Abstracts: Oral Presentations

All oral presentations will take place in the Devon Room at the times listed below

Augustine & Culture Seminar Program (ACSP)

(2:00 p.m.)

Playing Mother: The Daunting Possibilities of Artificial Womb Technology
Author: Hanlon, Erin
Advisor: Dr. Peter Busch

So often in our society, technological advances are met with the reaction that we must be wary of "playing God." Yet, we often ignore this concern when the technology is created for the betterment of society and to solve a critical problem. This was the case for the CHOP research team that created an extra-uterine physiologic support system for the extreme premature lamb, a bio-bag system that could support an extremely premature lamb within a womb-like environment that would allow for survival and development up to a fuller point of gestation. This research, when translated to humans, would give extremely premature babies an increased chance of survival and ability to thrive post-birth with limited health complications.

What I focused my research on is, what comes after this technology? We most likely will continue building upon this research until a baby could survive within this system from as early as conception. With a fully artificial womb and no need for a woman to carry a child, what possibilities does this allow for? How does this change women's role within society? Would we even need women involved in the process? Could women donate eggs as men donate sperm and men can have a child independently? Could this possibly eliminate the abortion debate? What kind of policies will we need surrounding fetuses and the process? What potential risks does this allow for? The very real possibility of artificial womb technology brings to light many questions and ethical dilemmas that we, as a global community, may face in the very near future and we must begin to explore these possibilities in order to make the most ethical and just decisions for the future of our society.

Biology

(2:15 p.m.)

Regulation of Drosophila courtship behavior and neuronal development by the Dissatisfaction nuclear receptor
Author: Duckhorn, Julia
Advisor: Dr. Troy Shirangi

How genes build the neural circuits that underlie innate animal behaviors is poorly understood. During courtship, Drosophila males court females with a series of innate behaviors, whereas females decide whether or not to mate. Mutations in the dissatisfaction gene (dsf), which encodes a developmental nuclear receptor, cause sex-specific abnormalities in both sexes. To understand how dsf influences the neural circuits that underlie courtship, we sought to identify the neurons that express dsf in the fly brain that contribute to courtship. Here, we find that dsf is expressed in several subsets of neurons in the fly nervous system of both sexes. We identify a small subset (i.e., 3+) of dsf-expressing neurons in the fly's abdominal nervous system that contribute to most behaviors that are altered in dsf mutant males and females. Loss of dsf function causes sex-specific anatomical phenotypes in these neurons, suggesting that dsf regulates neuronal development and courtship behavior by functioning with the sex determination pathway in flies. This work offers insights into how a developmental gene patterns the circuits for an innate animal behavior.

(2:30 p.m.)

The Pressure on Providers: A Qualitative Look into a Pilot Intervention for Hypertension Management

Author: McNelis, Kiernan
Advisor: Dr. Shivan Mehta (University of Pennsylvania, Penn Medicine. Gastroenterology)

Hypertension is a medical condition that affects approximately 30% of US adults. Elevated blood pressure poses long-term risk, but only about half of these adults maintain good control. Prior interventions revealed that medication adherence alone was not the primary factor resulting in poor blood pressure control. Other studies show the benefit of remote monitoring interventions by providing insight into the patients' behaviors outside of office visits, while reminding patients to monitor their blood pressure and take their medications. SupportBP is a 3-arm randomized control trial aimed at comparing the effectiveness of different approaches to improving blood pressure control. 250 patients aged 18-75 within the Penn Family Care (PFC) practice with at least 2 visits within the past 12 months with blood pressure readings exceeding recommended HTN guidelines were randomized to one of the three arms: remote monitoring of blood pressure (Arm 1), remote monitoring and social support (Arm 2), and usual care (Arm 3). Remote monitoring required patients to monitor their blood pressure measurements (3x per week) and medication adherence (1x per week) with feedback to the patient and to the clinical practice if measurements were out of control. After the 4-month monitoring period, patients were asked to come to PFC to answer a post-intervention survey and have their blood pressure measured. The primary outcome of SupportBP was to measure the patient's blood pressure reduction over the 4 month study period. The survey evaluated patient perceptions about the intervention. Additionally, the study includes a qualitative look into the experiences and perceptions of the clinicians who had one or more patients enrolled in SupportBP. An interview questionnaire was created and outreach was emailed to the 45 physicians still practicing at PFC in order for them to select a 30-minute time slot to schedule a phone interview. These interviews are ongoing, but they will provide insight into the clinicians' perspective of SupportBP. Of the 4 completed interviews, most clinicians expressed a positive perception of SupportBP because it engages patients and provides additional blood pressure readings. The clinicians all suggested that a specific provider should be dedicated to responding to

the SupportBP encounters. The clinicians' feedback and the patient surveys allow improvements to be made for future iterations of the intervention.

Electrical and Computer Engineering

(2:45 p.m.)

AxBy: Approximate Detection and Bypass of Trivial Computations for Energy-Efficient Computing
Author: Huang, Shenda; Ma, Dongning; Jiao, Xun
Advisor: Dr. Xun Jiao

The increasing success of emerging applications such as image/video processing, deep learning, and big data analysis has led their implementations on various hardware platforms including low-power embedded systems and high-performance computing platforms. However, the intensive computing workloads of these applications incur high energy consumption which remains a challenge for hardware implementation. Instead of reducing the energy consumption of each operation, such as voltage scaling, or reducing the number of operations, such as 'approximate memoization', we proposed AxBy, a novel method performing approximate detection and bypass of trivial computations for energy-efficient computing. We define the notion of trivial computations as computations of which results could be conveniently pre-determined instead of performing actual operations. For example, for a multiplication, one type of trivial computation is when any operand equals to 1 because the result of such multiplication equals to the other operand. Thus, such computations can be bypassed. Moreover, it is an architecture-independent technique that can be implemented in any platform. Since AxBy circuits need to balance the generality and the efficiency, AxBy is able to recognize all the possible types of trivial computations and is implemented in a group of scalable, reconfigurable approximate hardware module. Throughout experiments, the approach of AxBy could alleviate the energy consumption in different GPU applications including image processing and convolutional neural networks, with introducing minimal quality or accuracy loss.

(3:00 p.m.)

CACM: Controlling Approximate Computing for Minimized Energy Consumption with Quality Guarantee
Author: Wang, Xingjian; Ma, Dongning; Jiao, Xun
Advisor: Dr. Xun Jiao

As transistor scaling increasingly falls short in providing improved energy efficiency, alternative computing paradigms are urgently needed for the future computing industry. Approximate computing has recently arisen due to its success in many modern data-intensive applications such as multimedia and data analysis. However, current approximate computing research mostly focuses on using a single approximation setting across the entire system, which may limit the potential gain of

approximate computing. In this paper, we propose CACM, a workflow that can control the approximation setting for a given program, input data, and quality constraints so as to optimize energy efficiency while satisfying the user-defined quality guarantee. We formulate this control problem as a constrained combinatorial optimization problem and solve it with the genetic algorithm. We evaluate the effectiveness of CACM on various image processing applications and demonstrate a notable energy saving with an acceptable quality loss.

History

(3:15 p.m.)

"Farewell to Erin: Differing Perspectives of Emigration and the Famine of Irish migrants to the United States from 1815 to 1850."
Author: McDonough, Dan
Advisor: Dr. Craig Bailey

Amongst the Irish emigrants to America in the years immediately preceding and during the Great Famine, there were many differing feelings about leaving their homeland. These differences existed at every level: according to economic and social class, according to religion, according to ethnic identity and political agenda, and according to geographical location. For many upper and middle class Catholics, as well as for many Protestants, emigration was a sound economic choice; for lower class Catholics, especially in rural areas, self-preservation was the only concern; others, particularly Catholic but also some Protestants, and particularly of the middle class, a strong commitment to Irish independence and flight from British authorities played necessitated emigration. What it meant to them to be Irish, what was at stake for them in leaving their country forever, their feelings about the Famine, and who was to blame for the disaster all varied considerably. These are things I seek to answer in my research, and in particular I emphasize the perspectives of middle and upper class Irish urban Catholics.

Humanities

(3:30 p.m.)

Human Freedom, Fate, and Divine Providence in Epic Narratives
Author: Arnold, Caroline
Advisor: Dr. Helena Tomko

This project is an investigation of the relationship between human freedom and fate or divine providence, specifically as it appears in Homer's Iliad and Odyssey, Virgil's Aeneid, and Augustine's Confessions. Using an interdisciplinary approach that draws from theological, philosophical, and literary resources from the Greco-Roman and Christian traditions, this project examines the

distinction between the pagan concept of fate and the Christian understanding of divine providence, and the place of human freedom within each of these concepts. My study included a close reading of each of the aforementioned literary texts accompanied by relevant philosophical-theological readings, including Plato's "Euthyphro," "Phaedrus," and selections from the Republic, and Augustine's On Free Choice of the Will and selections from City of God, in order to address the question, How does human freedom operate within either a fated or a providentially designed order? The pagan poets Homer and Virgil are ultimately unable to depict how human freedom could truly coincide with the unfailing power of fate. Virgil in particular, through his depiction of human deviations from a fated destiny, attempts to maintain both the inevitability of fate and the reality of human freedom in his Aeneid and open the question of the relationship between the two. Yet, Virgil fails to adequately answer this question. The Christian Augustine in his Confessions successfully addresses this question, crafting a narrative in which the divine will is depicted as unfailing even in the midst of human deviations from the divine will.

Theology & Religious Studies

(4:00 p.m.)

Sacred Self-Expression: Love and Trans Authenticity
Author: Arnold, Caroline
Advisor: Dr. Ilia Delio

Theistic cosmologies have historically inspired religious communities to alienate transgender individuals. While some institutions encourage tolerance of diversity, underlying cosmological conceptions of God and the human person must still be re-examined to recognize the significance of the transgender experience as such. Synthesizing gender studies with theology, this interdisciplinary project argues that God's nature as deeply personal Love implies a sacredness in gender authenticity itself, including transition. Each unique human person is the product of a universal evolution toward deeply personalized consciousness. Gender, when freed from rigid constraints, is a social expression of this personalized self in a common cultural language. As infinite Love, God actualizes in the universe in deeply personal love. Therefore, by personalizing knowledge of one another and enabling deeper love between human persons, gender authenticity, in its fluidity, ambiguity, and continuous newness, deepens God's existence in the universe. For transgender individuals, living out one's authentic gender, and the social, physical, or emotional transition many undergo, is sacred.

Abstracts: Posters

Astronomy, Astrophysics and Planetary Science

A-01: Asteroseismology of Red Giant Eclipsing Binary Stars
Author: Rodriguez, Jonathan; Prsa, Andrej
Advisor: Dr. Andrej Prsa

With the advent of the relatively new field of astronomy, called asteroseismology, it is becoming easier for astronomers to generate accurate models for stellar structure and stellar evolution. Calibrating these models to have little error is difficult because stars are too far and dim for us to be able to obtain fundamental stellar parameters like mass and radius. This is the significance of eclipsing binary red giant stars and asteroseismology. Eclipsing binary stars are two stars that orbit each other around a certain point, and their orbital plane is in line with respect to the Earth; this means we can see the stars eclipsing each other. Red giant stars are large in radius, have low mass, and are dim stars that are usually in the late stage of stellar evolution. The stochastic oscillations that occur on these stars reveal information about the internal structure of a star, much like earthquakes reveal information about the internal structure of the Earth. Red giant stars specifically are useful because their global stochastic pulsations have frequencies that align with K2's long cadence, measuring from to . Eclipsing binaries are significant because radius and luminosity can be estimated from their light curves, and mass can be estimated through radial velocities. Using two K2 data sets for 16 observed eclipsing binary red giant stars, we have created Python code to generate light curves and reveal peak frequencies from the solar-like stochastic oscillations on the surface of these stars. The raw light curves were generated with Pre-search Data Conditioning Simple Aperture Photometry flux (PDCSAP Flux) vs. time, where PDCSAP flux contains a more processed version of two data columns of flux, including artificial mitigation, with 1- statistical uncertainty. In order to get the peak frequencies, the light curves had to be processed further using Fourier transforms which decomposes frequencies from a signal. In this case the signal comes from these red giant stars in eclipsing binaries. We have successfully reached the point of calculating the power spectrum and plotting it to get the fully processed individual frequency signals. Our next step is analyzing which stars from each data set have clean enough data for us to use. Then we must find the large separation () and the maximum frequencies of the stars (), which will lead us to our final step of calculations: inferring individual stellar masses and radius.

A-02: Asteroseismetric Scaling Factors and Binary Stars
Author: Tumblety, Lexi
Advisor: Dr. Kelly Hambleton

Asteroseismic scaling factors have proven to be efficient for calculating masses and radii for stars like our Sun, on the main sequence; however, in recent studies the scaling factors appear to be less accurate for red giant stars, stars burning hydrogen to helium in the core. A popular method to validate the scaling factors is by using binary stars with pulsating components. By studying the

motions of binary stars, as well as luminosities and surface temperatures, both mass and radii can be measured. Previous studies such as Gaulme et al. (2016), Brogaard et al. (2018), and Thembessl et al. (2018) not only show disagreement in their results, but also in their methods to calculate masses and radii. Some papers seem to have suffered from zero-point issues, while others use software like JKTEBOP, which is not well suited for the binaries in question. My part in this research will entail modeling a binary system with a red giant component and a pulsating component using advanced methods, finding mass and radii and ultimately comparing these results to that of other studies and that of the asteroseismic scaling factors. The final goal of this research is to validate and/or calibrate asteroseismic scaling factors in their pursuit to calculate masses and radii for stars off the main sequence.

A-03: Big Data and Eclipsing Binaries: Developing an Optimal Training Set for an Artificial Neural Network

Author: Kline, Tyler; Prša, Andrej
Advisor: Dr. Andrej Prša.

Due to the launch of new, more sophisticated space telescopes and instrumentation such as Gaia, astronomers will soon have access to more data than they have the human capital to analyze. A computational solution to this problem is necessary. One such solution is an Artificial Neural Network (ANN). An ANN, when properly trained to recognize eclipsing binary (EB) light curves, can quickly compute a solution of basic EB parameters. However, previous attempts to train an ANN have produced unsatisfactory results due to a lack of similarity between the training set and input data.

Dimensionality reduction is a method of visualizing high-dimensional datasets by mapping them into a two- or three-dimensional dataset that can be plotted and understood by humans. An effective dimensionality reduction algorithm will preserve structure of the high-dimensional dataset in the low-dimensional projection. We investigated the viability of the dimensionality reduction algorithm t-Distributed Stochastic Neighbor Embedding (t-SNE) for comparison of EB datasets in order to identify key features of the EB parameter space that must be replicated in an appropriate training set. First, we demonstrated the viability of t-SNE by applying the algorithm to sets of exponentials and sixth-order polynomials. When projected into two dimensions, we found the exponentials clustered according to their area, and the polynomials clustered according to the magnitude of the coefficient of the sixth-order term. We determined that when sets of EB light curves of n points were projected from n-dimensional space into 2-dimensional space using t-SNE, light curves strongly clustered according to primary eclipse width and depth.

In the Fall 2019 semester, we will use this result by projecting synthetic light curves used for training alongside observed data. This will allow us to gauge the similarity between the synthetic training set and the observed data to manipulate the synthetic training set so its parameter space closely resembles the observed data's parameter space. This is critical to the success of the ANN, as it will poorly recognize EB light curves with parameters that lie outside the parameter space of the training set.

A-04: Brute Force Parameter Evaluation for Eclipsing Binary Stars

Author: Petrallo, Alexander
Advisor: Dr. Andrej Prsa

The modern era of astronomy has brought a significant increase in the amount of data collected, however there aren't enough astronomers to process it. It is therefore necessary to improve our methods of automation to analyze the abundance of data, specifically eclipsing binary light curves. An eclipsing binary star system is comprised of two gravitationally-bound stars that orbit a common center of mass, with an orbital plane aligned in such a way that the stars are observed eclipsing one another. Eclipsing binaries play a crucial role in understanding stellar evolution, as changes in apparent magnitude of the system plotted over time allow certain characteristics of the stars to be determined. The goal of this project is to automatically compare the light curves of observed binary systems to synthetic light curves in order to approximate parameters of binary star data. The parameters considered include temperature ratio, sum of fractional radii, esinw and ecosw, and the sine of the inclination. An approximation of the observed stellar parameters can be established via brute force comparison of observed data and tens of thousands of synthetic light curves. Using MPI to take advantage of parallel computing power, and using PHOEBE2 modeling software, tens of thousands of light curves with a wide range of parameter values were synthesized and compared to observed data more efficiently. This allows us to understand how different attributes of a star system affect light curves and thus how the physical properties of a star dictate their evolution.

A-05: Census of Local Stellar Neighborhood: Ages, Compositions, Irradiances, Kinematics & Habitability of Stars Within 25 pc

Author: Ferguson, Zach
Advisor: Dr. Edward Guinan

A multi-dimensional analysis of the Gliese-Jahreiss (GJ) Catalog which refines and expands the catalog of nearby stars by: strictly limiting the stars included to only those which are less than 25.0 pc distant (the Local Stellar Neighborhood, LSN); compiling confirmed extrasolar planetary systems; compiling spectral indicators log[Fe/H] and log[R_HK'] from the literature; compiling stellar rotation data from the literature; categorizing, based on space motion, stellar orbits through the Galaxy – i.e. thin disc, thick disc, halo; compiling coronal X-Ray emission luminosity measurements log[L_X] from the NEXXUS catalog; determining stellar ages by relations utilizing rotation periods, color indices, log[R_HK'], log[Fe/H], and log[L_X]; and assessing habitability of these exoplanetary systems. The survey utilized n = 1834 stars: 23 A-type, 141 F-type, 204 G-type, 523 K-type, 744 M-type, and 96 D-type white dwarfs. Of these, 738 stars' ages were found through at least one relationship. There were also 142 stars whose ages were found through more than one relation, the standard deviation of which showed $\bar{\sigma}$=0.405, indicating that the method yields reasonable results across the multitude of relationships but also highlighting the need for more refined understanding and modelling of the stellar aging process. The study found 20 confirmed exoplanets which orbit in the habitable zone (HZ) of the host star. However, it is unlikely that more than 25% of these exoplanets may be suitable for life.

A-06: Determining Age, Rotation & Emissions of dK & M-Type Stars: A Glimpse into the Potential Habitability of Red Dwarf Hosted Planets

Author: Purcell, Kathlyn; Engle, Scott
Advisor: Dr. Scott Engle

Due to stellar invariability, long lifetimes and local abundance, dK & M-type stars have become the focus in the search for other-worldly habitability. These Red Dwarf (RD) stars are essential in the search for life, but due to their long lifetimes and invariability (the very same characteristics that make them potentially habitable) using the traditional methods to determine their ages and other related data becomes impossible. In order to understand these stars and their habitable zones we must devise a new method for determining their age. Over the past several years this project has developed a relationship to link stellar rotation rates to age in RD stars. This process allows the ability to observe the star and directly calculate its age. Age can be the key to unlocking multitudes of other traits about the star and the conditions any orbiting planet will be subject to. During the previous year, RD stars' X-Ray, UV and atmospheric (X-UV) radiation were compiled from the International Ultraviolet Explorer (IUE) satellite and the Hubble Space Telescope (HST) in order to develop a relationship and link these values to the age of the star. In its current stages, our search has been expanded to include Ca II radiation along with an expanded version of the X-UV data. Ca II, while not a direct indicator of conditions in the RD atmosphere, plays an important role in characterizing the star. While the X-UV radiation is blocked by the Earth's atmosphere, Ca II flux can penetrate and allow observations to be made from the ground allowing for an abundance of data and a more financially- friendly observation. With these X-UV, Ca II and age relationships the entire XUV environment around a RD star is characterized and the conditions on an orbiting planet allow us to easily determine its habitability.

A-07: Hot Jupiters: Formation, Evolution and Ultimate Fates – Focus on the HD 189733 Hot Jupiter System

Author: Gunther, Samuel
Advisor: Dr. Edward Guinan

Hot Jupiters are an important class of gas giant extrasolar planets which have masses and radii similar to Jupiter, but unlike Jupiter they have very short orbital periods ($P < 10$ days) and thus exist very near to their host stars. Because of their high masses and large sizes, Hot Jupiters are the easiest extrasolar planets to detect via Doppler-Effect radial-velocity observations or via planetary transits. Currently, there are two main theories explaining how these planets are formed. According to the migration theory, Hot Jupiters initially form farther away from their star and migrate inward. The alternative theory, the "In Situ" Hypothesis, is that instead of the gas giants migrating inward, the cores of Hot Jupiters began as more common super-Earths, but then accreted gaseous envelopes while at their current locations, becoming gas giants in situ and experiencing little change in period over time. HD 189733 is the nearest and brightest ($V \approx 7.67$ mag) Hot Jupiter transiting exoplanet system and photometry of HD 189733 has been carried out at Villanova with observations being made in 2007 and as recently as 2017. These observations were made to determine the transit eclipse times of the system to search for changes in its orbital period due to tidal and magnetic interactions with the host star. By adding more timings from the ETD, the Exoplanet Transit Database, and performing new observations of HD 189733, a more refined decrease in orbital period was found suggesting that the migration theory is correct. The orbital decay rate was also calculated for 8 more Hot Jupiters, and 6 of them exhibited a decrease in orbital period.

