and work ethic leading up to 1700s, and the hypocrisies of Enlightenment thought on issues of race. This all led me to argue that it was a need to justify slavery that caused the worst 18th century racism, as politicians, thinkers, and merchants looked for a way to sustain a profitable system that also posed serious moral problems.

Humanities

D-76: The Great Exchange: Deification in St. Augustine
Author: Ethan Swain
Advisor: Dr. Kevin Hughes

The Great Exchange: Deification in St. Augustine offers an examination of Augustine's particular theology of deification and places him as the Western father of deification. Deification is the means by which we enter into the life of the Trinity, the eternal family of God. To be deified is to become or actualize our "primary identity" as children of God. Our human deification is both the reason the Word became flesh and the reason we exist at all. God "stooped down to become man in order to raise us up as his children." The essay starts with a historical examination of Augustine's life and the theological and political context in which he examines deification. The essay then examines the Christological and Christocentric nature of Augustine's theology, the balance of individuality and community in the Totus Christus, and the mystical and ecclesiastical shape this body takes. In turn, I argue that the Western mystic tradition takes up deification not as a subject of scholarly discipline, but as a pattern for an authentic life lived. It is in the mystic tradition that Augustine's theology blossoms for centuries to come; for mysticism is theology in its purest form – not an individual abstract research question, nor a departmentalized subject, but a mode of being.

D-77: Karol Wojtyla's Theo-Dramatic Imagination in The Jeweler's Shop
Author: David Miranda
Advisor: Dr. Helena Tomko

While the late Pope John Paul II is largely remembered for his historic pontificate, his early intellectual contributions and formation as Karol Wojtyla are often overshadowed. In this project, I focus on the former pontiff as an artist of poetic drama and deeply influenced by his Polish literary/cultural context, specifically engaging his most famous play The Jeweler's Shop. In this meditation on spousal love, Wojtyla presents a work propelled by inner meanings rather than narrative action, echoing his philosophical work regarding the essence of human action within Thomistic personalism. Additionally, Wojtyla incorporates scriptural imagery to frame the movement of interior selves, demonstrating divine involvement. In order to preface a close reading of the play, I first explicate Wojtyla's literary development within his Polish context, proceeding to survey his work as an eventual author and playwright. I then detail the central tenants of Wojtyla's philosophical development and unique contributions to personalism. Finally, by considering the centrality of scripture in divine revelation, I engage in a close reading of The Jeweler's Shop as a theo-drama, a play in which Wojtyla places man within in a dialectic between the personal and the supernatural, the reality of human action and the movement of divine revelation. In this way, I emphasize the singular importance of Wojtyla's unique work as a playwright in understanding his pontificate.

D-78: A Classification of Religious Terrorism and its Effects on US Counterterrorism Policy
Author: Paul Elhallal
Advisor: Dr. Daniel Philpott

Since 9/11, United States counterterrorism policy has viewed terrorism as a single phenomenon, not allowing for any discrimination in its classification. Under the National Strategy for Combating Terrorism (NSCT), this broad notion of terrorism has resulted in the development of a foreign policy that is ineffective because of its broadness, unable to take the particular measures necessary to combat certain forms of terrorism. Scholarly work to date has examined the existence of different forms of terrorism and debated the utility of such terms as "religious" in academic classifications of terrorism, but little has been done to examine the factors which distinguish one form of terroristic violence from another. To this end, this paper seeks to develop a methodology for classifying different forms of Islamic terrorism. It attempts to develop a taxonomy of religiously motivated terrorist organizations by examining distinguishing factors such as the stated ends of a group, it's possible political motivation, the targets of their violent activity, the religious adherence and practice of its leaders and members, and its involvement in the external community, (i.e. hospitals, schools, welfare programs, etc). This paper then uses the Shiite organization Hezbollah as a case study in applying the proposed methodology, and will briefly examine the effects of this methodology on United States counterterrorism policy.

