# Abstracts: Oral Presentations

***All oral presentations will take place in the Devon Room***

## Biology

### *(1:30 p.m.)*

**Exploring the Genetic Toolkit of *Crithidia bombi***
Authors: Lockett, Sarah; Bieber, Blyssalyn; St. Clair, Faith; Povelones, Megan
Advisor: Dr. Megan Povelones

*Crithidia bombi* is a monoxenous trypanosomatid parasite that infects bumblebees by adhering to the ileum of their intestinal tract. Parasites may persist in an infected colony or be transmitted to neighboring colonies via the fecal-oral route. *C. bombi* infection affects the reproductive success of a colony by reducing the fitness of the queen. To better understand the complex relationship between the parasites and their hosts and the implications this has on pollinator health and ecosystem services, we are establishing new genetic techniques for study of *C. bombi*. Using constructs for genetic modification of *Crithidia fasciculata*, a highly-related kinetoplastid, we episomally expressed cytoplasmic GFP in *C. bombi* wildtype cells. To our knowledge, this is the first genetic modification of *C. bombi* and will be useful for in vivo visualization of infection. We expressed an episomal construct containing a c-terminally GFP tagged copy of *C. fasciculata* ribonuclease H1 (RNH1) and localized RNH1 to the kinetoplast and nucleus in *C. bombi*. We also adapted methods for studying in vitro adhesion of *C. bombi*. *C. bombi* adheres to glass and to untreated tissue culture plastic, in what appears to be a density dependent manner. Preliminary observations suggest that flagellar length is also correlated with cell density. We were able to observe rosettes after 48 hours of growth in wild type and RNH1 tagged cells, indicating that genetic modification did not impact cellular adhesion.

### *(1:45 p.m.)*

**Quantitative D note variation in Carolina, Black-capped, and hybrid chickadees**
Authors: Salartash, Savrina; Coppinger, Brittany; Curry, Robert
Advisor: Dr. Brittany Coppinger

Communication variation between species tells us how genetics influence species-typical behaviors. In Pennsylvania, Carolina Chickadees (*Poecile carolinensis*; CACH) and Black-capped Chickadees (*Poecile atricapillus*; BCCH) overlap in a hybrid zone where admixed offspring often display intermediate behavioral phenotypes. The chick-a-dee call, including D notes, communicate predator threat and social cohesion. CACH and BCCH produce qualitatively and quantitatively different notes, which have not previously been assessed at the individual level with known ancestry. We investigated if hybrids produced D notes of intermediate acoustic structure compared to notes produced by unadmixed individuals. We recorded calls from four sites, using 10 species-diagnostic SNPs to determine species ancestry. Pitch of D notes increased, and note duration decreased, with

extent of CACH ancestry; inter-note interval did not vary with ancestry. Results confirmed D note structure varies with species, while showing hybrid birds produce D notes with intermediate properties, support the hypothesis that genetic ancestry influences call development in individual chickadees. Future studies will determine if receivers attend to differences in D note structure.

# Civil and Environmental Engineering

## *(2:00 p.m.)*

**Enhancing the anion exchange capacity of biochar for the immobilization of PFAS in soil**
Authors: LaBarbara, Toni; Samonte, Pamela; Xu, Wenqing
Advisor: Dr. Wenqing Xu

Per- and polyfluoroalkyl substances (PFAS) are highly stable organofluorine compounds that resist environmental degradation due to the strength of C-F bonds in their structures. PFAS' high chemical and thermal resistance, and the hydrophobic properties of their nonpolar C-F tails, have made these compounds popular for industrial uses including their impregnation in building materials, paints, and paper goods. The wide-spread industrial use of PFAS since the 1940s has introduced more than 3,000 PFAS to various components of the environment. PFAS are bioaccumulative, and can cause adverse health conditions such as stunted immune response, infertility, high cholesterol, and kidney and testicular cancer. As a result, the EPA has recommended a maximum combined concentration of 70 ng/L of perfluorooctanesulfonic acids (PFOS) and perfluorooctanoic acid (PFOA) in drinking water to protect public health. Since 2016, 1.3% of drinking water systems in the U.S. exhibit concentrations of at least one long or short-chain PFAS beyond 70 ng/L, affecting at least 5.5 million Americans and making PFAS contamination a primary concern for human and environmental health. Studies show that one substantial source of PFAS contamination is the application of biosolids from wastewater treatment facilities on agricultural lands, impacting thousands of sites worldwide. This project explores the effect of porosity and metal-salt pretreatments on biochar's ability to immobilize long and short-chain PFAS in soil. After optimizing the process of producing biochar with an enhanced anion exchange capacity, the biochar samples are characterized using FTIR, BET, and SEM. Finally, batch adsorption kinetics experiments determine the most effective pyrolysis temperature and metal-salt pretreatment for PFAS sequestration.