A-08: Mars Garden: A comparative study of plant growth in Martian simulant regolith and hydroponics systems
Author: Eglin, Alicia
Advisor: Dr. Edward Guinan

Over the next several decades, NASA and private enterprise missions, such as SpaceX-Mars, plan to send human missions to Mars with the ultimate goal of establishing a permanent human presence on this nearby planet. In order for a colony on Mars to be self-sustaining, it will be necessary to provide food by growing plants in sheltered and heated greenhouses. Due to the cost of transporting materials into space, it will be too expensive to bring soil from Earth to Mars, therefore the growing medium must already be abundant on the red planet. Past research at Villanova University has proven that it is possible to successfully cultivate plants in simulant Martian regolith, however there are many issues with the dirt that need to be remedied before it is suitable for agricultural applications. The regolith must be stripped of perchlorates, which are poisonous to humans, and an organic material, such as worm castings, must be added to the regolith to provide nutrients for the plants, as Martian regolith is inherently sterile. In addition, the clay-like properties of the regolith exacerbate problems such as root-rot, wilting, and root-growth deficiency. Because using regolith as the growing medium presents significant challenges, this study explores the usage of a hydroponics system as an alternative to regolith-based agriculture. In a hydroponic system, no soil is used and the plant roots are placed directly in a nutrient solution, producing plants that grow larger and more quickly than their soil-based counterparts due to the ease of nutrient-absorption. A direct comparison between Martian simulant regolith and a hydroponics system indicates hydroponics are preferable for agriculture on the red planet, and future work will look to further optimize the hydroponic system.

A-09: The Behavior of SU Ursae Majoris Stars: Properties and Mechanics of Dwarf Nova RZ Leo Minoris
Author: Baldys, Brad
Advisor: Dr. Edward Sion

SU Ursae Majoris stars are a class of dwarf novae which possess very short rotation periods, short intervals of quiescence between outbursts of radiation, and slight increases in apparent magnitude during recurrent outbursts when compared to outbursts of classical novae. The mechanism by which the qualities of SU Ursae Majoris stars function are largely unknown. To further understanding of these elusive objects, archival observations of RZ Leo Minoris (a known SU Ursae Majoris star) from the International Ultraviolet Explorer (IUE) space telescope was processed and analyzed using pre-existing models to provide insight as to how this class of star may operate.

Biochemistry

A-10: Are duplicated gene products involved in bacterial capsule biosynthesis involved in pathogenicity?
Author: Cha, Eugene; Palenchar, Peter; Palenchar, Jennifer B.
Advisor: Dr. Jennifer B. Palenchar

Previously, we have identified four genes that have been duplicated only in pathogenic bacteria. To ask if the duplicated gene products contribute to bacterial pathogenicity, we will ultimately characterize each gene in vivo and in vitro. In the work presented herein, we describe the progress towards cloning and initial characterization of four different genes encoding enzymes involved in the metabolic pathway for capsule biosynthesis from the non-pathogenic bacteria E. coli MG1655: GDP-mannose dehydratase (GMD), phosphomannomutase (PMM), GDP-mannose pyrophosphorylase (GMPP), and GDP-fucose synthase (GFS).

A-11: The Effect of Proteasomal Ubiquitin Receptors on the 26S Proteasome
Author: Hughes, Danielle
Advisor: Dr. Daniel Kraut

The Ubiquitin-Proteasome System represents the major passageway for protein degradation in eukaryotic cells. The 26S proteasome is the primary machine of the pathway; the location in which misfolded, damaged, or regulatory proteins are degraded. Unique components of the complex affect its capability of degradation, for some proteins experience favorable unfolding while other proteins experience partial unfolding. In this project, we analyzed the influence of proteasomal mutants and ubiquitin receptors on the unfolding ability of the 26S proteasome. When tagged with polyubiquitin chains on the substrate, proteins attach to the ubiquitin receptors on the 19S regulatory particle. This particle then passes the protein to the 20S core, the site of degradation, in which proteins can either be degraded or released. Although the ubiquitin tag is removed in the beginning of the process, this element serves a vast importance in the degradation pathway. The Rpn2 R809E mutation, created to destabilize the S3 state, drastically reduced the unfolding ability of the proteasome. Interestingly, mutation of the adjoining ubiquitin receptor Rpn13 partially rescued the Rpn2 R809E mutation as the double mutation was no worse than the Rpn13-pru mutation on its own. Even more cooperation between Rpn2 and Rpn13 was seen with the milder Rpn2 R813E mutant, designed to destabilize the S1 state. Thus, ubiquitin binding and conformation together dramatically affect the unfolding ability of the 26S proteasome.

Biology

A-12: Behavioral response of purple sea urchins (Strongylocentrotus purpuratus) to external force
Author: Naughton, Kaitlyn
Advisor: Dr. Michael Russell

As benthic intertidal organisms, sea urchins are exposed to multiple external forces including waves during high tide (Denny, 1988) and predation during low tide (Tomanek and Helmuth, 2002). In order to resist dislodgement, urchins use adhesive tube feet to remain attached to substrates.

Previous studies indicate that there are both population-level differences and substrate-level effects on adhesive performance of sea urchins (Stark et al., in prep). Working hypotheses suggest these differences could be due to chemical and morphological differences, but there is little work on behavioral differences. In this study, we assess the adhesive performance and behavior of populations of purple sea urchins from Bodega Bay and Bean Hallow California on glass and plexiglass using two different stimuli. The results of our study show that when placed on plexiglass, urchins from both populations demonstrate a walking behavior without leaving behind adhesive footprints, indicating little to no adhesion to the substrate. Urchins on glass are more likely to hunker down and leave behind failed tube feet and footprints after being pulled from the substrate. We also found that, in general, urchins behave differently in response to two different types of force stimulus. Specifically, when experiencing a downward force, sea urchins are less likely to hunker down to glass than when experiencing an upward force. The difference is only statistically significant in urchins from Bean Hallow, suggesting a population-level behavioral difference. Behavioral differences among populations could be explained by differences in habitat, local wave dynamics, or the presence of predators. Future work will focus on tube foot behavior when experiencing the two types of force stimulus.

A-13: Characterizing the role of nuclear body protein ZC3H8 in proliferation, apoptosis, and DNA repair of mouse mammary tumor cells

Author: Sato, Rhiann; Schmidt, John A.; Knepper, Janice E.
Advisor: Dr. John Schmidt

The zc3h8 gene encodes the fetal liver zinc finger protein, Fliz1, and is a presumed oncogene that is overexpressed in mouse and human mammary tumor cell lines. Fliz1 protein localizes to PML bodies in cell nuclei, which are among a number of critical regulatory factors involved in tumor suppression. While Fliz1 is believed to be critical in PML body maintenance, Fliz1 overexpression has shown links to tumorigenic cell behavior in breast cancer. Recent literature supports a positive relationship between proliferation and Fliz1 expression, and while further amplification of Fliz1 expression is believed to induce apoptosis, the latter claim remains mostly unproven. To explore this further, mouse tumor cells were equipped with an inducible tetracycline regulator to dosage-dependently drive Fliz1 expression in response to the antibiotic, doxycycline. Negative control cells and cells with this inducible expression were dosed with doxycycline or etoposide, an apoptosis-inducing agent, to be counted and categorized as live or apoptotic via Annexin V flow cytometry. Cells with induced Fliz1 expression boasted a higher live cell count following doxycycline treatment, though the shape of the resulting histogram resembled that generated by replicate samples treated with etoposide. This may suggest that driving Fliz1 overexpression has both proliferative and apoptotic consequences in mouse mammary tumor cells. Regarding the colocalization of Fliz1 and PML bodies, we also sought to deduce how knocking out Fliz1 might influence genome maintenance and DNA repair. Via immunofluorescence microscopy, the localization and fluorescence intensity of Histone H2AX protein—a phosphorylated variant of H2A, which replaces conventional H2A within nucleosomes in response to double-stranded breaks—were imaged to visualize DNA damage caused by etoposide and subsequent efficiency of repair. Cells with Fliz1 knocked out expressed less H2AX protein than cells with Fliz1 following a 24-hour recovery, implying that the absence of Fliz1 may somehow be associated with more efficient DNA repair. These data propose major implications regarding the role of the zc3h8 gene in

regulating behavior and maintenance—mainly proliferation, DNA repair, and cell death—of mouse mammary tumor cells.

A-14: Evaluating Knockdown of GPER and Granulocytes to Assess Their Roles in Estrogen-Induced Uterine Inflammation in the Rat Model
Author: Culberson, Erica
Advisor: Dr. Louise Russo

This project seeks to evaluate the role of G-Protein Coupled Estrogen Receptor (GPER) and granulocytes (PMNs) in the rapid estrogen(E2)-induced immune response of the uterus, and how each variable affects the activity of the other. A pilot experiment was conducted to confirm knockdown of GPER and PMNs, and to determine the effect of knockdown of one variable on the prevalence of the other. 31 premature rats were ovariectomized and treated with either saline, "scramble" morpholino control, or GPER morpholino, and further treated with either saline, normal serum, or anti-PMN serum. Rats were E2-treated 4 hours before uterine harvest. 2 sections of tissue from each rat were evaluated through immunohistochemistry, imaged on the immunofluorescence microscope, and quantified for signal intensity using ImageJ. Signal intensity for PMN abundance demonstrated a 14.97% decrease from saline to normal serum, and a 49.12% decrease from the saline to anti-PMN serum, indicating PMN knockdown. Results also showed a 39.63% decrease in intensity from the double saline control to the saline-GPER group, suggesting GPER knockdown decreases PMN recruitment to the uterus. Quantification of GPER knockdown is pending. Further experiments will quantify knockdown on uterine matrix remodeling through transmission electron microscopy. Evaluating the role of these variables on uterine matrix remodeling will supplement the characterization of uterine responses to E2 for the betterment of women's health.

A-15: Examining the Role of Ly6A in Tumor Immunity
Author: Rathbun, Luke; Buzinkai, Noah
Advisor: Dr. Anil Bamezai

The objective of my experiments was to determine if Ly6A, expressed in T lymphocytes, is an immune checkpoint inhibitor. Immune checkpoint inhibitors are inhibitory T cell surface proteins that act as an "off switch" for the immune system and prevent hyper-activity of T cells and autoimmunity (response to self-tissues). In an immune response to a pathogen, this "off switch" is functional after the immune system has effectively eliminated the pathogen. However, when fighting cancer, the levels of immune checkpoint inhibitors on T cells become too high before the cancer is cleared, thereby promoting T cell exhaustion. Blocking the function of immune checkpoint inhibitors as a form of cancer immunotherapy has therefore become a popular treatment method in cancer patients. Antibody blockade of immune checkpoint inhibitors relieve T cells from exhaustion and reverse the inhibition. Examples of these antibodies include Pembrolizumab (PD-1 inhibitor) and Atezolizumab (CTLA-4 inhibitor). I set out to investigate the role of Ly6A in tumor immunity and its role as an immune checkpoint inhibitor. To compare the role of Ly6A with that of PD-1, I transplanted B16 melanoma tumors into mice lacking the gene for Ly6A and PD-1 to assess the survival of tumor-transplanted mice. I observed that both the Ly6A -/- mice and the PD-1-/- mice had delayed rejection of transplanted B16 melanoma tumors. With the absence of Ly6A resulting in

delayed tumor growth, this provides early evidence that Ly6A, like PD-1, may also behave as an immune checkpoint inhibitor. .

A-16: Genomics of Hearing Loss: Exome Sequencing as a Primary Approach to Diagnostics

Author: Lawrence, Audrey; Devkota, Batsal; Lou, Minjie; Krantz, Ian
Advisor: Dr. Ian Krantz (Children's Hospital of Philadelphia, Division of Human Genetics)

Hearing loss affects 466 million people worldwide, with 3 out of every 1,000 babies born in the United States diagnosed each year. Hearing loss is nonsyndromic in 70% of individuals. Most pediatric cases of hearing loss have genetic causes. Very early detection (< 6 months of age) in affected individuals and follow-up intervention significantly improves outcomes (academic, social, professional, etc.) compared to patients receiving later care. Sensorineural hearing loss results from failure in the inner ear (cochlea, auditory nerve, etc.) and is a highly heterogeneous condition. Nonsyndromic sensorineural hearing loss (SNHL) patients are currently offered a genetic test for diagnosis. The AUDIOME is a two-tier exome sequence analysis that involves the sequencing of all 20,000 genes that code for proteins, followed by panel analysis of 119 genes currently implicated in sensorineural hearing loss. Despite the thoroughness of this test, only about 50% of AUDIOME patients are currently genetically diagnosed. Research identifying variants in novel genes associated with sensorineural hearing loss to expand the AUDIOME panel will improve diagnostic yield. Here, exome data from individuals with a negative or uninformative AUDIOME gene panel testing were pulled for whole exome analysis. Using population gene databases in combination with variant analysis and scientific literature searches, potential additions to the AUDIOME were identified. Future studies will determine the utility of adding these new genes to the AUDIOME.

A-17: Identification of siRNAs Implicated in the Mechanism of Learning of Pathogen Avoidance

Author: Salerno, Nicholas
Advisor: Dr. Elaine Youngman

The objective of my research is to discover the specific mechanism by which small RNA molecules promote learning in the model roundworm, Caenorhabditis elegans (C. elegans). C. elegans encode for an abundance of small RNAs in their transcriptome, and therefore, are an ideal model organism for studying the functions of siRNA molecules. For associative learning to occur there must be an up regulation in serotonin and by using confocal microscopy we can determine if this up regulation is up or down stream of the action of the small RNA molecules. Secondly, a research group identified certain small RNA molecules that may be involved in associative learning of pathogen avoidance. However, they used different methods and their results conflict with data recorded in our lab. Therefore, I conducted choice assays to compare the effects of the different experimental conditions. These experiments allow us to understand what variables impact associative learning and the small RNA molecules involved. Currently, the protocols for the staining experiment are being adjusted to better observe signal. In the second assay, early experiments point to the strength of virulence of the bacteria, Pseudomonas aeuruginosa, and growth conditions

A-18: Influence of the dissatisfaction and fruitless genes on neuronal development and behavior in Drosophila

Author: Meeh, Kristen; Shirangi, Troy
Advisor: Dr. Troy Shirangi

The dissatisfaction (dsf) gene influences the innate courtship behaviors of Drosophila melanogaster. The neuronal and developmental mechanisms by which dsf influences courtship behavior is not understood. Here, we found five clusters of dsf-expressing neurons in the Drosophila brain that (1) are sexually dimorphic in cell number, and (2) co-express the Drosophila sex-differentiation gene, fruitless (fru). We discovered that the loss of dsf function affects cell number in most of these neuronal clusters, suggesting that dsf contributes to behavior by regulating neuron number. Interestingly, in some clusters, the change in cell number from the loss of dsf was sexually dimorphic, indicating that dsf activity is somehow integrated with the sexual differentiation pathway in flies. Analysis of dsf and fru double mutant flies revealed that dsf influences cell number in a dimorphic manner by genetically interacting with the fru gene. These results suggest that dsf may contribute to the neuronal pathways underlying courtship behavior by interacting with fru to specify proper neuronal cell number in specific regions of the fly brain.

A-19: Investigating the genetic interaction between the loss of the nonstop decay pathway and siRNAs in germ cells

Author: Brennan, Catherine
Advisor: Dr. Elaine Youngman

Throughout all the kingdoms of living things, cells utilize mechanisms to defend their genomes from harmful genetic elements such as transposons and viruses. Small noncoding RNA molecules are critical defense elements for these types of mechanisms in eukaryotes. It is already known that the germline works hard to protect DNA. In model organism Caenorhabditis elegans (C. elegans), specifically, small RNAs in the germline protect DNA. It has not been studied as closely, however, whether the same holds true for RNA. Nonstop decay is a type of mRNA quality control used to eliminate mRNAs that lack a stop codon in eukaryotes. Both the nonstop decay pathway and small RNAs are known to affect fertility and brood size. Previously, the Youngman lab has shown that one particular nonstop transcript in C. elegans is targeted by endogenous siRNAs that aid in destruction of the transcript, suggesting a link between the nonstop decay and endogenous siRNA pathways. In genetics, similarity in phenotypes when different genes are mutated can indicate that the genes are involved in a similar process. Based on the fact that mutations in these two pathways appear to have similar phenotypes (temperature-dependent sterility), I hypothesize that the nonstop decay pathway and small RNAs work in concordance to carry out mRNA surveillance, and that this process affects fertility. Through the summer, brood size counts were taken based on eggs laid and eggs that went to adulthood at three different temperatures for the ski;pelo double mutant of the Nonstop decay pathway and Mut 7, a small RNA mutation. The results were very similar to each other in phenotype and consistent with the hypothesis. I am currently working on creating different mutants to record their brood size and to determine if these mutants are consistent with the ones tested during the summer.

A-20: Is oil sands development in Alberta, Canada increasing priority pollutant deposition to the surrounding environment?

Author: Khozouri, Emily
Advisor: Dr. R. Kelman Wieder

Oil sands mining in northern Alberta, Canada is known to emit nitrogen and sulfur oxides to the atmosphere, which are delivered to the region's ecosystems as acid rain. Peat bogs cover 6-10 % of the land in the oil sands region. In these bogs, peat is a brown, soil-like material consisting partly of decomposed vegetable matter formed by the genus of moss known as Sphagnum. Peat accumulates vertically as Sphagnum mosses grow such that in a peat profile, the age of the peat increases with depth. Sphagnum-derived peat is known for its ability to scavenge and immobilize atmospherically deposited elements. By quantifying the age of peat at different depths, along with chemical element concentrations, patterns of historical element deposition can be reconstructed. I reconstructed historical deposition of elements from peat cores from McKay Bog (relatively close to oil sands mining sites) and McMurray Bog (farther away from oil sands mining sites). Peat from 210Pb-dated deep cores previously collected were microwave digested and analyzed for concentrations and of priority pollutants (Sb, As, Be, Cd, Cr, Ni, Se, Ag, Zn, Tl),base cations (K, Na, Ca, and Mg), and Fe, Al, and V using inductively coupled plasma emission spectrometry. Results indicated that since the onset of oil sands development in 1970, deposition of base cations(K, Na, Ca, and Mg) and of Ag, As, Cr, Fe, Al and V have increased at McKay Bog, but not at McMurray Bog, with no clear evidence of increasing deposition of Cu, Ni, Zn, and Cd at either site. Peat cores can be a valuable tool to quantitatively assess the extent to which oil sands mining has been directly contributing to elevated priority pollutant deposition in the oil sands region of northern Alberta.

B-21: Recovery Process in Adult C. elegans Following Acute Environmental Stress

Author: Jacob, Paul
Advisor: Dr. Matthew Youngman

Because it shares several evolutionary conserved pathways that aid its response to environmental stressors, the nematode Caenorhabditis elegans has become a notable model for studying aging, stress, and, more recently, recovery after challenge. Recent studies of recovery from bacterial infection in young (adolescent) C. elegans found most of the infected animals were able to recover and implicated a role for conserved transcription factors (TFs) in the recovery process. However, little is known about the process of recovery in adult C. elegans, including the possible genes and pathways involved. In this study, adult C. elegans were briefly exposed to bacteria to assess their ability to recover from infection. It was found that post-reproductive adult C. elegans ranging from six to eight days old can successfully recover from 24 hours of pathogenic exposure. Furthermore, preliminary results following RNAi treatment indicate that the following TFs are related to the recovery process: DAF-16, ELT-2, and ARID-1. The study demonstrates that the process of recovery from environmental stressors such as infection remain intact even in adult C. elegans. With regards to human application, the findings suggest possible gene/gene pathway candidates necessary for recovery from environmental stress in older adults.