Mathematical Sciences

D-79: Feverprints: A Crowdsourcing Study of Human Temperature
Author: Ronald Berna, Jonathan Hausmann, Jared Hawkins
Advisor: John Brownstein

Temperature measurements are used in healthcare settings in decisions to admit patients to the hospital, perform invasive procedures, or provide antibiotics; however, the most widely-used definitions of normal (98.6°F) and febrile (100.4°F) temperatures derive from a single study conducted in 1868. More recent research has highlighted lower average and febrile temperatures, and described temperature fluctuations based on gender, age, circadian rhythm, and other variables, yet many of these conclusions are based on small sample sizes. We created Feverprints, a ResearchKit app available on the Apple App Store, to collect thousands of crowdsourced temperature entries from hundreds of iPhone users in order to gain a better understanding of temperature in health and disease. We report data from temperatures collected from March 2016-June 2017. Broadly, we observed differences in diurnal temperature oscillation among different groups, assessed association between fever and particular symptoms, and analyzed differences in medication use for fever.

Nursing

D-80: Toddlers Involved in Unintentional Shootings in the U.S.A.
Author: Lauren Munter, Agnes Cho, Anika Nana, Katherine Mohr
Advisor: Elizabeth Dowdell

Background: Over the past decade shocking news headlines have emerged reporting on the rising incidences of children under the age of five who accidentally fired a gun. In 2016, approximately 56 cases of unintentional shootings involved toddlers who mishandled a gun that injured or killed themselves or others. A systematic review of the literature was conducted to evaluate the health, prevalence, prevention, and education associated with unintentional shootings by toddlers since 1990.
Methods: Our question was, "What is the rate of toddlers unintentionally killing themselves or others with a gun?" A search of CINAHL, PubMed, EBSCO, Social Sciences, and PsycINFO yielded articles for review. We then utilized the Critical Appraisal Skill Programme (CASP) to evaluate the quality of the remaining studies, and narrowed our findings.
Results: Sixteen articles were included in this review. The majority, 15, used retrospective, quasi-experimental, or randomized control trial design. One was qualitative and one was a systematic review. Themes fell under four major headings: gun safety and storage in the home, attitudes and beliefs, evaluation of safety counseling, and prevalence of gun incidents.
Conclusion: Most unintentional shooting incidents by toddlers occurred in the home, involved a family member, and resulted from insufficient education regarding home safety and well-child anticipatory guidance. Several knowledge gaps were identified in the occurrence as well as suggested strategies for prevention. Health care providers are in a unique position to implement measures to decrease the risk of these accidents by using education strategies as well as developing policies to bolster parental education to ensure that responsible conduct is enforced for safe gun practices.

Physics

D-81: Iron biomineral core structure and magnetism of in vitro reconstituted human ferritins overexpressed in E-coli
Author: Steve Kim, Thomas Longo, Arthur Viescas, Georgia Papaefthymiou
Advisor: Georgia C. Papaefthymiou

Ferritin is a protein responsible for the storage and regulation of iron in living organisms. It is composed of a spherical protein shell and an iron biomineral core stored in its interior cavity. The core consists of ferrihydrite. Mössbauer spectroscopy can be used to find the oxidation state and coordination symmetry of the iron ions and overall electronic and magnetic properties of the core. Using this spectroscopic technique, we have tested the core-shell model of ferritin on engineered mammalian proteins overexpressed in E. coli, containing various ratios of heavy (H) and light (L) amino acid chains. The core-shell model states that the biomineral core is composed of a magnetically ordered inner core and an outer magnetically disordered shell. Due to its nanometric size (d~ 7 nm) the ferritin core is superparamagnetic at room temperature, which means that the magnetic moments of the iron ions are constantly flipping in direction. By entering lower temperatures (4.2K-80K) through the use of liquid helium, we were able to stabilize the magnetic moments of ferritin to achieve nuclear Zeeman splitting, which gave answers to the magnetic properties of the varied protein. Our study probes the structure and superparamagnetic properties of the core and their dependence on the nature of the protein shell. In addition, morphological characteristics were unveiled through transmission electron microscopy. This allowed us to further study the magnetic behavior of ferritin. Preliminary results seem to validate the core-shell model of the ferritin biomineral core and shed some light on its dependence on the H/L chain ratios, i.e., the number of ferroxidase centers on the protein that affect reaction kinetics and the molecular pathways involved in iron nucleation and aggregation within the ferritin cavity.