# Communications

## *(2:15 p.m.)*

**Domesticating Activism: The Rhetoric of the Women's Rights Pioneers Monument**
Author: Lay, Madeline
Advisor: Dr. Bryan Crable

Although purportedly an installation focused on the past, the Women's Rights Pioneers Monument in Central Park, New York is deeply connected to this moment in contemporary U.S history. First, Sojourner Truth's omission from the original design indicates that whiteness continues to occupy a default position—not only in the story of the Women's Rights Movement, but within U.S history and culture more broadly. Her initial absence reflects a lack of acknowledgment of the role of Black women in the Women's Rights Movement and, more generally, suggests key omissions in our memories of past movements for social change. Moreover, even in its revised version, the Monument's depiction of cross-racial feminist activism merits scholarly attention since it appeared months after the Black Lives Matter protests of Summer 2020. Scholars have begun to focus on the rhetorical dimensions of the struggle over the removal of memorials, such as those of Confederate soldiers, but in this essay, I instead focus on something that might be more readily overlooked: the addition of a new memorial and the rhetorical work that it does in relation to these issues of race and activism. Through my research, I have concluded that the Monument problematically depicts social change with a rhetoric of domesticity, interpersonal or interracial relationships, and symbolicity. The Monument imagines successful social change to be more civil and passive in nature, creating a collective memory that the fight for Women's Rights was not much of a fight at all, but rather a group of three women speaking, writing, and organizing around a kitchen table.

# Education and Counseling

## *(2:30 p.m.)*

**Foregrounding Disability: Factors Influencing 6-12 English Language Arts Teachers Leading Disability-Related Classroom Discussion**
Author: Jacobson, Rebecca
Advisor: Dr. Christa Bialka

Class discussions can work to dismantle societal norms, which gives teachers the power to mitigate ableism by discussing disability as a social identity with their students. However, many teachers refrain from doing so for various reasons. This exploratory, qualitative study explores the factors that influence teachers' decisions to lead disability-related discussions in 6-12 English classrooms through interviews with 13 in-service English teachers. Findings reveal that disability representation in literature, classroom/school culture, and personal factors influence teachers' decisions to discuss (or refrain from discussing) disability with their students. Implications include providing teachers with support from professional resources and including disability representation in the curriculum by dismantling systemic barriers that prevent teachers from having agency in their classrooms. The current body of literature focuses on the changes that can be made to create facilitators for

disability-related discussion, but rarely does it provide teachers with solutions for systemic barriers that cannot be changed easily or when teachers do not have the autonomy to remove these barriers. This research sheds new light on the institutional obstacles teachers face when trying to discuss disability as a social identity with their students.

# History

## *(2:45 p.m.)*

**Something Borrowed, Something New: Development of Diplomacy in the Sino-American Relationship, 1989 - 1996**
Author: Lanoue, Alivia
Advisor: Dr. Marc Gallicchio