B-22: Role of Ly-6A in vivo Regulation of T Cell Activation and clonal expansion using B16 Melanoma Tumor Transplantation Mouse

Author: Buzinkai, Noah; Rathbun, Luke
Advisor: Dr. Anil Bamezai

Cancer is notoriously difficult to treat as the cells comprising the disease are derived from the patient's own cells. Due to this, and a myriad of other suppressive factors, the patient's immune system cannot effectively target the cancer cells, resulting in radiation therapy becoming the primary method of treatment. However, a newer field of research and treatment, immunotherapy, relies precisely on using the patient's own immune system to fight cancer. There are a variety of ways this is achieved. One option that has shown promise in melanoma, is immune checkpoint blockade therapy. This method relies on inhibiting cancer cells innate ability to suppress the immune system by enhancing the activity of suppressive ligands like PD-1. By blocking the PD-1 ligand, the checkpoint inhibitor can no longer suppress lymphocytes and there is a heightened immune response against the cancer cells. Over the summer, I investigated a potential new checkpoint inhibitor, Ly6A. Specifically, we sought to illuminate the early time kinetics of lymphocyte response in mice with Ly6-A knocked out. I compared the data from the Ly6A-/- mice with experiments performed in tandem with PD-1 -/- mice. Based on the data we have thus far collected, there is a lesser total number of activated lymphocytes in the draining lymph node in early responses to melanoma in Ly6A -/- mice, but as tumor volume increases, the response is similar to PD-1 -/- mice. These experiments will be the basis to further investigate anti-tumor T cell responses in Ly6A-/-, PD-1-/- and wildtype mice.

B-23: Running Up Hill: The Effect of Surface Roughness and Incline on Locomotor Performance and Behavior of Temperate Ants

Author: Conte, Anthony
Advisor: Dr. Alyssa Stark

Climbing organisms need to stay attached, yet mobile in an environment that is constantly changing (Gorb, 2008). Many species of ant climb great distances while foraging, using soft footpads coated with an adhesive secretion (Endlein and Federle, 2015). Understanding ant locomotor performance and foraging behavior in various conditions, such as inclined substrates, is not trivial. Despite their climbing acumen, ant running speed slows on wet or rough substrates, and it is unknown exactly why. (Yanoviak et al. 2018). The reason for the reduction in speed is unknown, but may be related to adhesive performance. Ants are an important part of the world's ecosystems, making up around 20% of all terrestrial animal biomass (Schultz, 2000). Therefore, the way ants interact with their environment, and each other, likely dictates larger scale ecological factors such as species distribution and resource availability. In this work, the relationship between surface roughness and running speed as well as adhesive performance on common species of local ants was investigated. Since running speed depends on static adhesion, or how strongly an ant can cling to a substrate, adhesion was examined as well. Adhesion was tested by harnessing the ants with thread, and using a spring scale to measure the force required to remove them from both smooth and rough substrates. Running speed was measured on vertical and horizontal surfaces, for both smooth and rough substrates. Preliminary results show that ant running speed depends on substrate roughness,

orientation, and static adhesive performance. Future work will investigate the morphological structures responsible for the variation in locomotor and adhesive performance.

B-24: Song discrimination and male aggressive behavior within a songbird hybrid zone
Author: Day, Lily
Advisor: Dr. Robert Curry

Hybridization is of great importance in evolutionary biology: it has a wide range of implications, including possible determinants or benefits for the fitness of hybrid offspring, and the maintenance or reduction of biodiversity. Two closely-related songbirds, Black-capped (BCCH) and Carolina chickadees (CACH), hybridize along a northward-shifting zone that crosses Pennsylvania. Playback experiments can help us to understand the role of song in male-male interactions in territorial or mate-guarding displays within such a hybrid zone. I observed behavioral responses of male chickadees to BCCH and CACH songs through playback experiments, incorporating model chickadees to elicit a focused response from the subject males. I conducted 39 experiments at Hawk Mountain Sanctuary across 14 active nests, for an average of 2.79 experiments per subject male. I also determined song repertoires through recording males' dawn chorus songs, to ascertain whether a male sings differently "on his own" (as a function of his genotype) than he does when "challenged" with experimental stimuli. The Curry lab will gather genotype information using DNA extracted from blood samples from subject chickadees in order to characterize the males as black-capped, Carolina, or hybrid chickadees. Preliminary analysis of behavioral responses to song playback experiments show that males vary in their vocal response in terms of both quantity and type. Additionally, some subject males preferentially responded with aggressive gargle calls rather than song, and some males were more reactive than others in terms of spatial responses, such as swooping at or attacking the model. I am continuing to score recordings and video from the experiments; of scored experiments, males gave a total of 2,673 vocal responses, with 62.4% being BCCH song or a close BCCH variant, 1.7% being CACH song, 1.0% being hybrid song, and 34.9% gargle calls. Further analysis of behavioral responses with respect to genotype information and the male's own song repertoire will help resolve the extent to which, at least in terms of male-male interactions, birds in the hybrid-zone are "honestly" signaling about their own genetic identity through song, in ways that might affect the dynamics of hybridization.

B-25: The Effects of Climate Change on Future Interactions among Wood Warbler Species (Parulidae)
Author: Willis, Lloyd
Advisor: Jason Tallant (University of Michigan) and Dr. Jordan Price

A well-known aspect, and unfortunately consequence, of human development is its devastating damage and disruption to the surrounding environment. Although there are impacts that occur in the atmosphere, hydrosphere, and lithosphere, the influence of the changing environment on the biosphere, specifically on wildlife and biodiversity, to some is of the utmost significance. When species share similar climates and location, they may coexist in the same species range and within these ranges are opportunities for species interactions. These interactions can either be established, with species coexisting peacefully in their own ecological niches, or it can be disrupted by foreign

species entering the wildlife community. These disruptions in species interactions are becoming more common as climate change continues to impact ecological dynamics. If modern emission rates continue to persist, areas of species range overlap and thus future species interactions, are likely to be severely influenced as a result.

B-26: Using the InVEST model to determine the spatially-explicit coastal vulnerability of the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR)
Author: Yang, Philip; Verutes, Gregg; Dix, Nikki; Chapman, Samantha
Advisor: Dr. Samantha Chapman

The large proportion (40%) of the U.S. population that lives on the coast is threatened by rising sea levels and extreme storms, which are expected to become stronger and more frequent. Coastal habitats, like wetlands and reefs, have been shown to decrease the coastal vulnerability of people and property by 50% on a national scale. In northern Florida, the city of St. Augustine is perched within the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), which encompasses a network of mangroves, marshes, and other wetland habitats. It is essential to determine which portions of this coastal network of public and private land are most exposed to storm-induced erosion and inundation. Using the InVEST model developed by The Natural Capital Project (Stanford University / World Wildlife Fund), we are determining spatially-explicit coastal vulnerability using a numerical index (coastal vulnerability index - CVI). Vulnerability is determined after exposure results are overlaid with biophysical and social data. Data layers for high/low dunes, forests, oyster beds, reefs, and wetlands are collected and used as natural habitats. Coastal wave exposure data is obtained from global WaveWatch III data. County shoreline data layers give information on geomorphology. Local bathymetry data layers were applied. The other data layers are in the process of being acquired. After InVEST generates CVI values for the coast, ArcGIS can be used to display the information in a map-like form by sorting the CVI by color or size. Using these sorting methods, ArcGIS can also help us see how different factors (geomorphology, elevation, natural habitats, changing sea levels, and wave and wind exposure) affect each other and how they each affect coastal exposure. The resultant map will be provided to local scientists, policymakers, land managers, the public, and all stakeholders our team has formed relationships with through a larger NSF-funded project at the GTMNERR (www.wetfeetproject.com). This product can be used for spatially-explicit coastal development planning and prioritizing funds and efforts for coastal protection.

B-27: Achromatic plumage brightness in Carolina, black-capped, and hybrid chickadees
Author: Gammons, Caraline
Advisor: Dr. Robert Curry

Achromatic (black, white, gray) brightness can be a very important signal that especially affects inter and intra-species relationships in social animals. Black-capped (BCCH), Carolina (CACH), and Hybrid (HYCH) Chickadees are highly social songbirds whose achromatic patches of feathers can be measured by the UV light they absorb and reflect. Social birds often use these visual factors to determine their relationships with one another. When a signal is reflective of the state of an individual, it is called signal honesty. New interspecies relationships are beginning to emerge as the

Carolina Chickadee advances northward, converging with Black-capped Chickadee territory and creating an area of hybridization between the two species called the hybrid zone. I measured the visual (400-700nm) and UV (300-400nm) reflectance of 6 body regions on 69 adult Chickadees from four sites that are either predominantly Black-capped, hybrid, or Carolina territory to determine whether there is a significant interspecies variation between the two species, and if their hybrids exhibit intermediate and varied plumage brightness. Preliminary results suggest that there are significant differences in UV chroma among birds at the different sites, with birds from BCCH sites having more UV chroma than birds from CACH sites. The results from the HYCH sites were intermediate and varied, suggesting that hybrid index (how much Carolina and how much Black-capped a hybrid is genetically) correlates to plumage brightness. Birds of all three groups also exhibited sexual dimorphism in their plumage brightness, with males being brighter than females. These results suggest that UV reflectance is important in determining sex, species, and hybrid index of Chickadees.

B-28: Developing methods for understanding eQTLs

Author: Tsai, Kathryn; Amariuta, Tiffany; Luo, Yang; Raychaudhuri, Soumya
Adviser: Dr. Soumya Raychaudhuri (Brigham and Women's Hospital, Broad Institute, Harvard Medical School Biomedical Informatics)

In statistical genetics, an expression quantitative trait locus (eQTL) captures a significant association between a single-nucleotide polymorphism (SNP) and variation in expression levels of a gene locus. Many of these SNP-gene relationships offer potential understanding of disease heritability for development of therapeutic drug targets. However, as the size of eQTL datasets and power of eQTLs increase, many of these SNPs may be in linkage disequilibrium with each other and result in a false positive signal for causality. Using three datasets that detect eQTLs from genome-wide association studies (GWAS) and RNA-sequencing (RNA-seq) in humans, this study consists of three parts: (1) investigation of mechanistic hypotheses, (2) visualization of gene locus architecture and thus discovery of true casual eQTLs, and (3) identification of cell-type specificity of eQTLs. It compares local or cis-eQTLs, SNPs within approximately 1000 base pairs to the gene that they affect, and distant or trans-eQTLs, SNPs greater than 1000 base pairs from the gene with which they are associated. Furthermore, it investigates a new type of eQTL that has been made possible through advances in sequencing technology: single-cell eQTLs, cis-eQTLs that have been found in at least one cell type. Overall, this study is promising in the development of computational methods and pipelines that can provide insight into eQTLs, genetic differences between populations, and risks associated with complex diseases.

B-29: Disk tillage results in a greater carbon footprint than no tillage in a corn-soybean rotation system

Author: Spanier, Nicole; Schmer, Marty; Jin, Virginia
Advisor: Dr. Virginia Jin (University of Nebraska-Lincoln; Agronomy and Horticulture)

In agricultural systems, there are many tilling practices which release varying amounts of greenhouse gasses (GHG) and require a range of energy inputs. Therefore, sustainability between the different tillage systems can differ. To determine which tilling practice has the smallest carbon footprint, I utilized a Life-Cycle Assessment (LCA). LCAs identify the extent and the hotspots of GHG impacts

in agricultural systems. I investigated the differences in carbon footprint between no-till cropland and disk till cropland in a corn-soybean rotation system at a farm near Lincoln, Nebraska. Soil organic carbon (SOC) was also compared between the two tilling systems and two different depths were considered, as a net loss in SOC suggests the carbon is being released as GHG and could be a large emissions contributor to the LCA. Data that was taken every year from 1999-2011 was used in the analysis. In the LCA, I used measured soil GHG emissions, SOC changes, and crop yields in addition to standard measurements of emissions from production of seed, herbicide, pesticide, and other factors across the tilling types. When comparing SOC changes, I found no difference between the tilling types and the 0-30 cm and 0-150 cm depths, indicating this was not a main contributor to the difference in carbon footprints. When the overall carbon footprints of the no-till system and the disk till system were compared using the LCA, the disk till had a larger carbon footprint. The difference was mainly due to the differences in soil GHG emissions. Therefore, the results suggest that eliminating tillage would lead to a more sustainable farm system and likely decrease monetary farm inputs.

B-30: Impact of FilmArray Blood Culture Identification Panel on Management of Patients with Contaminated Blood Cultures in a Pediatric Emergency Department

Author: Bui, Lilian
Adviser: Dr. Craig Shapiro, Dr. Shannon Chan, Dr. Karen Ravin (Nemours/Alfred I. duPont Hospital for Children, Division of Infectious Diseases)

Contaminated blood cultures result in unnecessary repeat lab draws, antibiotic administration, and hospital admission. Prior to rapid diagnostic testing, organism identification occurred about 48 hours after the detection of microbial growth. In August 2014, the Nemours/Alfred I. duPont Hospital for Children (N/AIDHC) clinical microbiology laboratory implemented the BioFire Diagnostics FilmArray Blood Culture Identification (BCID) Panel which tests for 24 bacteria and yeast and three antibiotic resistance genes with results within two hours. Given the decreased time to organism identification, our study evaluates whether the implementation of the BCID correlates to a reduction in the frequency of patients with contaminated blood cultures returning to the ED, antibiotic administration, hospital admission, and length of stay. A retrospective cohort study was conducted on patients who had contaminated blood cultures drawn in the ED pre- (2010-2013) and post-implementation (2015-2018) of the BCID panel. 63 patients in the pre-implementation period were compared with 52 patients in the post-implementation period. The frequency of patients returning to the ED, antibiotic administration, and hospital admission decreased but only antibiotic administration was statistically significant. The results may be due to lack of provider confidence in the BCID results despite its high specificity and sensitivity. The study suggests there is potential to further reduce unnecessary interventions for patients with contaminated blood cultures.

B-31: The X-MAID R171W Moesin Mutant Affects Intramolecular Interactions and Perturbs Nuclear Structure

Author: Deshler, Bailee; Avery, Lyndsay; Burkhardt, Janis
Adviser: Dr. Janis Burkhardt (Children's Hospital of Philadelphia Pathology and Laboratory Medicine)

"X-MAID (X-linked moesin associated immunodeficiency) is a genetic mutation causing severe-combined immunodeficiency (SCID). It results in lymphopenia and high susceptibility to infections in patients. X-MAID is specifically caused by an R171W mutation in the FERM domain of the moesin protein. Moesin is a member of the ERM family of proteins. All cells express some levels of each member, yet moesin is the predominant protein in the immune system. When moesin is active, the FERM domain is attached to the cellular membrane and the ABD domain is phosphorylated and attached to actin. The two domains can bind together and produce the inactive conformation. The R171W mutation occurs at a predicted binding site. We hypothesize that the R171W mutation decreases the binding affinity between the domains. This would push moesin towards the active conformation, increase it's phosphorylation, and alter the cell's morphology. Protein binding assays were used to determine the decreased efficiency of the R171W-FERM binding to ABD compared to the WT-FERM. Phosphorylation levels of moesin were determined using western blot. Current data does not show pMoesin differences. Stable and overexpressing moesin tagged GFP were visualized in HeLa and Jurkat cell lines using confocal microscopy. The R171W mutation does not appear to affect the morphology of the HeLa cells. However, the Jurkat cells had deformed nuclear membranes and higher DNA concentrations."

Chemical Engineering

B-32: Computational Screening for Developing Optimal Intermetallic Transition Metal Pt-Based ORR Catalysts at the Predictive Volcano Peak
Author: Waldt, Conor; Rankin, Rees
Advisor: Dr. Rees Rankin

Practical development of cost-effective and environmentally sustainable oxygen reduction reaction (ORR) catalysts has not yet been fully realized despite years of effort. Specifically, state-of-the-art ORR catalysts typically require high Pt-loading while still suffering significant overpotential losses and only providing moderate current density. In this work, we present results from new DFT calculations screening a wide range of Pt3(MN)1 ternary catalysts to see the range of values for oxygen adsorption energy (the known ORR volcano plot descriptor) such systems can achieve. Our results identify many promising materials based purely on performance via this descriptor; unfortunately, many of these promising candidates still require a very high loading of rare precious transition metals in the guest (MN) composition role. We have further used our results to generate a predictive fitted model for the ORR descriptor value itself based on the normalized valence and mass of a given fcc(111) Pt3(MN)1 surface compared to Pt(111). This predictive model is presented to help illustrate and guide the selection of further candidate systems in the continued search for the rational design of cost-effective, high-performance Pt-based ORR catalysts.

B-33: Improving Gene Therapy via Development of Capture of Adenosine Methylated Plasmid (CAMP)
Author: McKean, Jessica
Advisor: Dr. Jacob Elmer

Efficient delivery and expression of synthetic DNA has the potential to improve treatments for a variety of genetic disorders. Unfortunately, successful DNA delivery and expression is currently hindered by the host cell's innate immune systems. These systems appear to respond to the synthetic DNA as they would to the foreign DNA of a pathogenic virus. The goal of this research is to elucidate the host cell's response to synthetic plasmid DNA (pDNA) to work towards a long term goal of manipulating this response to increase transgene expression. This goal is approached through the development of a new technology (CAMP) that will enable researchers to identify proteins that are bound to plasmid DNA. Specifically, CAMP utilizes the unique methylation mark found at GATC motifs on bacterial pDNA to separate and recover pDNA after it has been transfected. Recovery of transfected pDNA enables its physical analysis with the possibility of discovering previously unknown plasmid binding inhibitory proteins.

B-34: Inhibition of cGAS/IFI16 DNA Sensing Pathways to Improve Gene Therapy
Author: Hong, Min Ji
Advisor: Dr. Jacob Elmer

Gene therapy is a powerful tool with great potential to treat or prevent major diseases by replacing mutated genes or adding better ones. However, genes must be delivered using a vector, often viral, rather than direct insertion into the cell. When foreign bacterial or viral DNA enters the cell, defense mechanisms that lead to apoptosis or inhibition of translation are often activated, preventing the gene from being expressed. This innate immune response, while necessary as a protective measure against infectious organisms, is currently a significant hindrance for many gene therapy treatments. The goal of this project is to enhance transgene expression by inhibiting various targets in the cGAS/IFI16 DNA Sensing Pathway, including OAS2, cGAS, STING, and RNaseL. 4 cell lines will be used: HEK, PC3, MCF7, and Jurkat. Planned methodology is two-fold: the first experiment will inhibit OAS2 via CRISPR-Cas9 knockout, and the second experiment will expose cells to treatments of known inhibitors of cGAS, STING, and RNaseL (RU.521, H-151, and Fe2+/Cu2+/curcumin, respectively). Effects of inhibition will be tested for both experiments by transfecting the cells with a bacterial plasmid containing a GFP reporter gene and calculating the transfection efficiency for each inhibition method. Comparisons to the unaltered parental cell lines will be made to draw conclusions regarding any changes in transfection efficiency.

B-35: Dispersed calcium oxides and lithium orthosilicates CO2 sorbents
Author: Mendez, Joseph; Rajan,Melwin
Advisor: Dr. Michael Smith, Dr. Charles Coe, Mr. Anthony Vallace

Using carbon dioxide absorbing materials in petrochemical reforming processes would cut energy consumption and greenhouse gas emissions. Processes which would benefit from CO2 sorbent enhancement include thermodynamically limited reactions such as the water gas shift reaction and steam methane reforming process. A mesoporous lithium orthosilicate (LOS) is being studied in order to increase production of hydrogen gas in a water gas shift reaction. The production of hydrogen gas is important because it is a clean fuel that could power vehicles and stationary power plants. Moreover, LOS is an effective high temperature reversible CO2 sorbent. However, when bulk LOS – a low surface area material – absorbs CO2 gas, a shell of lithium carbonate and lithium metasilicate is formed. This resulting layer slows the adsorption and reaction of CO2 with the

remaining core of the LOS particle. In order to make the LOS most effective, the goal is to shrink the sorption domain sizes to improve the rate and amount of CO2 sorbed. The different LOS samples studied were synthesized in different environments and were characterized with a suite of characterization tools (XRD, N2 adsorption, and TGA). Within the different synthetic methods made this summer, the study resulted in a reversible LOS sample having 20 wt% CO2 uptake at 600°C with high sorption kinetics, higher surface area than previous LOS samples, and a stable working capacity over 20 cycles without degradation.

Building off previous findings that dispersed calcium oxides perform more efficiently than bulk phase calcium oxide, various oxide supports were used to determine the compositional and textural characteristics' (surface area and pore volume) effect on sorption capacity and efficiency of the CaO. Atomic layer deposition (ALD) was found to reduce the domain size for CaO based adsorbents resulting in enhanced efficiency for high temperature CO2 sorption. Magnesium aluminate (MgAl2O4) spinal support demonstrated the quickest adsorption kinetics and CO2 capacity of the sorbents tested, surpassing 17 wt.% CO2 uptake at 600°C.