E-82: How the Translocation Dynamics of DNA in an Oscillating Electric Field Change with Frequency

Author: Rhys Duff, Thomas Longo
Advisor: M. Muthukumar

To make DNA sequencing more efficient and economical one proposed method has been to use nanopores. In nature, nanopores are the gateways that exist on a cell's membrane, and are used by proteins which pass through them. By artificially creating these nanopores in a salt solution we can measure the current flow of the salt ions that pass through the nanopore, and if there is a strand of ssDNA in the nanopore the current measured will change in accordance with the type of base that is in the constriction point, or the narrowest point, of the nanopore. In doing this, theoretically, we can completely sequence any strand of DNA that goes through the nanopore. However, there are two main problems with this method; the DNA translocates too quickly to measure accurately and nearby bases inside the constriction point influence the output current. My project seeks to better understand this process through molecular dynamics simulations. In my simulations, I will be testing whether applying an alternating current to the system will slow the translocation time of the ssDNA, and thereby, increase the accuracy of the sequencing process. In addition, I will be looking for the optimal frequency of the alternating current to maximize the length of the translocation time.

E-83: Synthesis and Structural Characterization of Geometrically Frustrated Double Perovskites

Author: Connor Williams, Demetrios Papakostas, Dr. Jeremy Carlo
Advisor: Dr. Jeremy Carlo

Geometric magnetic frustration occurs in a material when magnetic order is inhibited by the arrangement of magnetic ions. This frustration is often seen with triangular or tetrahedral coordination moments favoring antiparallel (antiferromagnetic) alignment. Frustrated materials have

been shown to exhibit a variety of magnetic ground states because of the cancellation of normally dominant interactions, providing a clearer picture for how magnetism arises in materials, and thus are of great interest to the research community. Double perovskites of composition A2BB'O6, with 'rock-salt' order of magnetic B' ions, potentially exhibit frustration. Double perovskites are of particular interest due to their chemical versatility, which enables the synthesis of many different compounds with divergent magnetic properties, providing great potential to yield new insights into frustration physics.
We report synthesis and structural characterization for the following four compounds: Ba2YbMoO6, Ba2YWO6, Ba2LuWO6, and Ba2ScMoO6. The compounds were synthesized with solid state methods, and structurally analyzed using x-ray diffraction and Rietveld refinement. All compounds crystallize in the simple cubic perovskite structure, as expected based on their respective Goldschmidt tolerance factors, a theoretical measure used to predict the stability and structure of perovskite materials. Successful syntheses and characterizations of Sr2ScMoO6, Ba2YbNbO6, Ba2YNbO6, BaSrScMoO6, and Ba2LuNbO6 were also achieved, all crystallizing in the cubic structure, except for Sr2ScMoO6, which crystallizes in a tetragonal structure."

Acknowledgements: We would like to acknowledge Dr. Bryan Eigenbrodt of Villanova University for use of his high temperature furnace, and the Research Corporation for Scientific Advancement for financial support

E-84: Synthesis and Magnetic Characterization of Geometrically Frustrated Double Perovskites

Author: Demetrios Papakostas, Connor Williams, Dr. Jeremy Carlo
Advisor: Dr. Jeremy Carlo

Geometric magnetic frustration occurs when magnetic ions are arranged spatially in such a way that inhibits the development of magnetic order. Frustrated magnetic materials are of interest to the research community due to their rich phase diagrams with a wide variety of magnetic ground states. This is due to exotic physics and high sensitivity to parameters such as doping and structural distortion.