George H.W. Bush entered the White House confident that his past with China would enable him to deal directly with a communist Beijing. This was primarily because both Bush and Beijing favored the One China policy. He soon learned, however, that the Taiwanese did not. The Taiwanese desire to separate from 'One China' angered the mainland and demanded a response from Bush. Further, China's modernization movement in the 1980s coincided with Taiwan's democratization. The discrepancy between modernization and democratization was leading to confrontation in the Taiwan Strait. Further, for Bush to outwardly support either China or Taiwan would have global ramifications. Professors Edward Mansfield and Jack Snyder elaborate on these ramifications. They posit that there is a direct correlation between democratization and war. In investigating their theses, and the counterarguments against them, one thing becomes clear: Taiwan is an anomaly. As Taiwanese began to prefer independence, China was developing infrastructure that could suppress it. The 'One China' policy brought an interesting dilemma to political analyses of cross-Strait relations. Considering that Taiwan is a part of one China, its democratization efforts were poised against an autocratic reign. Mansfield and Snyder, and their critics, contend that either democratization or autocratization increases a nation's propensity for war. None of these theorists assume that both processes could occur simultaneously, as they did in the Taiwan-China confrontation. Bush unexpectedly became the first president to deal with the unraveling of the diplomatic friction regarding 'One China' that had existed since 1972. Such a development was so unexpected that even internationalist theorists who study conflict had not created a model to describe what was taking place.

# Humanities; Philosophy

### *(3:00 p.m.)*

**The Good Death**
Author: Tsai, Joshua
Advisors: Dr. Helena Tomko; Dr. Stephen Napier

As a society, we have a fear of death. We discuss it in euphemisms or shy away from even its mention, hoping that modern medicine will delay its onset. So, when the inevitable eventually does come, we are ill-equipped and unprepared to face death. We need to rehabilitate our relationship with death so that we are enabled to die well and live better for it. The solution is twofold: making our healthcare infrastructure more accommodating to the dying and amending our own lives in the knowledge that we will one day die. Healthcare workers need to be trained in how to treat aging and dying patients with honesty and consideration so that patients can be well-equipped to make their healthcare and life decisions. Palliative medicine improves the quality of life as patients near death and should be made more prevalent through education and the lowering of barriers to access. Healthcare professionals are not the only ones who play a role in our good deaths. Each human person plays an active role in how they live and die, and this duty ought to be taken more seriously. Living a good life includes cultivating valuable relationships and seeking greater meaning in life. Most importantly, one should acknowledge one's finitude, despite the fear that comes with it. Living life in this light allows one to cherish the life that one does have and to prepare for the good death that all people deserve.

# Mathematics and Statistics

### *(3:15 p.m.)*

**Maximum Number of Colorings Among Graphs with a Fixed Number of Vertices and Edges**
Author: Mahmud, Abdullah Al Rafi
Advisor: Dr. Melissa Fuentes

Our project is based on a well-known problem in Graph Theory called the Graph Coloring Problem (GCP): Color (or label) the vertices of a graph in such a way that no two vertices that share an edge receive the same color. This problem has applications in scheduling problems, register allocation, and mobile radio frequency assignment and among others. For a given graph G and a set of colors, we denote P_G(q) as the number of ways to color the vertices of G using at most q ≥ 1 colors so that the GCP is satisfied. This is a well-studied parameter in Graph Theory, and there are many problems involving P_G(q) that have yet to be solved. The general problem we considered in our project is as follows: "Among all graphs with n vertices and m edges, which graph(s) attain the highest value of P_G(q) for a fixed number of q colors?" Linial and Wilf proposed the problem in the mid-1980s. Solving this problem would help to better determine the running time of a well-known algorithm, called the Backtrack Algorithm for the GCP. We solved the problem for specified values of n, m, and q. Let T_r(n) denote the Turán graph - the complete r-partite graph on n vertices

with partition sizes as equal as possible. We have proven that when the number of colors q=5 and the number of vertices n is sufficiently large, the Turán graph T_3(n) has more colorings than any other graph with the same number of vertices and edges as T_3(n). The key to proving this was to solve a difficult quadratically constrained linear optimization problem, which we will present in our talk.