Both these sorbents surpass the current commercial adsorbent being developed which has only 6 wt% CO2 working capacity. The supported CaO has 6 wt.% capacity at temperatures as low as 400 °C allowing for lower temperature sorption enhanced reforming process (SERP) cutting energy consumption and cost. A hybrid approach based on these results may further improve these high temperature sorbents.

B-36: Elucidation and Inhibition of the Host Cell's Intracellular Defense Mechanisms Against the Plasmid DNA Used in Gene Therapy

Author: Bragen, Samantha; Hong, Angela; Harris, Emily; Elmer, Jacob
Advisor: Dr. Jacob Elmer

Viral vectors are currently used to create CAR T-cells that effectively treat leukemia, but the efficiency of viruses is highly variable. Electroporation is an alternate method that produces high transfection rates, but it kills a significant amount of cells in the process. Cationic lipid transfection, has also been shown to successfully deliver genes to T-cells, but expression of the genes appears to be inhibited by some host cell defense mechanism. This study seeks to first identify genes that may be repressing gene expression by comparing the gene expression patterns of electroporated and Lipofected cells. Any genes that are found to be highly expressed in Lipofected cells (but not in the electroporated cells) will then be eliminated from the cell's genome. The resulting "knock out" cells will then be transfected via Lipofectamine to determine if removal of the target gene leads to an increase in gene expression. In the event that no differentially expressed genes are identified, we will instead target the OAS2 and IFI16 genes, which have been previously shown to be upregulated following transfection with Lipofectamine. We believe that these genes may be inhibiting transgene expression, since IFI16 is involved in cell regulation processes including apoptosis, and has been shown to recognize pathogenic DNA in cell nuclei and cytoplasm. OAS2 is known to play a critical role in cellular antiviral responses, as it inhibits protein synthesis (and thus viral replication) once it is activated by the presence of foreign genetic material in the cell. It is hypothesized that there is definitely a variation in the genome of the two Jurkat cells transfected with each method, caused by the electric current in electroporation, and the engineered cells missing the target gene inhibiting

transfection will achieve a much higher expression rate upon cationic lipid gene delivery than the Jurkat cells that did not have a gene removed from their genome.

Chemistry

B-37: A Family of Chelating Ligands Containing N-Heterocyclic Carbenes
Author: Cheng, David; Fish, Zoe; Ngo, Dalyna; Casillas, Eduard; Zubris, Deanna
Advisor: Dr. Deanna Zubris

The overall purpose of our project was to use multi-step synthesis to create novel ligand derivatives (ring-expanded N-heterocyclic carbenes) as Lewis bases. In future work, these Lewis basic ligands will be combined with Lewis acidic iron sources to form new catalysts for atom transfer radical polymerization (ATRP). Different substituents were chosen for our ligand to fine-tune sterics and electronics, including methyl, methoxy, t-butyl, and fluoro. For these four ligand options, all synthetic precursors to the final ligands were successfully prepared. One cyclization attempt suggests the desired product was formed, though further purification is needed. Future goals involve cyclization attempts for all four ligand options, metalation to form a family of iron catalysts, and testing in ATRP to create polymers for use as biological adhesives.

B-38: Characterization of a Putative Cyclooxygenase from Cyanothece (sp)
Author: Ardith, Held
Advisor: Dr. Barry Selinsky

A putative cyclooxygenase protein involved in the conversion of arachidonic acid to prostaglandin H2 has been identified in the cyanobacterium Cyanothece. The gene encoding the Cyanothece protein was cloned in LIC vectors and expressed in BL21* cells. Successful cloning of the Cyanothece gene was confirmed using restriction analysis; gel electrophoresis showing the presence of DNA fragments of the expected lengths of the digested plasmid confirmed successful cloning. Although the protein was able to be expressed, it was insoluble and not able to be solubilized through a variety of solubilization techniques. The gene encoding the Cyanothece protein was then mutated based on sequence analysis, and the mutated protein was expressed in BL21 cells. A silent mutation which added one new restriction site was designed in each PCR primer for mutation in addition to the mutations of interest. Successful mutation could then be confirmed via restriction analysis by digesting the mutation products with the chosen restriction enzymes. The mutated protein was expressed in BL21 cells; however, like the wild type protein, it was insoluble. Further experiments should be conducted to solubilize the wild type protein and the mutated protein to determine changes in functionality of the mutated protein.

B-39: Co-Solvent Preferences in Lithium-Ion Electrolytes
Author: Afable, Jessica; Jorn, Ryan
Advisor: Dr. Ryan Jorn

Ethylene carbonate (EC) and propylene carbonate (PC) are common lithium electrolyte solvents, which are used for energy storage in lithium batteries. This research focuses on exploring the origin

of the different behaviors of these two organic compounds during battery operation. We have developed a model for their behavior by analyzing computational data acquired from simulations and compared with results from experiments. This research specifically aimed to confirm or deny the preference for one solvent over the other by dissolved lithium ions. The amount of solvent found in the lithium ion solvation shell with respect to the solvent amount found in the bulk electrolyte was considered in several contexts: bulk electrolyte, graphite surfaces, and the air interface. In a past experiment, a significant preference for EC over PC was indicated, but this data is not consistent with any other research to date. However, given that this unique data was acquired from mass spectrometry, a similarly unique experimental method, the effect on solvent preference of an air interface as opposed to a liquid ion interface was also investigated.

B-40: Discovery of Novel Small Molecule Factor D Inhibitors
Author: Abo, Kyle; Ung, Victoria; Kraut, Daniel
Advisor: Dr. Konstantinos Agrios

Factor D, a serine protease, plays a vital role in the regulation of the alternative pathway and the complement system overall. Dysregulation of the complement system has been linked to many rare diseases such as adult macular degeneration (AMD) and paroxysmal nocturnal hemoglobinuria (PNH). Factor D inhibition by small molecules has been considered to be a viable approach in order to develop novel therapeutics for these rare diseases. A small library of novel small molecules was synthesized based on a lead compound. The synthesis, biochemical evaluation and structure activity relationships (SAR) of these molecules will be discussed in this presentation.

C-41: Dissolved Organic Matter Signatures in High Arctic Snow
Author: Tiu, Romeo
Advisor: Dr. Amanda Grannas & Dr. Vanessa Boschi

Anthropogenic influences impact all corners of the globe including the Arctic. Dissolved organic matter (DOM) in snow samples, including condensed aromatic compounds from the combustion of fossil fuels, could provide a unique metric as to the type of material being transported and deposited in these regions. In this experiment, the DOM in snow samples collected over the course of 9 months from Alert, Canada were analyzed and characterized. These samples were analyzed using high resolution Fourier-transform ion cyclotron resonance mass spectrometry to determine 1) the chemical nature of DOM present in the snow and 2) how the composition of this pool of organic material changes throughout the year. Overall, we observe that lignin-like molecules (a compound associated with the cell wall of vascular plants) and lipid-like molecules are the most abundant in Alert snow samples. Additionally, compounds with the general molecular formula CHO are most abundant relative to formulas with greater amounts of heteroatoms (N, S and P). Through comparing the meteorological conditions to the DOM contents of the snow, there appears to be a strong, indirect correlation between the temperature and the abundance of aliphatic, lipid-like molecules and a direct correlation to the abundance of protein-like compounds. This may indicate the influence of biological activity on the DOM pool with warmer temperatures favoring a lower lipid production and a greater protein synthesis. Although the condensed aromatic pool did not correlate with temperature, it was particularly abundant in samples collected during October, possibly due to the increased frequency of forest fires during the summer months.

C-42: Evaluating Sulforaphane's Cryoprotectant Capabilities for CAR-T Engineering
Author: Pensabene, Kaitlin
Advisor: Dr. Aimee Eggler

Chimeric Antigen Receptor T-cell therapy, or CAR-T therapy for short, is a newly emerging immunotherapy that has been successful in treating B-cell cancers. One major concern in the process of CAR-T therapy is cryopreservation – or the practice of using very low temperatures to preserve living cells. Cryopreservation induces high levels of oxidative stress and reactive oxygen species, or ROS, which can be damaging to T-cells. This research examines how cell viability post-thaw can be improved by a small molecule called sulforaphane (SFN). SFN is derived from cruciferous vegetables and activates the Nrf2 transcription factor, a master regulator of antioxidant and cryoprotective genes. Nrf2 upregulates antioxidant gene expression by binding to the antioxidant response element (ARE), a regulatory gene whose activation can be quantitatively assessed with an ARE reporter assay. Using methods such as growth curves, ARE assays, and western blotting, sulforaphane's cryoprotectant capabilities were assessed in Jurkat cells – an immortalized line of leukemic T-cells. The results of these experiments show that Jurkat cells are highly resilient to damage caused by cryopreservation. According to the growth curves performed, there was no indication that the control group Jurkats experienced apoptosis in the three-day period post-thawing, and thus, the cryoprotectant effect of SFN could not be assessed. Additionally, the ARE reporter assays showed successful transfection of Jurkat cells - a cell line that is notoriously difficult to successfully transfect. Following treatment with SFN and/or dtBHQ, a hydroquinone with antioxidant abilities, the Nrf2/ARE pathway in Jurkat cells was activated. Going forward, primary T-cells will be studied in place of Jurkats to assess if healthy T-cells are more susceptible to cryopreservation-induced cell stress and apoptosis and can be used as a model cell line for cryoprotection experiments.

C-43: Functions of Rpt1 Subunits in the 26S Proteasome
Author: Ellis, Emily
Advisor: Dr. Daniel Kraut

The 26S proteasome is a protein complex in eukaryotic cells that plays a vital role in degrading unneeded or unwanted proteins. The most important components of the proteasome are two 19S regulatory caps and a 20S core particle1. The base of the regulatory cap is composed of a ring of 6 Rpt subunits, which are ATP dependent motor proteins that grab onto the substrate protein and pull it down towards the core particle. Each Rpt subunit contains a loop of amino acids with a central tyrosine residue. The Rpt subunits are non-identical, and mutating various Rpt subunits has been shown to have diverse effects on degradation. New findings have suggested a spiral-staircase mechanism to explain how substrate is translocated by the pore loops into the core particle. This research now aims to determine the effects of mutating three Rpt subunits in a row versus mutating every other Rpt subunit. By creating mutations in multiple Rpt subunits of a single proteasome, further insight can be gained regarding the link between the Rpt subunits and protein degradation efficiency and processivity.

C-44: Further Investigation into Rigidity-Activity Relationships in BisQAC Amphiphilic Antiseptics

Author: Leitgeb, Austin; Sanchez, Hugo
Advisor: Dr. Robert Carden, Dr. Kevin Minbiole

Quaternary ammonium compounds (QACs) are a widely utilized chemical compound found in antiseptics. Previous research has shown that there is a strong relationship between the restriction of free rotation around the carbon-carbon bond centrally located among the diamine core and the QAC's antimicrobial activity. Based on these previous findings from our group, we sought to examine the effect of linker geometry for pyridinium-based QACs. To this end, we prepared a series of 36 bisQACs with either alkane, alkene, or alkyne linkers and varied long, non-polar carbon chains in order to create amphiphilic compounds. The bisQAC compounds were tested against a panel of six different strains of bacteria, including MRSA. Surprisingly, QACs with less rigid alkane and alkene linkers showed higher antimicrobial activity compared to QACs with more rigid alkyne linkers. Compounds with carbon chain-lengths between 11-13 revealed greater antiseptic activity over their longer non-polar carbon chain counterparts. One of the compounds produced, DPE-11,11 produced significant bioactivity, suggesting that chain length is more important than core rigidity as this was not the most geometrically restricted type of compound. Changes from bromide to tosylate counter ions showed no appreciable advantage in antimicrobial activity, while, amide side-chains showed slightly higher activity compared to alkyl side-chains.

C-45: Ion Association and Electrolyte Structure in Lithium-Ion Batteries

Author: Duborg, William
Advisor: Dr. Ryan Jorn

The association of lithium salts impacts their transport and chemistry in energy storage devices. In this work we focus on the role of salt association in changing electrolyte structure in lithium-ion batteries. During battery operation surface films are formed which alter the environment seen by lithium ions, however are these effects impacted by the degree of cation-anion association? To address this question, an electrolyte comprised of ethylene carbonate (EC) solvent and dissolved LiPF6 salt was simulated at surfaces commonly found in rechargeable batteries during operation (LiF, Li2CO3, and Li2EDC). Previous work on similar systems has shown that both the interface and the salt association change the solvation structure of Lithium ions in the electrolyte. The goal of this research is to better understand the interplay between these effects by using charge scaling to vary the strength of salt association. This investigation includes looking at the densities, coordination numbers, orientations, and other aspects of the lithium ions, EC, and LiPF6 in our simulations to better understand how charge scaling affects the solvation structure of the lithium ions.

C-46: Mechanochemical Coupling of ATP Hydrolysis and Substrate Unfolding by the 26S Proteasome

Author: Bragança, Christopher
Advisor: Dr. Daniel Kraut

The Ubiquitin Proteasome System (UPS) is the canonical pathway for protein degradation in eukaryotic cells. Proteins targeted for degradation are first tagged with a polyubiquitin chain through a series of enzyme-catalyzed reactions before degradation. After polyubiquitination, the 26S proteasome hydrolyzes ATP to processively unfold substrates before they are degraded in the 20S core particle. In this project, we manipulated the ATP concentration to examine the mechanochemical coupling of ATP hydrolysis and substrate degradation. To manipulate the ATP concentration in vitro, we gradually substituted ATP for ATP-γ-S, a non-hydrolyzable analog of ATP, until the proteasome was exclusively exposed to ATP-γ-S. Our substrates contain green fluorescent protein, making it possible to detect fluorescence, and either an Neh2Dual region as a site for ubiquitination, or ubiquitin-like domains (UbL) for substrate recognition. With every substrate tested we saw a sharp decline in initial degradation rate with the replacement of only 25% ATP. Malachite Green assays and ATPase assays showed that ATP-γ-S severely inhibits ATPase rates of the proteasome. These results suggest that ATP-γ-S binds in the proteasome's ATPase motor and clogs it, explaining why initial degradation rates sharply decrease with the removal of only 25% ATP.

C-47: Screening of Polymeric Gels As A Means Of Controlling Local Skin Delivery

Author: Blanchard, Simon
Advisor: Dr. Hugh D.C. Smyth (University of Texas at Austin, Pharmacy)

"Skin Cancer is the most common cancer. While most forms of skin cancer have high survival rates if they are caught early, some can metastasize and are very difficult to treat once this happens. Inhibition of Matrix Metallopeptidases (MMPs), can be effective in preventing growth and metastasis of existing tumors. For this reason, they may be especially useful in the treatment of skin cancers as they may prevent metastasis. Systemic delivery of MMPIs can cause unwanted side effects, so localized delivery is preferable. By incorporating MMP inhibitors into polymer gels, the drug can be administered topically and its distribution within the skin and into the systemic circulation may be controlled.
Polymers were formulated to contain a model MMP inhibitor and applied to human skin samples using a high throughput skin permeation screening method. After the permeation study was run, samples were removed and the concentration of the drug that crossed the skin was quantified using High Performance Liquid Chromatography
HPLC analysis showed that all of the tested formulations permeated across or were retained in the skin at varying degrees. Further, some differences between the polymers, as well as between the same polymers with altered concentrations of cross-linking agents, were statistically significant.
Polymeric gels are shown to be a viable method of delivering MMP inhibitors topically. Due the permeation enhancing effects of different polymers and the effects of various concentrations of cross-linking agents, Formulations could be customized to penetrate the entire tumor, without entering the bloodstream and causing systemic effects. "

C-48: Synthesis of Antibacterial Pyranopyran Analogs

Author: Chen, Thomas; Greene, John; Roireau, Jack; Giuliano , Robert
Advisor: Dr. Robert Giuliano

(+)-Diplopyrone is a natural phytotoxin isolated from the fungus Diplodia mutila and is considered the main cause for cork oak decline in parts of Southern Europe, where the disease has significant negative economic and environmental impacts. The goal of this research was to synthesize carbohydrate-based analogs of the putative structure of (-)-diplopyrone—specifically the methoxy, amide, and sulfonamide analogs, in which their herbicidal and antibacterial activity could be tested against common bacterial pathogens in catfish. Additionally, the sulfonamide analog could potentially be further tested for its use in medicine due to sulfonamides playing an important role in chemotherapy along with being investigated for their anticancer properties. Studies of Ferrier glycosylation reactions prompted us to test whether an N-glycosidic linkage at the α-anomer could ultimately afford the sulfonamide analog. Results showed that not only was the N-glycoside synthesized successfully, but yields were high. In subsequent steps, an intermediate underwent Wittig olefination to afford the Z-alkene 12 (Scheme 2). The last ring-closing step, however, has yet to be completed. The amide analog was successfully synthesized from the nitrile analog by utilizing a copper catalyst, which was then sent to the USDA who confirmed antibacterial activity. The methoxy analog synthesis is similar to the synthesis of the nitrile, with the primary difference being the Ferrier rearrangement which used methanol promoted addition at the anomeric carbon. Selective desilylation and oxidation were successfully achieved, however, Wittig olefination produced side products and will be attempted again in the future.

C-49: Synthesis of bis-NHC ligands and their corresponding iron (II) complexes for use in polymerization of petroleum derived monomers

Author: Garcia ,Nicole; O'Donnell, Katelynn
Advisor: Dr. Deanna Zubris

Synthetic polymers like plastic have benefited society substantially but many are produced from monomers that are derived from petroleum. These monomers require a lot of energy to polymerize industrially and substantial carbon dioxide is released in the current process. We are interested in a class of monomers known as LAMs, or less active monomers, that have important potential application as biological adhesives yet are challenging and energy-intensive to polymerize with current methods. Our interpretation of the chemical reaction mechanism for LAM polymerization suggests that earth-abundant iron catalysts with organic ligands containing strongly electron-donating N-heterocyclic carbenes (NHCs) are ideal to reduce the energy needed for polymerization and to make plastic production more sustainable. The synthesis and characterization of various organic NHC ligands and their respective iron catalysts are described here. In future work, we will conduct LAM N-vinyl pyrrolidine polymerization trials using iron catalysts we have prepared and attempt to harness the power of photocatalysis to make LAM polymers more sustainably.

C-50: Synthesizing and Characterization of α-H3[PW12O40] and other Polyoxometalates (POMs)

Author: Sokoloski, David; Paul, Jared
Advisor: Dr. Jared Paul

During the summer, I set out to synthesize several polyoxometalates specifically α-Dodecatunstophosphoric Acid: α-H3[PW12O40] or more commonly known as PW12. The PW12 POM was characterized using Infrared Spectroscopy in order to confirm its identity as well as UV-Vis. The white, loosely structured PW12 was synthesized in yields as high as 72% and was then used as the starting material for two other POMs: K7PW11O39 • 14 H2O (PW11) and K6[PNiWO40H2] • 16 H2O (nickel POM). The white, powdery PW11 was also confirmed with Infrared Spectroscopy but was only synthesized in yields up to 27%. The nickel POM synthesis yielded a light, green powdery substance but future work needs to be done in order to successfully confirm the synthesis.

C-51: The Effect of Mono-Ubiquitination on The Unfolding Ability of The Proteasome
Author: Manfredonia, Abramo; Jordan, Ximena; Kraut, Daniel
Advisor: Dr. Daniel A. Kraut

The Proteasome is a protein complex involved in the degradation of misfolded and regulatory proteins. Ubiquitin tags direct proteins to the proteasome for degradation. The enzymes that attach these tags to substrates are able to build chains of ubiquitin with different architectures and branching patterns. Previous studies indicated differences between Keap1 and Rsp5 ligases in ubiquitin tag branching patterns and how these patterns influence the unfolding ability of the proteasome. In this project we created substrates with either mono-ubiquitination or K48 linked ubiquitin chains, and examined the effect on the unfolding ability of the proteasome using the ARIH1/UbcH7 complex with CDC34. ARIH1 is an E3 ligase that functions with UbcH7 to attach ubiquitin to target proteins through a RING/HECT hybrid mechanism. The ARIH1/UbcH7 complex can only function when activated with Cul3/Rbx1-Nedd8, allowing for mono-ubiquitination of the target substrate at multiple lysine sites. These mono-ubiquitin tags are then extended by the E2 enzyme CDC34 to construct longer K48 linked, ubiquitin chains. No noticeable difference was observed in the unfolding ability of the proteasome due to the different ubiquitin branching pattern, although inefficient ubiquitination made analysis difficult. Combining neddylation and ubiquitination in a single system gave increased substrate ubiquitination. Further testing will be done to verify this conclusion and reoptimize the reaction.