We successfully synthesized and performed magnetic susceptibility measurements (using a SQUID magnetometer) on the following compounds: Ba2YbMoO6, Ba2YWO6, Ba2LuWO6, Ba2ScMoO6, and Sr2ScMoO6. Susceptibility measurements were also conducted on the non-magnetic niobate equivalents. Magnetic susceptibility measurements provide a useful probe into how much frustration compounds exhibit. In our measurements, the compounds Ba2ScMoO6, Ba2LuWO6, Ba2YWO6, and Ba2YbMoO6 exhibited Curie-Weiss behavior with no evidence of magnetic transition down to 2K. Measurements were conducted under zero field cooled and field cooled environments, and from fits to the data, the nature of magnetic interactions may be determined. Double perovskites, of the form A2BB'O6 tend to exhibit frustration in the presence of anti-ferromagnetic correlations, and their frustration index can be determined from fitting the susceptibility data. Ba2ScMoO6, Ba2YWO6, Ba2LuWO6and Ba2YbMoO6 had large and negative Curie-Weiss temperatures, indicating antiferromagnetic correlations.

Our data suggests these samples also have high frustration indices, given their high Curie-Weiss temperatures, and that no irreversibility or other evidence of magnetic ordering was present down to 2 Kelvin.

Acknowledgements: We would like to acknowledge the Research Corporation for Scientific Advancement for financial support and Dr. Graeme Luke of McMaster University for assistance with magnetic measurements

E-85: Development of a Microwave Calibrator for Cosmological Measurements
Author: Vincent Mutolo, David Greene, David Stilwell
Advisor: Dr. David Chuss

We are developing a calibrator for an instrument to measure the Cosmic Microwave Background (CMB). The calibrator must fill a ~1 m aperture and have a reflectivity below a few parts in 10,000,000 over a broad spectrum from millimeter-wave radiation through the far-infrared. The geometry of the calibrator is an array of cones that utilizes the high-absorptivity loaded-dielectric in concert with a geometry that maximizes radiative coupling. We are optimizing the geometric taper of the cones to reach the reflectance specification while maintaining manufacturability. The cones are made of an epoxy and stainless steel mixture that provide a highly-absorptive dielectric that is capable of being cast into the desired profile. We are also refining the manufacturing process to reach the challenging physical design specifications.

E-86: How the Translocation Dynamics of DNA in an Oscillating Electric Field Change with Frequency
Author: Thomas Longo, Rhys Duff
Advisor: M. Muthukumar

To make DNA sequencing more efficient and economical one proposed method has been to use nanopores. In nature, nanopores are the gateways that exist on a cell's membrane, and are used by proteins which pass through them. By artificially creating these nanopores in a salt solution we can measure the current flow of the salt ions that pass through the nanopore, and if there is a strand of ssDNA in the nanopore the current measured will change in accordance with the type of base that is in the constriction point, or the narrowest point, of the nanopore. In doing this, theoretically, we can completely sequence any strand of DNA that goes through the nanopore. However, there are two main problems with this method; the DNA translocates too quickly to measure accurately and nearby bases inside the constriction point influence the output current. My project seeks to better understand this process through molecular dynamics simulations. In my simulations, I will be testing whether applying an alternating current to the system will slow the translocation time of the ssDNA, and thereby, increase the accuracy of the sequencing process. In addition, I will be looking for the optimal frequency of the alternating current to maximize the length of the translocation time.

Psychology

E-87: Measuring the Role of Competition Between Memories After Reactivation During Sleep
Author: Gianna Perez, Paula A. Pacheco, James W. Antony, Kenneth A. Norman
Advisor: Dr. Kenneth Norman

Analyzing lateralized brain responses to imagined motor movement is a powerful way to decode mental representations in the wake human EEG, but it is unknown if such responses can be seen