# Nursing

## *(3:30 p.m.)*

**Parents' Influence on Adolescents' Relationship With Food: A Systematic Review of the Literature**
Authors: Miller, India; Oliver, Tracy
Advisor: Dr. Tracy Oliver

Background: Parenting practices, such as imposing very strict food rules or role modeling healthy eating habits, have the potential to lay the foundation for their children's long-term eating behaviors and relationship with food. During adolescence, children begin to increase their autonomy by making their own food choices, and various parenting styles may contribute to the healthfulness of these eating behaviors. Purpose: To investigate the ways in which parents influence adolescents' relationship with food and their eating behaviors. Methods: A systematic literature review was conducted reporting on the ways in which parents may influence their adolescents' relationship with food. PRISMA guidelines were followed, and articles were searched through CINAHL and PubMed databases utilizing search terms: adolescents, parents, caregivers, parental influence, parenting styles, eating behaviors, unhealthy eating, and relationship with food. Articles were published between 2017-2022 and were assessed using the Quality Assessment table. Results: Twelve articles met the inclusion criteria and were included in the systematic review. Articles revealed three themes: rigid parenting practices, positive role modeling, and adolescents' dependence on parents for food acquisition. Conclusions and Implications: This review suggests that rigid parenting practices may result in less healthful eating behaviors, leading to adolescent weight gain and guilt about parental disapproval. Positive parental role modeling may result in more healthy eating behaviors and higher consumption of healthy food. Adolescents continue to depend on their parents for access to foods within the home. This review provides considerations when exploring the healthfulness of eating habits with their adolescent patients.

# Abstracts: Posters

***All poster presentations will take place in the Villanova Room***

## Astrophysics and Planetary Science

**A-01: Spectroscopic Determination of Radial Velocities of Red Giants in Binary Systems**
Authors: Severe, Darby; Hambleton, Kelly; Beck, Paul
Advisor: Dr. Kelly Hambleton

Red Giant stars in binary systems are crucial to understanding binary star evolution and the structure of binary star systems. In this study, we look at the spectroscopic observations from the 1.2 meter Mercator telescope on La Palma and the accompanying Kepler space satellite light curve data of KIC 7799540. Using these data, we have determined the radial velocities of the stars in the system and the orbital parameters of the system. The radial velocities were extracted with iSpec, an open-source framework for spectral analysis, in the target wavelength range of 478.11 to 653.56 nanometers. KIC 7799540 was found to be a double-lined spectroscopic binary. We modeled the radial velocities using PHOEBE, a binary modeling software package, to determine a model radial velocity curve and the following parameters: orbital eccentricity, semi-major axis, mass ratio, phase shift, the center of mass velocity, and argument of periastron. During the initial fitting of KIC 7799540, it was determined that the period and argument of periastron of the system are changing. This change in the period and argument of periastron could be indicative of apsidal motion or a tertiary companion in the system. Future work will consist of measuring the change in the argument of periastron, eccentricity, and period.

## Biochemistry

**A-02: Protein homology modeling of a prostaglandin synthase from Gram-positive bacterium *Mycobacterium smegmatis***
Authors: Ford, Elisabeth; Selinsky, Barry
Advisor: Dr. Barry Selinsky

*Mycobacterium smegmatis*, a bacterium from the *Mycobacterium* genus, has one protein that has been demonstrated to possess prostaglandin synthase activity. Prostaglandin synthases are eukaryotic proteins that generate chemical messengers known as prostaglandins, which have many important functions. Potential structures of the mycobacterium protein were examined to determine a possible true structure for the protein. Digital structures were built in trRosetta, Phyre2, and Swiss Model that were both modeled after template eukaryotic prostaglandin synthases and generated from statistical analysis of bond formation. To test the accuracy of these models, potential ligand docking was observed using AutoDock Vina. The success of these dockings was determined through the proximity of the ligand to experimentally determined active site tyrosines for lipid ligands (Y367 for mycobacterium) and histidines for heme docking determined through observation of the models

(H145 and H370 for mycobacterium). Some promising results were found with a Phyre2 model, which had both a successful heme docking and a linolenic acid (LNL) docking that, while not in the right configuration, was in the active site and interacting with Y367.