C-52: The Effect of Nitrogen Source on Lipid Production and Composition in Nannochloris eucaryotum Marine Algae
Author: Legaard, Emily; Bard, Sydney; Eigenbrodt, Dr. Bryan
Advisor: Dr. Bryan Eigenbrodt

The widespread use of fossil fuels in the modern world has caused, among many other harmful events, a concentration of CO2 in the atmosphere that is higher than ever recorded. A shift towards investigating renewable sources of energy has been occurring recently, and the Eigenbrodt Research Group is primarily interested in methods of creating biodiesel. Biodiesel has traditionally been derived from oils in food crops, but algae is a far more appealing source because of its relatively high yield of oil and the fact that it is not a food source for humans. In this study, Nannochloris eucaryotum, a common marine algae, was deprived of nitrogen, a nutrient essential for protein synthesis, causing the algal cells to produce and store large amounts of lipids. A limited amount of nitrogen was provided to the algae in one of two forms: nitrate (NO3-) or urea (H2NCONH2).

Nitrate and urea are of interest because wastewater is rich in both, potentially providing many ready locations where algae can be harvested for conversion into biofuel. Lipid production and storage in the two different colonies of algal cells was monitored over the growth cycle with both fluorescence spectroscopy and gas chromatography-mass spectrometry to visualize and quantify the lipids produced as a function of day of growth. Algae with access to urea and nitrate were found to behave relatively similarly. Future studies will include ammonium (NH_4^+) as the nitrogen source and total deprivation of nitrogen.

C-53: The Effects of Organic Matter Amendments on Tomato and Chamomile Productivity and Soil Nutrient Content

Author: Uriona, Eliana
Advisor: Dr. Vanessa Boschi

With changes in climate threatening crop yields, research that focuses on optimizing agricultural practices are vital. Biochar, chicken manure, dried molasses, and dried alfalfa were used to see how different organic matter amendments affect the nutrient content of soil and plant yields in a garden. While one raised bed was left untreated as the control, four different beds were treated individually with one organic amendment. In each bed, 5 tomato seedlings and 5 chamomile plants were planted. Both plants are commonly grown as a food staple and medicinal herb, respectively, in various parts of the world. Each week the plants were measured for overall plant growth including height, stem width, produce production and/or flower yield and diameter. In order to determine how the amendments affected soil nutrient loads, every two weeks soil samples were collected to determine changes in soil cation exchange capacity, nitrogen and phosphorus concentrations, and pH levels. Overall, the tomato plants grown in the alfalfa amended soils demonstrated the fastest growth rate in terms of plant height and produced the greatest amount of tomatoes, proceeded by tomatoes in the chicken manure amended soils, yielding 21.6 and 20.0 kg of tomatoes, respectively. The soils amended with molasses produced the least amount of tomatoes and produced the lowest overall tomato plant mass, even lower than the control. It appeared that CEC best correlated with total tomato mass yields relative to nitrogen, phosphorus and pH levels. However, only readily exchangeable nitrogen was assessed in this study which would not account for organically associated nitrogen in alfalfa that could be accessible to plants via microbial activity. The chamomile plants demonstrated poor performance overall with only two plants producing buds in both the control and dried molasses beds. An environmental cost/benefit analysis was also performed.

C-54: The Introduction of Hydrocarbon Fuels with catalytically incoporated $Sr_2Fe_{1.5}Mo_{0.5}O_{6-\delta}$

Author: Bradley, Marissa
Advisor: Dr. Bryan Eigenbrodt

In the world today fossil fuels including coal, oil, and natural gas, make up 85% of the world's energy. These fuel sources are used inefficiently in combustion systems and are non-renewable resources. One alternative energy source, that can potentially replace the current systems, is the solid oxide fuel cell (SOFC). The current commercially available SOFC anode is comprised of nickel mixed with yttria stabilized zirconium, or Ni/YSZ. Previously, this lab has synthesized and purified a new anode, $Sr_2Fe_{1.5}Mo_{0.5}O_{6-\delta}$(SFMO), which has outperformed the commercial cell in various

electrochemical tests. To improve the fuel catalytic properties of the SFMO material, the laboratory has begun to incorporate nickel into the crystal structure of SFMO, making Sr2(NixFe1.5-x)Mo0.5O6-δ (SFNMO). This summer's research included incorporating these new anode materials into SOFC device and exploring their potential to operate in a methane fuel environment. Standard electrochemical methods (voltammetry and impedance spectroscopy) were used to explore the performance of these systems. These studies explored how the incorporation of nickel will affect the anodes ability to catalytically utilize a direct feed of methane fuel. In addition, "reforming" of the methane fuel before interacting with the SFNMO anode was explored. Both steam reforming and oxidative reforming were attempted. The incorporation of copper into SFMO and its ability to operate in renewable hydrocarbon environments is also of interest. The new structure synthesized is Sr2(CuxFe1.5-x)Mo0.5O6-δ. Similar tests with methane and other hydrocarbon fuel sources will be tested after successful synthesis and purification of the material.

C-55: The Study of DNA Binding and Anticancer Activity in Ruthenium Complexes
Author: Hess, Mia
Advisor: Dr. Jared Paul

Ruthenium compounds used for various medical applications are studied thoroughly in science today. Starting with a compound of [Ru(bpy)2(6,6' bpy(OH)2]2+ that has been recently discovered to have potential anti-cancer properties, I am looking further into the mechanisms and potential DNA binding. Blue light activates a change in the complex that may bind to DNA in a similar way to cisplatin, a common chemotherapy drug, becoming a cytotoxic chemical that can lead to a more targeted light therapy. The part I am taking in this research includes studying the synthesis and characterization of [Ru(bpy)2(6,6' bpy(OH)2]2+ and other similar compounds. Following these steps, DNA binding studies using agarose gel electrophoresis are the main component of research comparing the reported compound with common chemotherapy drugs that are in use today. Studying and comparing the binding with DNA will help to further understand and bring more questions as to the mechanism that drives the cytotoxic ability of the ruthenium complex.

C-56: Are two crystallized proteins from the pathogens Burkholderia multivorans and cenocepacia beta-hydroxybutyrate dehydrogenases?
Author: Beadle, Azzeiza
Advisor: Dr. Jennifer Palenchar

"Our laboratory works with beta-hydroxybutyrate dehydrogenases (HBDHs) from trypanosomes and bacteria. Two putative HBDHs have been crystallized by the Seattle Structural Genomics Center For Infectious Disease (SSGCID, https://www.ssgcid.org/). The crystal structures are deposited in the Protein Data Bank (accession numbers 4TRR and 5UNL), but not published. The proteins have not been enzymatically characterized. The SSGCID kindly shared with our lab the constructs encoding the putative HBDHs. We have overexpressed the histidine-tagged proteins in E. coli, purified them to approximate homogeneity, and assayed for HBDH activity. We find that protein from B. cenocepacia has robust HBDH activity, but not the protein from B. multivorans. Kinetic parameters for the B. cenocepacia enzyme will be presented."

C-57: Investigation of Conformational State of the 26S Proteasome and Protein Unfolding Ability Using FRET

Author: Cresti, Julianna; Kraut, Daniel
Advisor: Dr. Daniel Kraut

The 26S proteasome is a crucial structure in eukaryotic organisms composed of multiple clusters of proteins with differentiated roles. Its function as a mechanical degrader of misfolded, mutated, and obsolete proteins has great implications in clinical studies, especially those that concern neurodegenerative diseases. In this research, yeast proteasome were transformed with fluorescent proteins, grown, and purified. The yeast proteasome doubly-mutated with fluorescent protein tags were isolated for use in tracking energetic conformational changes associated with the structure's unfolding ability, or its ability to thoroughly engage and break down proteins. These conformational changes were measured using the distance-dependent analytical technique Förster Resonance Energy Transfer (FRET). Mutant proteasome had the FRET pair mTurquiose as a donor chromophore and mNeonGreen as an acceptor. After preparing reactions with different substrates and conditions, a fluorimeter was used to collect emission spectra in which FRET observation was expected at the wavelength of the acceptor. Through Igor Pro data processing software, spectra could be generated and overlaid so as to compare FRET peak intensities among substrates known to induce specific conformational changes in the proteasome. As expected, yDAK54 mutant (Sem1-mTq, mNeonGreen-Rpn6) exhibited increased FRET signal with the introduction of ATPgS, an ATP analog, as opposed to ATP. Future fluorescence studies must be done to determine how the conformations of yDAK54 and a mutant, yJRC1 (Sem1-mTq, mNeonGreen-Rpn6, R809E on Rpn2), whose mutation is expected to bias the proteasomal conformation away from the s3 substrate-processing state, respond to substrate degradation.

C-58: Simulating Energy Barriers to Charge Transport in Lithium-Ion Batteries

Author: Peart, Shaniya; Raguette, Lauren; Jorn, Ryan
Advisor: Dr. Ryan Jorn

The efficient transport of lithium ions is critical to energy storage in many small electronic devices. Few experiments are capable of probing ion transport directly during battery operation, hence computer simulations provide an important approach to understand energy barriers to charge transfer. In order to simulate the transport of ions, a model is developed for the interactions between Ethylene Carbonate (EC) + LiPF6 + electrode surface materials. This work focuses on a new approach for studying lithium ion systems that removes a previous limitation. In previous work, the interfaces with solid lithium fluoride and lithium carbonate crystals were treated as frozen. The result from freezing these surface films was an exaggeration of their impact on electrolyte structure and dynamics. It is found that in allowing the interfaces to relax, most of the crystalline structure was maintained. In addition to stability, a greater increase in absorption of ions from the electrolyte into the interface was seen in comparison to the frozen model, while adsorption of ions remained consistent with that of the previous model. The data collected from this work indicates that the model using unfrozen crystal interfaces would prove beneficial in further study of these systems. Future work for this project includes using this approach to calculate free energy barriers. A strategy for doing so has already been implemented for an amorphous interface containing Li2EDC, providing valuable insights into the mechanism of ion transport.

C-59: Sleuthing the enzymatic activity of a Salmonella kinase
Author: Stanton, Destini; Palenchar, Peter; Palenchar, Jennifer
Advisor: Dr. Jennifer Palenchar

"An AIRs (amino imidazole riboside) kinase from Salmonella enterica has been characterized, and the crystal structure determined (J Bacteriol. 2003 185(1): 332-339; Structure 2004 12(10): 1809-1821). However, the physiological function of the enzyme is hypothesized not to be an AIRS kinase activity given that Salmonella does not generate AIRs. The sequence of the protein resembles that of a fructose kinase and the catalytic amino acids are conserved with the exception discussed below. We determined optimal conditions to express a His-tagged version of the protein in E. coli and assayed for fructose kinase activity. No fructose kinase activity was observed under our experimental conditions. Going forward we will test activity with other possible sugar substrates. Further, based on the crystal structure of the AIRs kinase, a tyrosine is important for interacting with the amino imidazole ring moiety. In characterized fructose kinases, the equivalent amino acid is a phenylalanine. We will next carry out site directed mutagenesis to convert this tyrosine to a phenylalanine and then query the resulting protein for fructose kinase activity. This work will allow us to better understand enzyme evolution, specificity, and aid in enzyme annotation."

Civil & Environmental Engineering

C-60: Assess the Properties of Pyrogenic Dissolve Organic Matter and Its Impact on the Formation of Disinfection By-Products in Drinking Water Treatment
Author: Dang, Minh
Advisor: Dr. Wenqing Xu

Due to the rise in number of forest fire events as an effect climate change, the amount of pyrogenic dissolved organic matter (pyDOM) has also been recorded to have an increasing trend in the recent years. The increased of pyDOM in drinking water source has had a negative impact on the drinking water treatment process. It is because pyDOM can contribute to the formation of disinfection byproducts (DBPs including both the regulated species such as Trihalomethanes (THMs) and unregulated species such as Nitrosamines. These DBPs are carcinogenic and pose risks to human health. This research characterizes pyDOM from grass and wood burned under nitrogen at temperature from 300 to 700 degrees Celsius by their standard UV absorption at 254nm (SUVA 254), electron donating and accepting capacity (EDA and EAC) values. We found that as temperature increases, both SUVA 254 as well as the EDC and EAC values of pyDOM decreases in a nonlinear fashion. This study also quantified the amount of THMs and nitrosamines formed by these pyDOM by both chlorination and chloramination disinfection processed. The amount of DBPs generated is also correlate them with SUVA 254, EDC and EAC values. The correlation found indicates that SUVA 254 is a good predictor for the formation of THMs; whereas, Nitrosamines formation is more difficult of forecast. This studies, thus, helps to understand the behavior and DBPs formation potential of pyDOM which will help with future mitigation of water treatment process in response to forest fire events.

D-61: Assessing Nutrient and Fines Accumulation in Green Stormwater Infrastructure Overtime

Author: Heffernan, Shaelynn; McKane, Ian; Sample-Lord, Kristin; Smith, Virginia
Advisor: Dr. Kristin Sample-Lord, Dr. Virginia Smith

Green stormwater infrastructure (GSI), such as rain gardens, are commonly used to reduce stormwater runoff volume and improve water quality. Over time, water transports nutrients and soil within the GSI, altering its ability to infiltrate stormwater and capture pollutants (e.g., nutrients such as phosphorus and nitrogen). The GSI dynamics control the effectiveness and long-term performance of the systems. For over fifteen years, multiple rain gardens on Villanova University's campus have been monitored and extensively studied, creating a rich archive of collected data. Previous and ongoing research of the on-campus GSI has shown that understanding and predicting deposition and accumulation of fines and nutrients is complex and varies significantly between different rain gardens. Leveraging this rich databank, this project aims to unravel the relationships between fines and nutrient accumulation and distribution within rain gardens over time. Understanding the mechanisms controlling transport and deposition of fines and nutrients in rain gardens over time will improve predictions of long-term performance and the design and maintenance of GSI. Three on-campus study sites were chosen as the focus of this study: Bioinfiltration Traffic Island (BTI), Fedigan Hall Retention Rain Garden (FR) and Fedigan Hall Infiltration Rain Garden (FI). At each site, field infiltration tests and surveys were completed to determine nutrient and fine sediment accumulation and distribution. Soil cores were collected and are being tested in the laboratory to determine fines content using particle size distributions, plasticity, organic content and nutrient concentrations of phosphate and nitrogen as a function of location and depth within the rain garden. Sampling and testing are performed approximately every six months and compared to the historical data to draw conclusions regarding changes in the rain garden soils and performance over time. This quantification of nitrogen, phosphate and fines spatially within the rain gardens will ultimately result in recommendations for optimizing future GSI design and reducing long-term operations and maintenance costs.

D-62: Thermal Imaging: Engineering New Solutions to Determine Energy Flux in Switchgrass

Author: Jacko, Brian; Krasowski, Devin
Advisor: Dr. Bridget Wadzuk

"Thermal imaging is a technology that is gaining rapid popularity in the fields of civil and environmental engineering. With this in mind, cameras equipped with thermographic capabilities can be utilized to study the behaviors of several varieties of plants, and how they interact with their ecological surroundings. In this study, thermal images were taken at regular intervals to determine the surface temperatures of Panicum virgatum (Switchgrass) leaves throughout several days and under varying conditions. These images were then processed through MATLAB to isolate total green area and create a matrix of temperature values for each pixel. Modeling the leaves as thin prisms of water, the collected surface temperatures were used to deduce overall energy flux. These data, when compared to overall mass of water removed from each plant daily, were able to illustrate the relationship between total energy input (via solar radiation) and energy output for the purpose of evapotranspiration through stomata.

This poster describes in detail the benefits of using thermal imaging to collect these data, as compared to more traditional methods, and the procedure through which these images may be processed to provide multiple relevant insights into the machinations of plant energy usage and water transportation. Through study, it was found that thermal imaging presents an effective means by which to perform energy balance calculations for the determination of energy absorption and output in Panicum virgatum, and (based on qualitative data) most other green, leafy plants as well. This study also found that data collected on days of high evapotranspiration (accompanied by high stomatal conductance measurements) was generally more accurate than that collected on slower output days (those with lower stomatal conductance values) as seen by a smaller margin of error between theoretical values and those calculated from the data. "

D-63: The Effect of Summer Stormwater Runoff on Stream Temperature at Developed Watersheds
Author: Kwak, Nayeon
Advisor: Dr. Andrea Welker

Villanova University is monitoring a total of five sites on streams in the Delaware River Watershed. The data is being used in a Before-After-Control-Impact study, rooted in the Stream Functions Pyramid Framework to determine whether damage sustained by receiving waters in a highly urbanized watershed can be reversed by implementing modern-day stormwater controls. Two of these sites are on Chrome Run (one site is immediately downstream of the new stormwater controls and another is about 900 m away), while three additional streams are monitored for comparison. Developed watersheds have a greater percentage of impervious surfaces, allowing unfiltered stormwater runoff to enter streams more quickly. This research focuses on the impact a highly urbanized watershed's stormwater runoff has on stream temperature during the summer months. Each site's stream temperature was collected in five-minute intervals, and a reference weather station located near the monitored sites utilized a tipping bucket rain gauge to measure precipitation. A storm event for each of the summer months – June, July, and August – was selected to be studied. The headwaters of Chrome Run experienced the highest stream temperatures, as well as the rapidest and greatest deviations from the before-storm conditions. The implemented stormwater control measures should reduce volume of stormwater runoff and increase the travel time of runoff in the watershed, ensuring less drastic fluctuations in temperature. In the future, Villanova will continue collecting and analyzing data to evaluate the effectiveness of the implemented stormwater control measures.

Communication

D-64: The Role of Anonymity in Incivility:
Exploring the Quasi-Anonymous Comment Space under YouTube News Videos
Author: Mann, Mansi
Advisor: Dr. Thomas Ksiazek

"Guided by the belief that prohibiting anonymous comments leads to less incivility, numerous news websites have taken steps to restrict user anonymity. However, previous studies offer mixed findings on how anonymity affects the level of incivility in user comments. In an effort to better understand the role of anonymity in commenting, this study focuses on the quasi-anonymous comment space of YouTube, wherein commenters are afforded the autonomy to be as anonymous as they choose. This research examines whether the level of incivility in the YouTube comments sections of news videos varies according to the level of user anonymity. A content analysis of 1043 user comments across 132 news videos on YouTube suggests that the level of user anonymity has no relationship with the level of incivility in comments to news videos. YouTube users who choose to disclose identity information in their usernames are not more likely to be civil in the comments sections. The results of this study suggest that, contrary to popular perceptions, higher level of user anonymity is not associated with higher likelihood of engaging in uncivil communicative behavior online. "

Computing Science

D-65: CPN Model Simulation: An Analysis of Operation Workflow Efficiency
Author: Robinson, Jake
Advisors: Dr. Vijay Gehlot

Simulation and modelling have been underutilized as research tools in healthcare services, despite this industry being the single largest in the US. These techniques have been used successfully in other industries to research potential inefficiencies in system workflows. These tools allow the researcher to measure and analyze desired statistics based on the model in order to study the efficiency of the system. In this project we used simulation tools in order to measure the efficiency of hospital workflow. We focused our model on the operating room, as this accounts for the majority of hospital revenue and cost. This project used a Colored Petri Net (CPN) to represent the surgical workflow of a patient from intake and reception to recovery and discharge. Simulations were run to determine mean wait time for patients and utilization rates of hospital resources. Our goal was to decrease wait time of patients in order to help improve patient safety and quality of care. The resulting statistics show that resources such as the nurse assistant and the operating rooms have high utilization rates and are likely places for bottlenecks to occur. They also show that other resources such as the reception nurse, recovery rooms, and anesthesiologist staff have low utilization rates and can be re-categorized or downsized to increase efficiency or reduce cost.

D-66: Facial Expression Recognition
Author: Penafiel, Joselyn
Advisor: Dr. Edward Kim

My goal is to recognize different facial expressions and then add different filters to those expressions.

D-67: Handgun Detection using Deep Learning
Author: Lyu, Zhengyan
Advisor: Dr. Edward Kim, Dr. Benjamin R Mitchell

"Handgun is one of the weapons widely available to civilians in the United States. Although it is commonly used for self-defense, it could also be a threat to public security, especially in crowded places. Therefore, our project tries to construct a real-time automatic handgun detection model based on Faster Region-based CNN (Faster R-CNN) that could potentially used for CCTV images. Faster R-CNN model is a popular object detection algorithm that can present many bounding boxes around the objects of interest. We have trained and tested our model over the handgun data set from Soft Computing and Intelligent Information Systems. The data set contains about 3000 images of guns with region proposals. To minimize the impact of the size limitation of this data set, we implemented transfer learning in our model, which allows us to use a constructed convolutional neural network (CNN) as the initial CNN for our model. Among several constructed CNNs, we selected the one with the best performance for our model after testing all of them. Then, some parameters were modified in our model in order to improve the accuracy based on testing results. In result, our model generally performs well on detecting the visual handgun. Our future work will focus on improving detection accuracy by implementing alternative models and/or twisting models' architects."