during sleep. Meanwhile, competition between simultaneously active memory representations can play a strong role in memory strengthening and weakening. Here we link unique sounds with lateralized motor imagery trials and replay them during an afternoon nap to assess whether we can obtain lateralized responses and whether they predict subsequent memory retention and memory competition. Subjects will first learn a series of sound/ image pairs, where some sounds are associated with more than one image. Next, they learn each item's spatial location on either the left or right side of the screen, practicing mental imagery before touching each one with their corresponding hand. After initial learning, subjects are directed to remember the location of one paired image and forget the other with differential monetary incentives to be allocated after the nap. Subjects then take an afternoon nap, during which we use targeted memory reactivation (TMR) during slow wave sleep to force two memories to compete by reactivating them simultaneously. Finally, subjects return to the lab after 1.5 hours for a post-nap test. Our initial results excluding the nap indicate subjects respond more accurately after the nap to high than low priority information, suggesting we can use this paradigm to manipulate memory priority. In the future, we expect that initially high value items will be prioritized and remembered over low value items, but we also expect an interaction to occur between TMR and priority. One possibility is that TMR cues may help memory for high priority information while hurting memory for low priority information. We also expect lateralized brain activity after TMR cues associated with left/right responses will predict the amount of competition and subsequent memory differences. These results would enhance understanding of sleep and memory competition and would contribute to the development of a classifier to decode left and right motor data from EEG.

E-88: The Role of the Lateral Habenula in Temporal Inhibition and Drug Addiction

Author: Dillon McGovern, Matthew Matell
Advisor: Dr. Matell

How human beings and animals perceive and monitor the passage of time is still widely unknown. Understanding which brain regions are necessary or sufficient for this capacity is crucial, as temporal perception plays a large role in social relations, planning and executive function. There are theories that indicate that dopamine is a primary agent in temporal perception and work done by Pine et. al provides evidence that there is a "a role of dopamine in controlling the relationship between the timing of future rewards and their subjective value" (Pine, Shiner, Seymour & Dolan, 2011). The ventral tegmental area (VTA) is a collection of neurons that release dopamine and it is activated in the presence of rewarding stimuli. The VTA is also implicated in cognition, motivation and addiction. Activation of the lateral habenula (LHb) inhibits the VTA and the presentation of painful stimuli or the lack of an expected reward can activate the LHb. There has been a substantial amount of research on the "relationship between reward learning and homeostatic regulation" (Wittman, Leland, Churan & Paulus, 2008) in respect to drugs that affect dopaminergic cells, such as cocaine and amphetamines. When these drugs are administered the VTA and other dopaminergic systems become highly active to reinforce pleasurable reward sensations. The LHb, the major inhibitory agent of the VTA, is inhibited when stimulant drugs are administered.

Stimulant drugs, such as Methamphetamine, are dopamine agonists which make them both habit forming and desirable. Stimulant use has also been implicated in affecting temporal perception (Williamson, Cheng, Etchegaray & Meck, 2008) by increasing perceived clock speed. When rats work and receive a reward, i.e a food pellet, dopamine is released to reinforce their responding behavior In a peak procedure task a stimulus(i.e tone) is paired with the availability of a reward after a designated

time has passed (i.e 10s) and only after the rat has responded by poking his nose through an infrared beam (other studies have used lever presses) Since rewards are only presented after the criterion duration has elapsed the rat will learn to respond at the desired time and a plot of response rate versus time will reflect this peaked responding. The rat is demonstrating temporal inhibition when it limits responding prior to the criterion duration. Rats were trained on a fixed interval schedules with short durations (10s) and long durations (20s). Groups were counterbalanced so that the two predictive cues (light and tone) were used for short durations in some rats and long durations in others. After peak responding at the criterion durations was sufficiently demonstrated bilateral electrolytic lesions of the LHb were performed by passing .5 milliamps of current through a stainless steel electrode tip for 10 seconds via a stereotactic instrument. Lesions the LHb will disinhibit this inhibitory system and result in a higher activation of the VTA. If the LHb is necessary for temporal inhibition and perception than this could provide an explanation for why individuals addicted to stimulant drugs show chronic seeking behaviors of lessening durations.