**A-03: Ubiquilin-2 and GFP sedimentation**
Author**:** Lliviciota, Jeniffer
Advisor: Dr. Daniel Kraut

Ubiquilin-2 (UBQLN2) is a shuttle protein that is usually found in the cytoplasm and functions as a receptor for polyubiquitinated proteins. UBQLN2 contains a ubiquitin-like domain (UBL), which interacts with the proteasome, and a ubiquitin-associated domain (UBA), which interacts with ubiquitinated substrates. Ubiquitinated substrates can thus be shuttled to the proteasome where they are degraded. UBQLN2 has also been shown to undergo liquid-liquid phase separation, forming protein-containing droplets. The goal for this research was to investigate how Ubiquilin-2 (UBQLN2) interacts with different substrates and how substrate and proteasome interactions affect phase separation, and how phase separation affects degradation by the proteasome. We performed two different types of experiments, first observing the sedimentation of UBQLN2, substrates, and proteasome separately and in combination, and second observing the degradation of substrates in the presence or absence of UBQLN2. We found that UBQLN2 and ubiquitinated substrates sediment reciprocally, with the extent of UBQLN2 sedimentation dependent on the ubiquitin chain linkage. The proteasome co-sedimented with UBQLN2 in the presence of K63-linked substrates. Finally, UBQLN2 protected a ubiquitinated substrate from proteasomal degradation, and we hypothesize that this effect may be due to UBQLN2-induced phase separation of the substrate.

# Biology

**A-04: Anatomical analysis of neurons in larvae that contribute to courtship behaviors of adult *Drosophila***
Authors: Miller, Kara; Murphy, Micaela; Duckhorn, Julia; Shirangi, Troy
Advisor: Dr. Troy Shirangi

The dissatisfaction (dsf) gene contributes to development of female and male courtship behaviors in *Drosophila*. We recently identified a small population of sexually dimorphic dsf-expressing neurons in the adult central nervous system that regulate female- and male-specific courtship behaviors. These neurons appear to exist in the nervous system of larvae as sexually monomorphic, segmentally repeating interneurons, suggesting that they may contribute to larval behavior and are repurposed during pupal life for dimorphic functions in the adult. To further investigate these neurons in larvae, I used the multicolor flip-out (MCFO) system to stochastically label individual dsf-expressing neurons in the larval central nervous system. I present evidence that dsf-expressing neurons of larvae exhibit extensive anatomical diversity, and that most, but not all neurons, exist as mature, differentiated neurons that likely contribute to larval behavior. These data provide insights into how neurons in a juvenile animal become reused for new functions in the adult.

**A-05: Call structure variation in Carolina chickadees and black-capped chickadees as a function of ancestry: an experimental approach**
Authors: Edmark, Caoimhe; Coppinger, Brittany; Curry, Robert
Advisor: Dr. Brittany Coppinger

When closely related species live in the same area, it is important that they, and other species around them, can understand and communicate with each other. Carolina Chickadees and Black-capped Chickadees are known to differ in their call and song structure; however, it is unclear how the hybrid Chickadees' calls and songs vary in relation to the parent species. We used a standardized threat to elicit alarm calls from parents at our study site nests, we recorded their calls and have scored and analyzed the sonograms of these calls to determine the extent to which call structure variation differs across the species. Carolina Chickadees have more variation in the number and type of introductory notes as well as fewer D notes overall than Black-capped chickadees which have fewer introductory notes and more D notes on average. The hybrid calls are most similar to Carolina Chickadee calls. These results can help us determine the extent to which these birds, and other animals in their area, understand and interpret their species-specific calls.

**A-06: cAMP signaling controls adhesion of *C. fasciculata***
Authors: Holmes, Nikki; Malfara, Madeline; Hodges, Kelly; Povelones, Megan
Advisor: Dr. Megan Povelones

*Crithidia fasciculata* is a mosquito-infectious kinetoplastid parasite. All kinetoplastids adhere to tissues in their insect hosts via the flagellum. While the mechanism is unknown, *C. fasciculata* serves as a useful model for this process because of its ability to adhere in vitro. Cyclic AMP (cAMP) is a second messenger involved in many kinetoplastid processes, including differentiation, social motility, and flagellar movement, but the pathway is uncharacterized in *C. fasciculata*. Two important enzymes in the cAMP pathway are adenylyl cyclases (ACs) and phosphodiesterases (PDEs), which create and degrade cAMP respectively. We have performed transcriptomic and proteomic analyses comparing swimming and adhered *C. fasciculata*, showing that cAMP signaling components, including both PDEs and ACs, are upregulated in the swimming stage. We have localized both a putative phosphodiesterase (CfPDEA) and a putative adenylyl cyclase (CfRAC1) to the flagellum in swimming cells. The PDEA is found along the length of the flagellum, while the RAC1 is primarily found in the distal third of the flagellum. Other kinetoplastids have displayed this same localization pattern, further supporting the flagellum as a signaling organelle. During adherence, *C. fasciculata* shortens the flagellum and undergoes multiple cell divisions as adhered haptomonads, forming rosettes. In adherent cells, both signaling components have relocalized to the cell body and are no longer detectable in the shortened flagella. Understanding the cAMP pathway in *C. fasciculata* may reveal the role of the flagellum in signal transduction and adherence in kinetoplastids, and we have created a model to describe this.