D-68: Improving Real-World Performance in Speech Noise Reduction
Author: Specht, Kathe
Advisor: Dr. Edward Kim

In the field of noise reduction, some models make the mistake of testing on the same noise present in the training dataset, which distances them from real world application. Another flaw with some models is computational intensity, which limits the applicability of the model. To address these problems, a dataset was made using the FreeSound and Common Voice noise and speaking datasets, respectively. The new dataset was made by merging the voice and noise files, and aims to provide testing data that is more realistic. A convolutional neural network model was then trained on this set to test the effectiveness of a less computationally intense approach to noise reduction.

D-69: Machine Learning helping Fashion Item Classification
Author: Tong, Sophia
Advisor: Dr. Benjamin R. Mitchell, Dr. Edward Kim

"“Prediction is the essence of intelligence” says Yann LeCun, this year’s ACM Turing award winner and one of the founding pioneers of a particular type of artificial intelligence, deep neural networks. Jeff Hawkins, founder of the Redwood Center for Neuroscience at Berkeley, proposed that prediction is intelligence framed by understanding. Neuroscientist Karl Friston says that the human brain is doing “active inference”, a type of prediction where perception is an input stimulus modulated by predictions and expectations. Indeed, we as humans can see that we are predicting all the time, ranging from our visual system's ability to expect that our environment will stay relatively constant between blinks, to our auditory system expecting to hear a loud bang when a cup hits the floor, to our language centers that can predict the end of people's sentences. Our ability to predict and anticipate the future helps in our understanding of the world around us including understanding intention, planning, and finding anomalies. Over the summer, Sophia assisted Dr. Mitchell and Dr.

Kim in exploring artificial intelligence learning algorithms. One task was looking at the current state-of-the-art in machine learning, deep learning, and formulating a machine learning model that learns how to classify images. The model was trained by looking at a sequence of images of various fashion items so that it classifies all the fashion items by category, and then trained to classify new images that it had never seen. Google's Tensorflow libraries as well as PyTorch were used in conjunction with recurrent neural networks to develop this project."

Economics

D-70: Empirical Evidence of the Glass Cliff
Author: Moyer, Olivia; Pfeiffer, Olivia; Vasquez, Alexandra
Advisor: Dr. Xiaoxiao L

"As more women step into leadership positions, there is talk of shattering of the glass ceiling, the metaphorical barrier that keeps women from rising above a certain rank. Recent research focuses on what occurs after women are placed in these leadership positions, where women are often placed in leadership roles during times of company crisis. This phenomenon of placing a women into a leadership position when the chance of failure is the highest is known as the glass cliff.
Prior qualitative research on the glass cliff has been in depth and in support of the phenomenon, though prior quantitative research has been more scarce and varied in results. Our goal in this project is to provide a more definite quantitative understanding of the glass cliff phenomenon in the United States. Our data was sourced from the Compustat, which provides both financial and leadership information for US companies. Our preliminary results suggest when firm performance declines or during uncertain periods (due to factors such as merger and acquisition), they are more likely to place a higher number of women in the executive positions the following year. However, this is not necessarily reflected in the CEO position, suggesting that though female leadership increases in times of crisis, the male CEO is still preferred. Over the summer, we cleaned our dependent y variable and narrowed the accuracy of our results. Further regressions will reveal more about the tendencies of the Glass Cliff."

Electrical and Computer Engineering.

D-71: ErrMAx: Machine Learning-based Input-aware Error Modeling of Approximate Adders
Author: Ma, Dongning; Ogunjimi, Raymond
Advisor: Dr. Xun Jiao

"As Moore's Law comes to an end and microelectronic scaling fails to satisfy the ever-increasing computing demand for low-power platforms, alternative computing paradigms such as approximate computing are urgently needed. Approximate adders have achieved tremendous success in various applications such as big data analysis and multimedia applications. While effective, approximate adders introduce errors into systems that can lead to unacceptable output quality. Hence, accurate error modeling of approximate adders is critical to balance the energy-quality tradeoff. Existing error

models of approximate adders cannot accurately capture the error behavior of approximate adders because they fail to consider the effects of input data. In this work, we propose ErrMAx, an input-aware error model of approximate adders based on machine learning. It can predict approximation errors for a given input. ErrMax has two stages: data collection and model training. First, we collect the training data through gate-level simulation. Second, we train the model using the random forest method by fitting the method into the collected training data. We evaluate the performance of ErrMAx using various real-world applications and show that the average prediction accuracy of ErrMAx is 99%."

D-72: Abusive Language Detection on Twitter in English and German with Auto-Machine Learning

Author: Jorgensen, Mackenzie; Choi, Minho; Becker, Jörg
Advisor: Dr. Marco Niemann (University of Münster, European Research Center for Information Systems)

Comment moderation online is an incredibly taxing task for moderators. Small companies especially struggle to filter through comments looking for abusive language manually. A semi-automated approach for abusive language detection is needed to assist moderators in filtering through posts. We present Auto-Machine Learning as a promising tool for the problem of abusive language detection online. Auto-Machine Learning takes over many of the machine learning pipeline steps, which otherwise researchers would manually configure. Hence, it enables non-machine learning experts such as moderators to create abusive language detection models to support them in their daily work. Auto-ML also provides a sped-up machine pipeline process for researchers who can focus their time on other aspects of their research rather than time-consuming manual machine learning configuration steps. For our research, we utilize Twitter data-sets in English and German, which are both multi-class labeled. Further, we highlight that multi-class classification through Auto-Machine Learning is successful in efficiently and effectively detecting abusive language on Twitter in English and German.

D-73: ErrMAx: Machine Learning-based Input-aware Error Modeling of Approximate Adders

Author: Ma, Dongning; Ogunjimi, Raymond
Advisor: Dr. Xun Jiao

"As Moore's Law comes to an end and microelectronic scaling fails to satisfy the ever-increasing computing demand for low-power platforms, alternative computing paradigms such as approximate computing are urgently needed. Approximate adders have achieved tremendous success in various applications such as big data analysis and multimedia applications. While effective, approximate adders introduce errors into systems that can lead to unacceptable output quality. Hence, accurate error modeling of approximate adders is critical to balance the energy-quality tradeoff. Existing error models of approximate adders cannot accurately capture the error behavior of approximate adders because they fail to consider the effects of input data. In this work, we propose ErrMAx, an input-aware error model of approximate adders based on machine learning. It can predict approximation errors for a given input. ErrMax has two stages: data collection and model training. First, we collect the training data through gate-level simulation. Second, we train the model using the

random forest method by fitting the method into the collected training data. We evaluate the performance of ErrMAx using various real-world applications and show that the average prediction accuracy of ErrMAx is 99%."

D-74: Modelling Lead Acid and Lithium Iron Phosphate Batteries Using Electrochemical Impedance Spectroscopy
Author: Culloo, Shannon
Advisor: Dr. Pritpal Singh

We rely on batteries constantly, with everything from our phones to electric vehicles depending on their ability to reliably store and supply charge when needed. One application of batteries that will become increasingly important is how they can be used for large-scale renewable energy storage. To keep up with the demand for these electrochemical devices, an understanding of how batteries work and how they can be improved is imperative. Before the battery energy storage systems (BESS) that will sustain the power systems of tomorrow can be designed, a realistic model of a battery is needed. The behavior of both lead acid and lithium iron phosphate batteries was emulated using equivalent circuit models. With this method, one can represent the battery with electrical components, the values for which were obtained by running a small alternating current signal through the device and examining the resulting impedance. This process is called Electrochemical Impedance Spectroscopy. In short, an equivalent circuit model approximating the performance of a real battery was developed by characterizing lead acid and lithium iron phosphate cells under different conditions- specifically, the variables of temperature, state of charge, and number of charge cycles were altered. Going forward, this enhanced representation of a battery will hopefully contribute to accurately simulating how they operate in power systems.

Geography and Environmental Science

D-75: Plant Best Practices: Which Are Most Beneficial for Pollinators?
Author: Hulet, Nina
Advisor: Dr. Lauren Lynch (University of Illinois- Urbana Champaign)

Pollinators, which are vital for both native plant survival and crop production, have been experiencing declines as a result of habitat fragmentation, climate change, decreased availability of food sources, and urbanization. In order to best protect these species, this study looks at the types of plants that are most attractive to pollinators. We conducted surveys of flowering plants and pollinator visitation at ten locations in the greater Chicago area. Each location consisted of three types of sites: a lawn, an ornamental garden, and a registered pollinator garden. Then, data was compiled to calculate the visitation rate of Hymenoptera, Lepidoptera, and Diptera to each species of flowering plant present in our sites, and determine which plants they preferred to pollinate. The results showed that Origanum, Geranium, Liatris, Asclepias, Perovskia, Nepeta, Ruta, Hydrangea, Persicaria, Agastache, and Spirea were the most beneficial plants for pollinators. Therefore, we recommend that households, businesses, organizations, and local forest preserves plant these species in order to promote the visitation and proliferation of pollinators. Future studies could conduct

similar research on a nationwide or global scale to identify the types of plants that work best for each region.

D-76: Examining Lead in Our Drinking Water
Author: Cruz, Yuliza
Advisor: Dr. Steven Goldsmith

"Throughout the United States there are cities and urban areas that suffer the consequences of having lead pipes due to the installation of them in the late 1800s. After discovering the harmful threats that Lead poses to the general public the Safe Drinking Water Act (SDWA) was enacted and created the ban on using lead for pipes; however, it did not enforce the replacement of lead pipes. Areas with old water systems are likely to experience the health effects that come with the corrosion of lead pipes. In the study, the collection of samples were gathered in accordance with United States Environmental Protection Agency (US EPA) guidelines. To keep conditions similar for each home, the samples were collected from a kitchen sink every Sunday morning. Incorporated into the study was Brita filtration to be able to determine the effectiveness of an at home water filter. To analyze the samples, the Environmental Protection Agency's Method 200.8 was used in this study to determine the total lead dissolved and the total recoverable lead, which includes lead dissolved and lead particulate, within the samples. The results from data analysis entail that flushing faucet water without any filtration for 30 seconds decreases the amount of lead found in water by 62%. The results from Brita filtration showed a decrease in lead by an average of 82-87%. This study can spread awareness to low socioeconomic communities about the importance of drinking water hazards. The health effects of lead can be prevented by simple education of letting water run before use and also by using an at home water filter. "

D-77: Exploring the freshwater salinization syndrome along a gradient of suburban development
Author: Henderson, Alec; Goldsmith, Steven
Advisor: Dr. Steven Goldsmith

Road salts are one of the most commonly used methods of deicing, particularly in the northeastern region of the United States where this method has been used for nearly a hundred years. Excess road salt from deicing ultimately enters local watersheds either by direct runoff or by first entering the groundwater, where it can have deleterious impacts on freshwater aquatic organisms. More recently, this excess salt has been associated with contaminant increases in pH, alkalinity, base cations (i.e., sodium, calcium, magnesium, and potassium) as well as several trace metals in streamwater due to ion exchange in the surrounding soils. This combined effect has been dubbed the "freshwater salinization syndrome." This study evaluated the impact of the freshwater salinization syndrome on dissolved metal concentrations in three suburban watersheds, each with a varying density of development: the Mill Creek, Indian Run Creek, and the East Branch of the Brandywine Creek. Watersheds were spatially delineated using Esri's ArcMap software and land use practices in each of the three systems determined were using the 2011 National Land Cover Database. Water samples previously collected during summer baseflow conditions were analyzed for selects trace metals (As, Ba, Cd, Co, Cr, Ni, Se, Sr, Pb, and Zn) using an inductively-coupled plasma mass spectrometer (ICP-MS) and for chloride using ion chromatography. Positive,

statistically-significant correlations were identified between streamwater concentrations of chloride and lead, nickel, strontium, and zinc for all three creeks suggesting elevated salt concentrations resulted in more metals entering the system. In addition, the relative concentrations of metals in each of the three watersheds varied as a function of land use, with higher concentrations linked to increased development within the watershed. Although metal concentrations did not exceed applicable USEPA guidelines, this relationship is concerning for ecosystem health as the volume of road salt used continues to rise.

D-78: Fate of sediment from seasonal storm deposition events
Author: Stumpf, Andrea; Weston, Nathaniel; Sutter, Lori
Advisor: Dr. Nathaniel Weston

"Salt marshes provide ecosystem services including carbon sequestration, flood mitigation, and nutrient removal, and climate change is threatening coastal salt marshes through sea level rise and reduction in sediment supply. Climate change may alter the intensity or frequency of storm events, and this study provides needed information that will be useful in assessing the resilience of marshes. Storms can result in high-energy waves that may cause erosion, wind damage, flooding, and result in storm-surge sediment deposition onto marshes. Storms may hasten the loss of marshes through erosion or sustain them through vertical sediment integration. The type and timing of storm events may alter the quantity and composition of sediment delivered to the marsh surface.
We investigate how sediment type, thickness of deposit, and elevation interact to determine the fate of storm sediment deposition. Our factorial design experiment assesses different scenarios, including Nor'easter ice raft deposition events (fine-grained sediment) and hurricane deposition events (coarse-grained sediment). Sediment was deposited at two high marsh sites and two low marsh sites on 0.5 meter squared plots with three different depths of coarse and fine sediment deposition (2, 6 and 10 cm). Change in deposition was measured over 9 months. The majority of control plots were within 4 mm except one site gained over a centimeter of sediment, showing the dynamic nature of sediment in the salt marsh ecosystem. In both high marsh sites, plots with higher sediment deposition lost more sediment (up to 37%); however, low marsh sites exhibited slight differences (up to 74% and 60%). The differences at the low marsh sites may be attributed to variation in plot location in relation to the river channel. Low marsh sites have overall higher sediment loss, likely due to higher flooding frequencies."

D-79: Impact of Anthropogenic Activity on Beach Pollution in Puerto Rico
Author: De Jesus, Beatriz
Advisor: Dr. Lisa Rodrigues

"Air and water pollution are a major public health concern for people around the world, especially those living in more vulnerable, less-developed countries. Air (nitrogen oxides, NO2 and NOx) and seawater (nitrate, NO3-) samples were collected from five beaches along the north coast of Puerto Rico every week for six weeks during the months of June and July 2019, using passive air samplers and sample bottles, respectively. Google Earth Pro was used to determine the amount and density of development surrounding each beach. The amount and types of marine debris found along a 1- mile stretch of each beach was characterized using the Ocean Conservancy's Volunteer Ocean Trash Data Form. Pollution levels were found to be higher in beaches with a higher density of surrounding

development and higher prevalence of marine debris compared to beaches with a higher density of surrounding greenery and lower prevalence of marine debris. For example, the average concentration of NOx in Ocean Park Beach, which has the highest density of surrounding development, is approximately 53% higher than the average concentration of NOx in Breñas Beach, which has a much lower density of surrounding development. Results for nitrate in water were much lower in value, but differed between locations in similar amounts thus proving a similar pattern. These findings provide insight on the severity of pollution on some of Puerto Rico's beaches, as well as the health hazards that may result from the pollutants. "

D-80: Investigating the relationship between hydraulic fracturing and metal pollution in Pennsylvania watersheds

Author: Borkoski, Matthew; Goldsmith, Steven
Advisor: Dr. Steven Goldsmith

Unconventional hydraulic fracturing (aka fracking) is a complex and relatively new way to obtain natural gas from the earth. This water intensive process involves anywhere from 2-10 million gallons of water pumped underground at high pressures to break apart the impermeable shale bedrock and release the embedded natural gas. Approximately 10% - 40% of the water and associated frack fluids pumped underground returns to the surface contaminated with ancient seawater that is also released from the shale. While initial studies have suggested that leaks from underground casing and surficial spills can impact shallow groundwater and streams, respectively, the extent to which fracking practices can impact watershed scale water quality remains unresolved. This study examines this knowledge gap, through the analysis of >100 surface and > 30 groundwater samples previously collected from 40 small watersheds (<10 mi2) in north central Pennsylvania (Bradford, Wyoming and Susquehanna Counties) from 2013-2015. Samples were analyzed for select trace metal concentrations (As, Ba, Cd, Co, Cr, Fe, Mn, Ni, Se, Sr, Pb, and Zn) using an inductively coupled plasma mass spectrometer (ICP-MS). The water chemistry results were analyzed for their potential correlation with number of fracking wells spudded (i.e., fracked), well violations, well density, and land use practices in each of the watersheds using the statistical software JMP. A statistically-significant correlation between Ba concentrations and the number of wells spudded in each watershed was identified for the 2014 and 2015 dataset. In addition, many stream and groundwater samples exhibited metal concentrations in excess of USEPA guidelines for freshwater quality and/or drinking water. These results suggest more studies are needed to evaluate the impacts on surface water quality.

E-81: Philadelphia's Local Food System

Author: Temple, Amira
Advisor: Dr. Peleg Kremer

Historically, Philadelphia is a city where many areas do not have access to healthy, affordable food. However, there have been attempts to remedy a lack of access to fresh food through multiple avenues of local food resources. This research project, Philadelphia's Local Food System, was originally started in 2008 by Dr. Peleg Kremer. The purpose is to record components that contribute to the local food system in Philadelphia. This includes farmers' markets, urban farms, and the Philadelphia Orchard Project, among many others. A Microsoft Excel spreadsheet is kept to record

suppliers and resources for locally grown food. In the future, this Microsoft Excel spreadsheet will be used to compose graphs and maps of Philadelphia's local food system. Upon conducting the Philadelphia Local Food System research, there has been a significant change in locally grown food resources. Orchards in Philadelphia have skyrocketed while farmers' markets have similarly done the same. Restaurants with farm-sourced food have increased and many new farms have begun to sell their produce in Philadelphia. Other areas have also changed, allowing many new avenues of access within the city. Evaluating the research, it is evident that Philadelphia's local food system has expanded over a period of eleven years.

E-82: Socioeconomic variables, health outcomes, and air pollution in Philadelphia
Author: Conway, Meghan
Advisor: Dr. Peleg Kremer, Dr. Kabindra Shakya

Some neighborhoods of Philadelphia have high rates of poverty and asthma. Previous studies have found an association between air quality and socioeconomic factors (such as poverty) and health indicators (such as asthma prevalence). Using citywide air quality data collected by mobile monitoring in summer 2019, this project studies the relationship between socioeconomic environmental risk factors, air quality, and ensuing health effects in the city of Philadelphia. Census-tract level health and socioeconomic data were extracted from public and government-generated datasets. Upon joining all three datasets with a Philadelphia census-tract shapefile in ArcGIS, we performed Spearman Rank Correlations between socioeconomic variables, air quality, and health indicators. Preliminary results suggest that census tracts with higher rates of poverty, unemployment, lack of higher education, and disabilities in populations older than 65 tend to display lower levels of inhalable particulate matter (PM2.5), but also tend to display higher instances of asthma and chronic obstructive pulmonary disease. Census tracts with higher asthma prevalence and chronic obstructive pulmonary disease tend to show positive correlations with PM2.5. This study also analyzes these variables in North Philadelphia near Temple University (15-20 census tracts), where both poverty rates and crude asthma prevalence are especially high, to identify localized trends in an area highly populated by students during the school year. Data connecting socioeconomic risk factors, air quality, and ensuing health effects can inform policies on social vulnerability to pollution in Philadelphia.

E-83: "A Finished Mug of Coffee, an Unfinished Story:
Evaluating Caffeine Concentrations in Estuarine Waters"
Author: Eastment, Leah
Advisor: Dr. Nathaniel Weston

The emerging contaminant caffeine is a developing problem aggravated by insufficient sewage water treatment. Caffeine levels in natural waters are directly linked to human activity as caffeine is predominantly found in beverages, foods, and medications. The occurrence of caffeine indicates the presence of raw or partially treated sewage most likely containing many other contaminants such as pharmaceuticals. Since these contaminants are not removed from drinking water, humans can unknowingly consume them which could be dangerous because the fate and effect of emerging contaminants are unknown. The consumption of contaminated drinking water could result in degradation of human health particularly in infants and the elderly possibly from developmental

complications, allergies, overdoses, or synergetic effects with other medication. This study analyzed the concentration of caffeine in natural waters along the salinity gradient in the Parker River Sound estuary in coastal Massachusetts. Twenty-eight water samples were collected along a 24 km transect of the estuary from the dam at the head-of-tide to the ocean inlet. A high-pressure liquid chromatograph method was developed to determine the caffeine levels in the samples. I found greater caffeine concentrations in freshwater samples and lower levels in saltwater samples, providing evidence of untreated or partially treated wastewater with caffeine entering the estuarine system that is either diluted or processed (likely through microbial decomposition) as freshwater mixes with saltwater along the estuary.