E-89: Measuring the Role of Competition Between Memories After Reactivation During Sleep
Author: Gianna Perez, Paula A. Pacheco, James W. Antony, Kenneth A. Norman
Advisor: Dr. Kenneth Norman

Analyzing lateralized brain responses to imagined motor movement is a powerful way to decode mental representations in the wake human EEG, but it is unknown if such responses can be seen during sleep. Meanwhile, competition between simultaneously active memory representations can play a strong role in memory strengthening and weakening. Here we link unique sounds with lateralized motor imagery trials and replay them during an afternoon nap to assess whether we can obtain lateralized responses and whether they predict subsequent memory retention and memory competition. Subjects will first learn a series of sound/ image pairs, where some sounds are associated with more than one image. Next, they learn each item's spatial location on either the left or right side of the screen, practicing mental imagery before touching each one with their corresponding hand. After initial learning, subjects are directed to remember the location of one paired image and forget the other with differential monetary incentives to be allocated after the nap. Subjects then take an afternoon nap, during which we use targeted memory reactivation (TMR) during slow wave sleep to force two memories to compete by reactivating them simultaneously. Finally, subjects return to the lab after 1.5 hours for a post-nap test. Our initial results excluding the nap indicate subjects respond more accurately after the nap to high than low priority information, suggesting we can use this paradigm to manipulate memory priority. In the future, we expect that initially high value items will be prioritized and remembered over low value items, but we also expect an interaction to occur between TMR and priority. One possibility is that TMR cues may help memory for high priority information while hurting memory for low priority information. We also expect lateralized brain activity after TMR cues associated with left/right responses will predict the amount of competition and subsequent memory differences. These results would enhance understanding of sleep and memory competition and would contribute to the development of a classifier to decode left and right motor data from EEG.

E-90: Impact of Paternal Childhood Adversity on Health Outcomes of Offspring
Author: Christie Cannarozzi, Madona Farag, Nicole Blekhter, Michael Medina
Advisor: Dr. Roy Wade

The purpose of this research is to investigate the impact of childhood adversity, not only on that individual, but also on their offspring. Adversity is defined by the following three domains: abuse, household stressors, and neglect. Within each domain, there was a list of specific factors. For example, abuse included physical, psychological, and sexual abuse. In order to assess these factors, a survey was developed that would be distributed to predetermined populations via email, mail, and phone. The role of the research assistants was to refine the survey and prepare to administer it to individuals who choose to complete it over the phone. The data collected will be used to assess the relationship between the above domains on various health outcomes and health risk behaviors, including alcohol abuse, smoking, cardiovascular disease, diabetes, and depression. This information can in turn help physicians better tailor their care for each individual. Furthermore, understanding these patterns can allow a physician to better prepare and assess the current and future health of a patient.

E-91: Development of a National Youth Firearm Risk and Safety Assessment Tool
Author: Nicole Blekhter, Christie Cannarozzi, Mike Medina, Madona Farag
Advisor: Patrick Markey

Firearm-related events are the third leading cause of death for children and therefore identifying factors that lead to gun exposure is important. The purpose of this project is to develop a questionnaire for pediatricians to use when talking to patients and patients' parents about guns and gun safety. In order to examine the perceptions of guns and the knowledge of gun safety among average youth, we helped coordinate youth focus groups. We separated the youth into focus groups according to their age. Similar focus groups were also conducted around the country, which helps develop a relevant and meaningful question set for pediatricians to use when asking patients and patients' parents about gun safety. These focus group responses may identify particular social determinants that increase the risk for youth injury due to gun violence or the presence of a gun.

E-92: Oregon National Primate Research Center Diet-induced acceleration of age-related retinal and neuropathologies
Author: Amanda Summers, Dr. Martha Neuringer, Dr. Trevor McGill, Jonathan Stoddard
Advisor: Dr. Martha Neuringer