E-84: Comparing the Heavy Metal Concentrations of Estuarine Organisms from Different Estuaries on the East Coast

Author: Curren, Gillen
Advisor: Dr. Nathaniel Weston

Heavy metals are metal elements that have a high density and atomic weight. They naturally occur in estuarine environments due to natural rock weathering. However, in the past century, heavy metal concentrations in estuaries have dramatically increased due to anthropogenic sources. An increase in heavy metal concentrations in estuaries is a concern due to the bioaccumulation of heavy metals in estuarine organisms, as heavy metals are not biodegradable. This study will focus on measuring the heavy metal concentrations of estuarine organisms like insects, plants, fish, benthic infauna, and filter feeders from the Delaware Estuary, Plum Island Estuary, and York Estuary. Plants such as saltgrass (Distichlis spicata) and cordgrass (Spartina alterniflora), filter feeders like the mussel Geukensia demissa and the soft shell clam Mya arenia found in low tide areas, and fish such as the mummichog (Fundulus heteroclitus), the Atlantic silverside (Menidia menidia), and striped bass (Morone saxatilis) will be analyzed for their heavy metals, such as copper, chromium, nickel, cadmium, and lead. The primary goal of this experiment is to determine whether the heavy metal concentrations in each organism are hazardous to the welfare of the estuary and to human consumers of estuarine organisms.

E-85: Spatial distribution of green infrastructure, local flooding and climate regulation in the city of Philadelphia

Author: Ahn , Kirsten: Bill, Victoria
Advisor: Dr. Peleg Kremer; Dr. Virginia Smith

"In a dense and impermeable urban environment, Green infrastructure (GI) provides many ecosystem benefits including urban cooling and runoff mitigation. The effect and spatial distribution of these benefits is determined by a combination of risk and vulnerability. Risk is determined by physical and environmental conditions; such as, the distribution of GIs and other vegetation in the city, local climate conditions, precipitation, and runoff magnitude. Vulnerability is dependent on physical elements of the built environment such as, properties of housing units and demographics. There is a lack of understanding of the spatial relationship between risk and vulnerability and the implication for planning of ecosystem services provided by GIs. In order to heighten our understanding of these relationships this study assesses the GIs mitigative impact on local flooding

and climate regulation in Philadelphia. In doing this, we created a spatially explicit framework to assess both risk and vulnerability.

Micro subbasins draining into city inlets were delineated and used as the spatial unit for this study. We then developed the spatial model for this study using ESRI ArcGIS Model Builder in Arc Pro 2.3 environment. The spatial model summarized runoff and surface temperature characteristics, census, and parcel data for each of these subbasins through spatial joins. The demographic data associated with each subbasin included population density, age, race, and poverty. Physical characteristics of the built environment included building age, the presence or absence of basements, and the building elevation relative to the roads. Precipitation data for a 10 year 24-hour storm was used to generate the runoff depth for each subbasin by the Rational and the NRCS methods. Two cloud-free Landsat images were used to map the surface temperature of Philadelphia. The estimated runoff depth for the city and surface temperature was spatially linked to the demographic data and parcel characteristics to generate risk and vulnerability maps. This framework allows an analysis of the spatial distribution of GIs, urban cooling, and storm runoff depth, and combine this data with the demographic data to prepare social vulnerability and risk maps in order to estimate the ecosystem services potential of GIs in the city."

E-86: Monitoring indoor air quality inside Subway Cars at Philadelphia Trains
Author: Saad, Alexander: Shakya, Kabindra
Advisor: Dr. Kabindra Shakya

"Globally, air pollution is a growing concern because of cardiovascular and respiratory diseases. Air pollution coupled with the growing popularity of public transportation highlights the importance of providing safe environmental quality amongst public transit. Each day SEPTA gives around 290,000 rides thus it is important to assess what the daily commuter is exposed to on public transportation. The main goal of this study is to monitor indoor air quality inside subway cars across three major subway lines of SEPTA system: Norristown High Speed line, Market Frankford line, and Broad Street line. PM2.5 and PM10 were measured using two nephelometers, black carbon using a microaethalometer and particle number concentrations using a laser particle counter. Monitoring was conducted during peak and off-peak hours. Mean PM10 for the Broad Street line on peak and off-peak hours was 28.21 ± 5.33 μg/m3 and 26.09 ± 1.12μg/m3, respectively. Similar to Broad Street line, peak hour PM10 concentration was larger than off peak hour at other two lines. The Broad Street had the highest black carbon (3209.73 ± 931.70) and average PM2.5 concentration (26.82 ± 4.33 μg/m3). Subway trains had higher PM concentrations than outside air by a factor of 1.42. This means the PM2.5 concentration inside the subway cars is higher than that of the outside air, slightly above the US EPA's daily standard of 25 μg/m3. "

History

E-87: The Impact of Thomas Jefferson's Meteorological Records
Author: Dee, Victoria
Advisor: Mr. James McClure

"Thomas Jefferson was not only the third President of the United States, he also had an interest in environmental science. Jefferson's interest would lead him to developing one of the largest consistent collection of weather records. While not all records remain, the existing records contain over 18,000 temperature readings, along with other readings including notes on barometric pressures and phenological observations. These observations are managed by the Papers of Thomas Jefferson and are being developed to a Digital Resource. These observations have been addressed in order to be manipulated and researched more thoroughly. Jefferson used advanced instrumentation and a tactical means to record daily weather readings.

Jefferson's weather readings can serve to help improve current understandings of History and Environmental Scientists. The use of the meteorological observations helps for researchers of history to better understand changes in movement, travel times and social interactions. The scientific instrumentation and ideologies give light to enlightenment inventions. The observations also serve to assist environmental scientists as a means of verifying tree rings and addressing phenological records. Jefferson's Meteorological records serve an interdisciplinary purpose. Jefferson's records were completed in a systematic order and therefore differentiate from prior records that focused on qualitative observations. The increase in focus on meteorological data can be explained by the impact of Jefferson on the American Philosophical Society, global politics, and his communications with other individuals. Thomas Jefferson's Meteorological records provide great insight into early nineteenth century science and social history. "

Marketing and Business

E-88: The "Dark" at the End of the Tunnel: How Lighting Ambience Might Affect Consumers' Attentions to Achieve a Goal.
Author: Lin, Yihang
Advisor: Dr. Yoon-Na Cho

Consumers are subject to different lighting conditions in their daily lives. Yet, a few studies have examined the influence of lighting on goal progression. Prior research demonstrates how darkness enhances social closeness among a group of people and individuals' perceived freedom. Based on these findings, we expect the distance towards the goal to be perceived as closer in the dark which leads consumers to be less likely to give up on a task. Our study was a 2 (ambient lighting: dark vs. bright) × 2 (goal progression: absent vs. present) between-subjects experimental design. Given a financial resolution scenario, a total of 239 participants from Mechanical Turk were randomly assigned to one of the four conditions. We tracked how their likelihood to complete the task changed. As expected, in dark environment, perceived distance towards the goal decreased. In addition, dark lighting was mediated by perceived distance on goal completion intentions. Further research directions are probed.

Mechanical Engineering

E-89: Applying Heat Exchanger Effectiveness Methodology to Maximize Air-Cooled Heat Sink Performance

Author: Minor, Juliet
Advisor: Dr. Alfonso Ortega

As the processor power of computer servers increases, the use of very high performance forced convection air-cooled heat sinks has become imperative to electronic cooling systems. This research study is focused on maximizing the thermal and hydraulic performance of air-cooled heat sinks for data servers. The work presented here applies the heat exchanger effectiveness methodology to provide a new understanding of how to design the ideal parallel plate heat sink. First, a mathematical model was developed in MATLAB to describe heat transfer and pressure drop of a parallel plate heat sink. This model was validated with experimental data and was then used to conduct a detailed parametric study of heat sink performance across various geometrical parameters such as fin thickness and spacing. The most common performance metric used for heat sinks is the thermal resistance. In this study heat exchanger effectiveness was used as an additional performance metric for the heat sink. It was found that thermal resistance is closely related to heat exchanger effectiveness. Furthermore, it is known that heat exchanger effectiveness has a maximum value of 1.0 and that well designed heat exchangers attempt to reach this effectiveness by maximizing heat transfer coefficient and surface area. The results of this parametric study concluded that for a given approach air velocity, effectiveness of a parallel plate heat sink is independent of the total heat sink width, as well as the total number of fins. This means that effectiveness depends only on mass flow through one channel, and fin length, fin height, fin thickness and spacing, as well as fluid properties. Therefore, once the heat sink geometry is designed to maximize effectiveness, the overall width of the heat sink can be adjusted to achieve the design thermal resistance at the lowest possible flow rate.

E-90: Atomic Scale Interaction between Nanomaterials and Polymers
Author: Yoo, Nicholas; Zhou, Dong; Xiao, Kai; Li, Bo
Advisor: Dr. Bo Li

Understanding the influence of the heterogeneity in nanomaterial structures, such as grain boundaries and defects, on their interactions with polymer will lead to a new insight of the structure-property relationship for hybrid and hierarchical materials. While there is a tendency to further decrease the size of nanomaterials and seek new capabilities for controlling atomic structures, these atomic structures could dominate the properties of nanomaterials and nanomaterials' interaction with polymer chains. To bridge this important gap, we utilize a new nanomaterial platform, two-dimensional materials (2DMs), in combination with a highly controlled solution-based polymer assembly process, in order to study how the atomic structures of 2DMs (e.g., grain boundary) initiate, stop, or guide the assembly of polymer chains. In this study, chemical vapor deposition MoSe2 and polyethylene (PE) are chosen as the target system. The solution-based assembly will enable a full adjustment of the polymer chains to maximize the influence from the atomic structures of 2DMs. We will use ORNL's high-end class Raman spectroscopy, atomic force spectroscopy (AFM), and scanning transmission electron microscopy (STEM), and transmission electron microscopy (TEM) equipment to classify the atomic nanomaterial structures in MoSe2 monolayers and analyze their influence on the assembly of PE polymer chains.

E-91: Microspine Material Testing

Author: Kitrick, Kerry
Advisor: Dr. Garrett Clayton

The performance of a small robot, recently designed and built in the Villanova University Mechatronics Systems Laboratory, was tested and evaluated. The robot, which was developed over the past academic year, was designed to climb vertical surfaces through the use of microspine technology, which uses small hooks to grip to the surface. Experiments were conducted to test various 3D printing materials for the microspine arms in order to find optimal climbing abilities and maximum performance. Ultimately, this robot could be modified so that it can be used for outdoor surveillance purposes.

E-92: Simulating Two Phase Cooling In Data Centers
Author: ValenzuelaGaete, Felipe; Phelan, James
Advisor: Dr. Alfonso Ortega

There has been increasing concern over the energy demand of data centers in recent years. As the power dissipated by processors increases, it becomes increasingly difficult and more important to cool them. The limit of air cooling is quickly being approached by the industry and other methods of cooling processors are being investigated. Liquid cooling shows promise, and its implementation has been seen in certain high-power applications. A potential next step to increase efficiency in cooling processors is to harness the latent heat of evaporation by boiling refrigerants. This research utilizes MATLAB Simulink to simulate both single phase cooling of a server and two-phase cooling of a server by solving simultaneous differential equations for a pumped system. This process can be applied either to a single leg, or racked server system. Future directions include running a physical experiment to compare to the virtual experiment results and using the changing densities of the refrigerant to run a pumpless system.

E-93: System Identification of a Nonlinear Dynamic System
Author: Trinkle, Ben
Advisor: Dr. Chandrasekhar Nataraj

"This project aims to design a MATLAB algorithm to determine values or equations of nonlinear damping forces acting on carts on a track. System Identification and dynamic principles were used to create the algorithm. Harmonic motion in the real world cannot be explained accurately using a model with linear damping coefficients. This project aims to accurately track and understand the motion of simple mass-spring-damper systems in the real world.
Analysis of the algorithm was tested using experimental data from a nonlinear fault simulator. The simulator uses a Servo motor to provide a harmonic force to a cart on a track. The cart is connected to other carts with springs, and damping is added with brake pads and ball bearings between the carts and the track. Laser voltage sensors track positions of the carts to a tenth of a millimeter."

E-94: Understanding the importance of heterogeneous phase distributions in the dynamic fragmentation of brittle materials: a computational approach
Author: Krueger, Joseph
Advisor: Dr. David Cereceda

"Unraveling the response of composite materials subjected to extreme environments is crucial for designing effective structures, in mitigating hazardous injuries to human life from flying debris, and enhancing the capacity to respond and recover as part of disaster management. However, a detailed picture of the behavior of these composite brittle materials under high strain rates, and in particular when there is a heterogenous distribution of phases within the material, still remains a challenge.
The goal of this project is to study how current models simulate high strain rate situations and adapt one to handle various heterogeneous distributions of two different brittle materials. Current proven models are only capable of homogenous distributions of two materials. In the pursuit of improving this model, systems were added that could distribute a secondary material into a solid bar of a primary material with a continuous distribution with controlled mean size and standard deviation. Currently, those defects are placed randomly within the bar. But thanks to the VURF summer research program, I am continuing to develop this model to allow for full control over the distribution of defects. Ultimately, this computational model will deepen understanding of material failure and improve the safety of newly developed materials."

E-95: Virtual Experiments for Two-Phase Cooling in Data Centers
Author: Phelan, James; ValenzuelaGaete, Felipe; Ortega,Alfonso
Advisor: Dr. Alfonso Ortega

The limits of air cooling are quickly being reached by the electronics cooling industry as a result of the high-power dissipation from devices such as GPU's and TPU's used in AI and Machine Learning applications. Two-phase liquid cooling offers the ability to dissipate higher heat loads than air cooling. In order to use two-phase cooling systems, it is necessary to control the cooling to individual heat dissipating components as they may change in time. In this study, we developed computational codes that simulate the transient behavior of single-phase and two-phase pumped cooling systems. Using physical equations and MATLAB Simulink, a series of codes were created to transiently simulate a single cold plate and a heat exchanger for single phase cooling loop with prescribed mass flow rate. Using built-in Simulink tools, the differential equations were solved simultaneously for each time step until steady state behavior was reached. This basic code was then refined for more realistic applications. First, the code was adapted to simulate a manifolded single-phase pumped system with multiple parallel branches cooling several heat dissipating devices or servers. Secondly, the single-phase cold plate models were altered to behave as two-phase evaporators and the single-phase heat exchanger was similarly altered to behave as a two-phase condenser. Finally, the requirement for a prescribed mass flow rate was removed and replaced with a requirement for specification of the pumping power. The single phase and two-phase codes were used to simulate the dynamic behavior of these types of cooling systems.

Nursing

E-96: Highs and Lows and Type 1 Diabetes Mellitus: The Lived Experience of Young Adults with T1DM
Author: Ottignon, Madeleine; O'Connor, Melissa; Whitehouse, Christina

Advisor: Dr. Christina Whitehouse, Dr. Melissa O'Connor

"Background: Type 1 diabetes is a chronic autoimmune disease that affects the body's production of the hormone insulin. This disease is diagnosed during childhood and adolescence and may have significant impact on mental health. Understanding the impact of diabetes on mental health during adolescence may provide knowledge about the mental health needs of young adults with type 1 diabetes.

Aim: To describe the lived experiences of young adults with type 1 diabetes and how it relates to their mental health status during adolescence.

Design: A qualitative explorative study using semi-structured interviews.

Methods: A convenience sample of 18 young adults with type 1 diabetes were recruited through social media (i.e. Instagram, Snapchat, and Facebook) and through an announcement in the monthly, national newsletter of the College Diabetes Network. Participants were interviewed individually via Apple Facetime and Google Hangouts. Professionally transcribed data were analyzed using thematic analysis.

Results: The mean age was 20.4 years. Average age of diagnosis was 9.7 years. The interviews generated 5 major themes: isolation; lack of proper support; negative mental health influence; food; and positive characteristics.

Conclusions: This study generated major themes of isolation and food impacts by participants. Many participants agreed that while they had support through family and friends, they felt they would best be reached by other people with type 1 diabetes. Participants also identified a lack of resources for managing type 1 diabetes in adolescence. This knowledge can assist healthcare professionals when caring for patients with type 1 diabetes through adolescence. "

E-97: School Shooters: A Review of Their Use of Social Media and Risk Behaviors
Author: Freitas, Erin
Advisor: Dr. Elizabeth Dowdell PhD, RN, FAAN

"Since 2013 there have been at least 421 recorded incidents of gunfire on school grounds. For many of these adolescent shooters, social media has been used as an outlet for self-expression. Social media use and its association with well-being is often under assessed, which creates a knowledge gap in identifying typical/atypical patterns and content of posts that may reveal warning signs. This study used 25 cases of American male school shooters from 2013 to 2019, ages 12 – 26 years. Following the Joanna Briggs Institute framework guidelines, media news outlets were searched using key words: social media, gun photo, mental health or psychiatric diagnosis, physical health, bullying, suicidal thoughts, and adverse childhood experiences (ACEs). National news outlets were searched, followed by in-depth searching of local media stories. The majority of school shooters (92%) had at least one social media account and 72% had posts on social media that contained distressing content. Over half (72%) of the sample had at least one reported ACE, 60% reported having been bullied, 52% received psychiatric treatment prior to the shooting, 48% had suicidal thoughts, and

44% posted at least one photo of a gun. This synthesis can inform screening and assessments made by nurses and other professionals who work with adolescent or young adult males in a variety of settings. Incorporating questions about social media posts, mental health, bullying, and well-being when working with high risk individuals may be proactive measures that can help prevent these tragedies from occurring."

E-98: The Needs of Caregivers for Older Adults with Diabetes
Author: Danner, Alyssa
Advisor: Dr. Christina Whitehouse and Dr. Melissa O'Connor

"INTRODUCTION: Caregivers play a crucial role in the management of older adults with Type 2 Diabetes Mellitus (T2DM). Caregivers often lack support and experience caregiver burden. The purpose of the study was to investigate the needs and experiences of caregivers of recently hospitalized older adults with T2DM. Semi-structured telephone and in-person interviews were conducted to understand the support that caregivers require from their perspective.

METHODS: Qualitative interviews were conducted using a semi-structured interview guide with open-ended questions that highlighted the caregivers' experience caring for a recently hospitalized older adult with T2DM. All interviews were digitally recorded and professionally transcribed. Once transcribed, transcripts were uploaded to ATLAS.ti to organize and retrieve data. Transcripts were coded independently by two researchers. Similar codes were identified to create themes and subthemes.

RESULTS: A total of 15 caregivers were screened. 10 consented to an interview. Most of the subjects were caregivers for a family member, with a majority of subjects caring for their parents. Participants were mostly female, above age 50, and non-Hispanic Black. The main themes that emerged from the qualitative data were: (1) the role itself, (2) role challenges, (3) role preparation, (4) co-diagnoses to T2DM. The sub-themes were: (1) obligation, (2) full-time role, (3) prior experience, (4) patient challenges, (5) caregiver challenges, and (6) social factors.

DISCUSSION: Caregivers of recently hospitalized older adults with T2DM were interviewed to explore the needs of these caregivers. Our findings provide an understanding of experience, tasks, and needs of caregivers for older adults with T2DM. The study revealed that many caregivers feel that caretaking is an obligation and a full-time role. Although many of the caregivers did not identify T2DM as the main concern due to co-diagnoses, the most pertinent patient and caregiver challenges identified include diet and time-management. "

Physics

E-99: A Further Analysis on the Wind Geometry of GRS 1915+105
Author: Jensen,Danny;Neilsen, Joey
Advisor: Dr. Joseph Neilsen

The black hole X-ray binary GRS 1915+105 has been the highlight of hundreds of studies since its discovery. GRS 1915+105 has been observed with such frequency because it possesses powerful jets, has a high luminosity, and displays erratic variability. As such, GRS 1915+105 has been targeted by various telescopes and spectrometers accounting for thousands of hours of exposure time. Here we report our analysis of two such observations collected using NASA's NICER spectrometer onboard the International Space Station. In two observations, taken just days apart, we observe the presence of strong Fe XXV and Fe XXVI absorption lines as well as the characteristic lines of other commonly present ions. We employ three different methods of spectral fitting to describe this absorption, which likely arises in a wind from the accretion disk around the black hole. While the present absorption spectra corroborate previous studies, there are notable differences between the two spectra that warrant further analysis.

E-100: Chandra and NuSTAR Observations of X-ray Variability from Sagittarius A* Flares
Author: Kwon,Caleb; Neilsen, Joseph; Nowak, Mike; Shuo, Zhang; Haggard, Daryl; Markoff, Sera; Baganoff, Fred
Advisor: Dr. Joseph Neilsen

The supermassive black hole Sagittarius A* (Sgr A*) at the center of our galaxy spends most of its time in a deep quiescent state that is frequently interrupted by flares which increase emission typically by factors of up to 10 but even up to 600. Through simultaneous observations made by the Chandra and NuSTAR X-ray telescopes in April of 2017 and 2018, we report on two flares found on 2017 April 11 (F17) and 2018 April 24 (F18). These flares averaged an unabsorbed 2-8 keV flux of (9.60±1.27)× 〖10〗 ^(-12) "erg" cm^(-2) s^(-1). Lightcurves were obtained and analyzed to find the duration of the flares, which were 2.9 and 2.7 ks. In our spectral analysis of the X-ray flares, there was no significant evidence for a cutoff in the X-ray spectrum. Furthermore, the data are consistent with power-law emission a by gas and dust in the interstellar medium. We found that the power law spectral index was $\Gamma = 2.25 \pm 0.12$ for F17 and $\Gamma = 2.30 \pm 0.1$ for F18. Further investigation with a more powerful telescope, like the Event Horizon Telescope, could prove to find the source of such variability with Sgr A*.

F-101: Investigation of Wind's Effect on LIGO's Hanford Observatory
Author: Caesar, Matthew; Dean, Ray
Advisor: Dr. Amber Stuver

This investigation aims to measure the impact of wind on the detector's glitch rate, lock status, and coherent wave background. These data characteristics comprise LIGO's confidence in any potential gravitational wave detection. By fully understanding the impact of high winds on the Hanford Detector, the LIGO team can take the correct steps to improving the data confidence. Analyzing the effect of wind speed on the omicron trigger rate and coherent wave background, it seems the wind has only a marginal, yet clear effect on LIGO's confidence level. The rate of the omicron triggers increases with the wind speed, but the average Pearson's correlation coefficient between wind speed and omicron trigger rates is only 0.2048. The average maximum wind speed during observing mode is 3.6941 m/s and the average maximum speed while not observing mode is 3.9567 m/s. The results

were gathered and presented to the LIGO team to help decide the necessity of a full wind fence surrounding the detector.

F-102: Mapping a Black Hole Wind: Determining the Orbital Period and Wind Geometry in GRO J1655-40
Author: Petretti, Catherine; Neilsen, Joseph
Advisor: Dr. Joseph Neilsen

In 2005, the black hole X-ray binary GRO 1655-40 went into outburst and produced one of the most powerful outflows ("winds") discovered in such a system to date (Miller et al. 2006, 2008; Kallman et al. 2009). Little is known about this massive wind, but Neilsen et al. (2016) discovered optical/infrared (OIR) emission from the wind that varies on the orbital period: a possible clue to its origin and geometry. However, the orbital phase of a dip in the lightcurve is uncertain because the phases are derived from data taken in 1998 and 1999. (Neilsen et al. 2016; van der Hooft et al. 1998; Greene et al. 2001). In order to determine more accurate phases and determine the wind geometry, a more precise orbital period is needed. We present our analysis of the I-band photometry from observations taken with the SMARTS 1.3-m telescope between 2006 and 2016. We used two methods (Phase Dispersion Minimization and the Eclipsing Light Curve code) in order to determine the orbital period of the system. We discuss the implications for the dip in the lightcurve and the geometry of the wind.

F-103: Structural Determination of Magnetically Frustrated Double Perovskites Ba2EuMoO6 and Ba2PrMoO6
Author: La Manna, Nicholas
Advisor: Dr. Jeremy Carlo

"Geometric magnetic frustration occurs in a material when magnetic order is inhibited by the arrangement of magnetic ions. The magnetic properties of a material result from the interactions between the magnetic moments comprising its structure. Depending on the nature of the interactions, the moments tend to align such that they are parallel, or antiparallel. However, in some cases the moments are arranged in such a way that only certain interactions can be satisfied at once. These materials are said to be magnetically frustrated because there is no way to align the moments such that all nearest neighbor interactions are satisfied. 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. Perovskites exhibit a great deal of chemical and structural versatility, making them excellent objects for systematic examination. We have studied the structure of two double perovskites, Ba2EuMoO6 and Ba2PrMoO6. X-ray diffraction was used to determine the crystal structure of both specimens. While we were unsuccessful in synthesizing Ba2PrMoO6 we have made promising leads in the exploration of Ba2EuMoO6. Depending on further results, we may conduct magnetic measurements in the future."

F-104: The Iron Biomineral Core of Human and Horse Ferritins: A Multi-probe Study via Mössbauer Spectroscopy, Transmission Electron Microscopy and Atomic Force Microscopy

Author: Ji, Kaixuan; Hurley, Lauren; Longo, Thomas; Bou-Abdallah, Fadi; Arosio, Paolo; Viescas,
Advisor: Dr. Georgia Papaefthymiou

Ferritin is the iron storage protein found in most living organisms from bacteria to humans. It consists of two distinct parts: an inorganic core of ferrihydrite surrounded by an organic protein shell. The protein shell consists of 24 amino acid chains or subunits of two types: a heavy chain (H) and a light chain (L). In humans, ferritin is found in many organs such as the liver, spleen, brain, and heart. The structure of ferritin varies depending on location. For example, ferritins in the brain and heart are H-rich, while ferritins in the liver and spleen are L-rich; they are associated with different functions. H-rich ferritins are responsible for frequent iron deposition and release, while L-rich ferritins are responsible for long-term iron storage. Since iron deposits in the brain have been linked to neurodegenerative diseases, such as Parkinson's and Alzheimer's, it is important to study structure/function relations in these types of ferritin. The number of H-chains (and therefore ferroxidase centers) on the protein affects the iron nucleation process and growth of the mineral core resulting in distinct physical characteristics, such as degree of crystallinity, particle size, or magnetic structure, which in turn can affect the chemical/physiological properties of the protein, i.e., iron release. Thus, a comparative study on the physical properties of cores grown within H-rich and L-rich human ferritins is conducted. Ferritin reflects iron concentration and responds to iron level in blood, so it is used in blood tests as a measure of iron status. However, the number of ferritins and the iron storage inside can be affected by factors such as inflammation, infection or pregnancy. Thus, a trial study is conducted on horse spleen ferritin to study other not previously considered physical properties of the protein, i.e., the stiffness or strength of the protein shell.

F-105: Variable Accretion Disk Winds in GRS 1915+105 with NuSTAR, NICER, and Chandra

Author: Aramburu Sanchez, Pablo; Neilsen, Joseph
Advisor: Dr. Joseph Neilsen

The black hole binary GRS 1915+105 is well known for its accretion and ejection processes, particularly its strong variability. We report on two periods of concurrent observations of GRS 1915+105 made by the X-ray telescope NuSTAR in June and August of 2017. The lightcurve of the first observations is steady, while the second shows high-amplitude limit cycles characteristic of the source. We analyzed the time averaged spectra as well as time resolved spectra for NuSTAR, dividing our observation into intervals with high and low count rates. We report disk temperatures of 1.733±0.003 keV and 2.04±0.07 keV for the first and second observations respectively, with generally weak disk emission at low flux. We find that the variability apparent in our second observation can be primarily attributed to changes in the disk flux and temperature; 2.198±0.005 keV at high flux, but 1.769±0.007 keV at low flux. We also report a significant iron absorption line (E~7.05keV) from an accretion disk wind in the spectra. Surprisingly, the wind appears to be stronger (i.e., higher equivalent width) at lower flux: the equivalent width at low flux is ~20% higher than its high flux counterpart for both observations. We discuss these results in the context of mechanisms for wind variability and lags with respect to the continuum. We compare our results to typical behavior of GRS 1915+105.

F-106: Interstellar Magnetic Fields in the Large Magellanic Cloud
Author: Webb Peter
Advisor: Dr. David Chuss

"Interstellar Magnetic Fields in the Large Magellanic Cloud
Author: Peter Webb
Advisors: Dr. David Chuss, Dr. Javad Siah, Dr. Jordan Guerra Aguilera, Joseph Michail

The HAWC+ instrument aboard NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA), measures polarized emission from magnetically aligned dust in the interstellar medium. These measurements enable us to examine the effects of such magnetic fields on the formation of stars. Recent data from HAWC+ on a nearby molecular cloud (Orion) has indicated an anti-correlation between dispersion of the polarization direction and fractional polarization. Using the data collected on 30 Doradus, a star forming region in the Large Magellanic Cloud (a satellite companion galaxy to the Milky Way) we have tested the polarization fraction/dispersion relation and found a much weaker correlation than in Orion. We have also mapped the angular dispersion throughout the region at four different wavelengths, providing a potential proxy for the line-of-sight component of the magnetic field (the polarization itself is sensitive only to the component of the field in the plane of the sky)."

F-107: New Polymers for Solid Polymer Electrolyte Lithium-Ion Batteries
Author: Hurley, Lauren; Clement, Thomas; Olivier, Romain; Picard, Lionel; Rannou, Patrice Rannou; Bernard, Laurent
Advisor: Dr. Lionel Picard

From portable electronics to alternative energy sources, current technologies demand safer, more powerful, less costly, and longer-lived batteries. Lithium-ion batteries are typically used because of their high capacity, high energy density, high specific energy, and cyclability, but they still fail to meet the requirements asked of them. Research has found that many of their shortcomings arise from the use of a liquid electrolyte, so one approach to improving battery performance is to use a solid polymer electrolyte (SPE). On a macroscopic level, SPEs have all the mechanical advantages of a solid, while on a microscopic level (and at temperatures higher than their glass transition temperature), they allow lithium ion conduction. Despite their promising characteristics, SPEs are nevertheless marked by some defaults, notably low room-temperature conductivities, poor electrochemical stability and weak lithium-ion transference numbers. In most research, the polymer poly(ethylene oxide) (PEO) was used, due to its low glass transition temperature (Tg), generally linked to good ion-transference number. However, pure PEO is 85% crystalline, and consequently suffers low conductivites under Tm (60°C). Therefore, the approach of this project was to explore the use of poly (trimethylene carbonate) (PTMC) as an alternative to PEO. Like PEO, PTMC also has a low Tg, but unlike PEO, it is much more amorphous, which yields a higher room-temperature conductivity. Moreover, it has a wider electrochemical stability window, which is important for high energy density systems. This research will discuss the conductivity and transference numbers of PTMC-based SPEs.

F-108: X-ray Analysis of MAXI J1348-630 with NuSTAR

Author: Anczarski, Jadyn
Advisor: Dr. Joseph Neilsen

"The black hole binary MAXI J1348-630 was discovered in January 2019 using the Monitor of All-sky X-ray Image (MAXI) International Space Station experiment. Following the discovery, six observations were taken using the Nuclear Spectroscopic Telescope Array (NuSTAR), a space-based X-ray telescope which observes in the 3 to 79 keV range. The first two observations occurred on 2019 February 1, and the next four on 2019 February 6, February 11, March 8, and April 3. The X-ray transient was observed in outburst, and over the six observations, the spectrum evolves from a hard state to a softer state. In the hard state, the spectrum is dominated by a powerlaw emission, but as the spectrum softens, the accretion disk emission becomes present. We are modeling the spectrum to determine physical quantities, such as the spin of the black hole, inclination of the system, and iron abundance in the accretion disk. Difficulties—due to differences in the response between Nustar's two independent detectors FPMA and FPMB—arose in modeling the spectrum. The cause of these differences has yet to be determined. Future work entails tracking down these systematic differences, as well as joint modeling with the Neutron Star Interior Composition Explorer (NICER)."

Psychological & Brain Sciences

F-109: Brain serotonin deficiency confers susceptibility to stress-induced increases in binge-drinking-like behavior in female, but not male, mice

Author: Waltrip, Leah; Dimitratos, Elisabeth; Dzera, James; Sachs, Benjamin D.
Advisor: Dr. Benjamin D. Sachs

Serotonin (5-HT) deficiency has been implicated in several psychological conditions, including major depression, obsessive-compulsive disorder (OCD), and alcohol use disorders (AUDs). While multiple preclinical studies have directly investigated the role of low 5-HT in depression-like and OCD-like behavior, relatively little research has examined the effects of genetic 5-HT deficiency on alcohol-related behaviors. Unpublished research from the Sachs Lab suggests that low levels of 5-HT can increase susceptibility to stress-induced binge drinking behavior in female mice, but initial work in males was inconclusive. This summer project subjected a new cohort of male wildtype and low 5-HT mice to chronic stress exposure for three weeks and subsequently tested them in the Drinking in the Dark (DID) model of binge drinking to establish whether low 5-HT also influences susceptibility in males. Following the DID protocol, samples from the hippocampus and nucleus accumbens were extracted to analyze potential differences in gene expression based on 5-HT levels, stress history and/or sex. Results indicate that chronic restraint stress increases binge-like drinking behavior in females, but not males. Furthermore, low 5-HT increased susceptibility to stress-induced binge drinking in females, but not males. Potential differences in gene expression that may drive such differences were explored, and significant sex differences in the expression of the genes GSK3, Axin, DICER, and GR were found. Collectively, the results indicate that the combination of chronic stress and low 5-HT levels can contribute to increased binge drinking behavior, at least in females.

F-110: Integration of acoustic cues in speech measured using auditory brainstem responses
Author: Henderson, M. Ryan; Toscano, Joseph C
Advisor: Dr. Toscano

Recent research in hearing science suggests that humans combine auditory cues early in processing and use information from cue interactions to categorize speech sounds, such as "chah" and "sha", into phoneme categories, consistent with animal models that suggest these effects occur due to the operation of the peripheral auditory system. These models predict that ambiguous sounds between "chah" and "sha" will be encoded similarly in the auditory brainstem despite acoustic differences between the cues, and it suggests that human listeners might discard a significant amount of useful information that is present in variations of individual auditory cues. Other models suggest that cues are initially encoded independently of each other and later combined after being weighted by their reliability in distinguishing phonemes, preserving potentially useful information. We evaluated these models by recording auditory brainstem responses while participants listened to four variants of the speech sounds "chah" and "sha" that differed along two acoustic dimensions (silence duration and rise time). Preliminary data show differences in encoding for specific acoustic cues in these sounds. Additionally, in behavioral testing, participants showed a much stronger reliance on the silence duration cue, suggesting that they track the two cues independently and weight this cue more. These data suggest that listeners perceive cues independently in early processing and weight them based on their reliability to achieve accurate speech recognition.

F-111: The Effects of Stressful Experiences on Parent Distress and Child Well-Being Over Time
Author: Wong, Peony; Herbers, Janette
Advisor: Dr. Janette Herbers

Research has shown that experiences of family homelessness pose considerable risks for children's health and development. Despite the challenges associated with homelessness, some children can adapt to these circumstances and demonstrate resilience, with good cognitive, social, and emotional functioning. Parent-child relationships involving warmth and responsiveness can act as a protective factor from the harmful effects that homelessness may have on children. This study examines differences in adaptation of children in families experiencing homelessness. We consider how stressful experiences or adverse life events impact parent distress and child well-being over time using data from 60 parents of children ages 0-5 years who were staying in emergency shelters at the time of recruitment. Participants were assessed at two different times, approximately four months apart, with questionnaires assessing life events, parenting stress, parent distress, parent-child relationship, and children's social-emotional well-being.

F-112: Transfer of temporal information occurs in both operant and Pavlovian procedures
Author: Mallon, Erica
Advisor: Dr. Matthew Matell

Animal behavior reflects knowledge of the temporal relations between external events. This study sought to further our understanding of the capacities for an internal clock used for time perception. Recent research using operant conditioning procedures has shown that rats will transfer learned

information to recalibrate their behavior across cues of differing modalities (light vs. sound) and durations following changes in the reward latency for a single cue. Whether such recalibration occurs in Pavlovian procedures is unknown. In this study, ten rats were run on an operant procedure that delivered a food reward after an 8s or 16s interval signaled by light or tone, respectively (counterbalanced), provided they completed a desired action (poking into a nosepoke aperture) after the appropriate duration elapsed. Ten other rats were run on a Pavlovian procedure, in which food was automatically delivered after these same cues and durations, irrespective of their behavior. After being trained with these conditions, the 16s cue was extended to 32s for all rats until their behavior adjusted to the new interval. Then, the 8s cue was tested in extinction, to see if the rats expected the delay associated with this cue to be extended as well. Results showed that rats in all conditions transferred the change in temporal expectancy from the long cue to the short cue, showing short cue temporal expectation significantly later than during training (27%, $p<0.001$), with no significant effects of procedure. These results suggest that temporal information may be represented in a centralized part of the brain, as the learning system (operant or Pavlovian) did not play a role in transferring temporal information across cues.

F-113: "Individual differences in language ability assessed by top-down lexical activation"
Author: Shahid, Nabiha
Advisor: Dr. Joseph Toscano

"While language comprehension is a universal ability in all humans, there are differences in language ability between individuals. For example, listeners may differ in the extent to which higher-level information about spoken words feeds back down to affect low-level speech perception. One challenge in understanding these individual differences is determining if they arise due to language-specific abilities or more general cognitive abilities, such as working memory and attention. In the current study, I used tasks designed to measure working memory (e.g., recall a sequence of letters that appeared after completing a simple mathematical expression) and language exposure (e.g., recognize the names of authors). I also measured individual differences in the size of the Ganong effect, which measures how higher-level language impacts low-level speech perception during spoken word recognition by examining perception of speech sounds varying between words and non-words (such as perception of the b/p sound at the beginning of "beace" vs. "peace"). Results will be presented comparing subjects' responses on the Ganong task with both language-specific and domain-general measures to better understand the nature of individual differences in language ability."

F-114: Belief Revision: Understanding how children create, maintain and revise their beliefs.
Author: Mir-Almaguer, Keren; Chlebuch, Natasha; Weisberg, Deena
Advisor: Dr. Deena Weisberg

"Understanding how children create, maintain, and revise their beliefs provides us window into learning and development. This study examines under what conditions do children revise their beliefs and whether there is an effect of age on belief revision. Children, ages 4-8 years old, were recruited from various museums (n=192). In this experiment, the child was introduced to a naïve hedgehog puppet and told they were going to work together to figure out what types of flowers bees

like. The puppet and child were presented with two flowers. Either the child or the puppet was asked to make an initial hypothesis about which of the two flowers bees like. They were then provided with evidence that contradicted that initial belief. At the end, they were presented with the two flowers again and the child was asked which of the flowers bees liked. Results suggest that children receiving explicit counter evidence are better equipped to revise their beliefs than children dependent on observed counter evidence. These results give us more insight into how children learn best in their different developmental stages. "

F-115: Challenges associated with Breastfeeding for Mothers of Infants Experiencing Homelessness

Author: Ayemere, Amenawon; Leonard, Jake
Advisor: Dr. Janette Herbers

When mothers experience extreme poverty and homelessness, these challenges could make breastfeeding more difficult and reduce the likelihood that infants experiencing homelessness receive this powerful source of nutrition and protection. My research project will investigate the rates and duration of breastfeeding within a sample of 75 mothers and their young children (ages 0-36 months) recruited while staying in family homeless shelters. I will also assess whether certain risk factors such as maternal depression, lack of social support, marital status, child care, and education relate to the likelihood of breastfeeding, and whether breastfeeding is associated with the quality of the mother-child relationship and the child's developmental outcomes in relation to physical, language, and social domains. I expect to learn that few mothers experiencing homelessness will breastfeed their infants, and that those who do breastfeed will not do so for more than a few months. I also expect to find that differences in experiences like maternal depression will relate to breastfeeding, and that breastfeeding will predict more positive parent-child relationships and healthier infant development among this high risk population.

F-116: Risk Factors Associated with Emergency Room Visits in Homeless Families

Author: Tebepah, Tariere; Buccelli, Alexandra; Herbers, Janette
Advisor: Dr. Janette Herbers

In the US, there are complexities in the healthcare system that limit accessibility to adequate health care for many lower income families and families who live in emergency housing programs (including shelters and state funded hotels/motels). Due to the lack of affordable healthcare available for low income families, there have been increases in number of visits to the emergency room with lower income families than higher income families who regularly have doctors' visits. Reports of the reasons for hospital use in homeless families are usually more severe as well, as there are many instances where other priorities are taken into consideration, including food, shelter, and clothing over routine healthcare. This ultimately leads to conditions not conducive to a child's optimal health and development. In this study, I analyzed and investigated the factors that predict ER visits for families experiencing homelessness--- more specifically whether resource accessibility (employment, education, social support, federal support), or intrapersonal experiences (maternal distress, stressful life experiences) has a greater impact on the frequency on ER use. The analyses from the interviews of approximately 75 parents from six different emergency shelters in

Philadelphia were used to determine if resource accessibility predicts ER visits beyond the influence of intrapersonal factors. The data indicates that adversity faced by the child, social support from friends of the parents, and the age of the parent predicted the total number of Emergency Room visits.

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