Overwhelming evidence supports the protective role of several essential nutrients in the human and macaque retina, which illustrates that there is a strong relationship between diet and retinal health. In the context of age-related macular degeneration (AMD)—the leading cause of blindness in aging populations—studies using non-human primate models have shown that diets lacking in carotenoids (lutein, zeaxanthin) as well as n-3 poly-unsaturated fatty-acids have accelerated the rate at which the disease pathology manifests, as well as the age of onset of the associated hallmarks. The specific hallmark of interest is the pathological accumulation of sub-retinal pigmented epithelium (RPE) deposits called drusen. Drusen contain protein components that are also observed in the context of brain aging—amyloid-, apoE, apoJ, and lipofuscin—that have also been identified in macaque brain tissue. Resting-state functional connectivity MRI studies observing a cohort of diet-deficient monkeys have shown major differences in the coordination of cortical brain activity as compared to age-matched controls. Based on the accelerated retinal aging that is observed in these animals in vivo and histologically, it is hypothesized that carotenoid and n-3 PUFA deficiency may also serve as a macaque model of accelerated brain aging, similar to dementia/Alzheimer's that is experienced in aging human populations. Findings from this study on the baseline rates in deposition of the aforementioned critical

protein materials in both macaque retina and brain will serve as preliminary data that will eventually direct the process by which we histologically investigate the neural tissue of the diet-deficient animals.

E-93: Perceptions of Social support, Community Support, and Emotional Well-Being in Parents Experiencing Homelessness
Author: Kenna Yadeta, Sarah C. Vrabic, Janette E. Herbers
Advisor: Matthew Matell

According to the Annual Homelessness Assessment Report for the year of 2015, 35% of the homeless population in the United States was composed of families with children. There are a variety of risks associated with homelessness including extreme poverty and greater likelihood of experiencing traumatic and other stressful events. These traumatic events can have long lasting effects. Parents of families experiencing homelessness then encounter a double crisis of parenting under circumstances of great stress and coping with homelessness simultaneously. Supporting these parents requires understanding how to provide effective community support in contexts of emergency housing for families. This study examined the associations among negative life events, perceived social support and support from emergency housing providers, and emotional well-being among parents experiencing family homelessness.

The sample consisted of 53 mothers with children between the ages of birth to 5 years. Mothers were recruited from four emergency shelters in Philadelphia. Mother's emotional well-being was measured using items from the Hopkins Symptom Checklist Short Form (Derogatis et.al.,1974) which asses the degree to which mothers experienced 14 symptoms of depression within the past week. Perceived social support was calculated based on mother's responses to 5 interview items asking whether they would have the help they needed in certain circumstances, such as needed to borrow $50 or needing someone to watch their children because they were ill. Perceived support from emergency housing staff was assessed via the Sense of Community Index II (SCI-2; Chavis, Less & Acosta, 2008), a 19-item, self-report measure of community support. Recent negative life events were assessed via the Life Events Questionnaire (Masten, Neeman, & Andenas, 1994), which asks mothers whether their families or children have experienced 25 different negative events in the past 12 months.

Bivariate correlations indicate a small but non-significant association between perceived shelter community support and emotional well-being ($r = -.138$, $p = -.324$). Recent family adversity was significantly correlated with perceived social support ($r = -.319$, $p = .02$) and emotional well-being ($r = .484$, $p = <.001$). Results of a multiple linear regression analysis revealed that, when perceived social support, support from emergency shelter, and recent family adversity were entered simultaneously as predictors of emotional well-being, only recent adversity emerged as statistically significant ($\beta = .473$, $p = .001$). This suggests that perceived support from both within and outside the shelter context do not predict parent emotional well-being beyond the association with recent negative life experiences for the family.

Sociology

E-94: Sociology and Criminology Forgotten Victims of Incarceration: Children of Prisoners
Author: Anna DalCortivo
Advisor: Dr. Jill McCorkel

This comparative study involves looking at United States and Irish prison policies as they impact the children of prisoners. The purpose of this research is to determine whether Irish policies contribute

to improved outcomes for children and to identify policies and practices that could be adopted in the U.S. to improve children's access to their incarcerated parent. The project consists of ethnographic, interview, and archival data. Specifically, while in Ireland we looked closely into the Family Links Program running in Limerick Prison and Wheatfield Prison, which is coordinated by the Childhood Development Initiative, Parents Plus and the Irish Prison Service. We also looked at the Bedford Row Family Project, which runs only in Limerick Prison. The research conducted this summer provided the foundation for Dr. Jill McCorkel to continue this project in Dublin this semester.

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