**A-07: Dissatisfaction and fruitless, two genes involved in the innate courtship preferences in males of *Drosophila melanogaster***
Author: Murphy, Micaela
Advisor: Dr. Troy Shirangi

The gene dissatisfaction (dsf) in *Drosophila* encodes a developmental nuclear receptor that affects courtship behavior in both sexes. Males homozygous for dsf null alleles are bisexual, courting males and females indiscriminately. Which dsf-expressing neurons contribute to this phenotype are not known. Dsf-expressing neurons that co-express the sex determining gene, fruitless (fru), are candidate neurons, as previous studies have implicated fru as a regulator of male courtship orientation. To test if dsf regulates mating preference through fru neurons, the Gal4/UAS system was employed to knockdown dsf expression in the fru-expressing neurons using RNA interference (RNAi). To determine if the loss of dsf activity affects the development of fru-expressing neurons, dsf- and fru-coexpressing neurons were visualized in dsf+ and dsf mutant genetic backgrounds. The results from these studies provide new insights in the genetic mechanisms that regulate innate animal behaviors.

**A-08: Do RNA helicases defend against heat stress?**
Author: Chae, Danbee
Advisor: Dr. Elaine Youngman

A link between genetic and environmental factors remains elusive as approximately 15% to 30% of couples are diagnosed with unexplained infertility [1]. It is crucial that the genetic basis of fertility is robust to changes in environmental conditions. Interestingly, a new aspect of RNA helicase has been revealed in which studies show those expressed in germ cells are important in stress responses [2]. In the model roundworm *Caenorhabditis elegans (C. elegans)*, the RNA helicase, *ddx-3*, is associated with stress granule assembly, which aids cell survival by serving as sites of translational silencing. Animals lacking functional *ddx-3* without the eIF4E-binding motif were found to be impaired in the stress granule-inducing ability under adverse environmental conditions [3]. Given the findings of how silencing certain RNA helicases threatens the survival of *C. elegans* under stress, **we hypothesized that the knockdown of RNA helicases expressed in germline development will lead to infertility in *C. elegans* under heat stress.** To test this hypothesis, 9 candidate genes expressed in the germline and unassociated with splicing or rRNA processing machinery were examined. N2 (wildtype) worms underwent RNA silencing and were grown at 20°C, the animal's optimal growth temperature, and at 25°C to study the effects of heat stress. Then, I conducted a brood size count for 4 consecutive days. Strikingly, preliminary results suggest that most genes reared under stress at 25°C reduced in brood size and some even showed no progeny. I am re-running the ongoing experiments to gather further data and updated results will be presented.

**A-09: Egg fertilization as an influence on investigation of hatching success and nestling sex ratio in hybridizing chickadees**
Authors: Garriga, Carlos; Curry, Robert; Coppinger, Brittany
Advisor: Dr. Alyssa Stark

Hybridization of Carolina Chickadees (CACH) and Black-capped Chickadees (BCCH) results in a dramatic decrease in hatching success. This may result from prezygotic barriers that prevent fertilization from occurring via incompatibility of genitalia or gametes. It could also reflect postzygotic barriers that prevent the full development of the fertilized zygote at any point in its

lifetime after fertilization. I studied differences in fertilization between four field sites spanning the hybrid zone in southeastern Pennsylvania. I collected 42 eggs in 2022, of which 45% had a clear germinal disk examined under a fluorescent microscope to find evidence of fertilization. Another 31% of the eggs had distinct embryos that signified a halt in development, and 24% of the eggs were inconclusive. Further analysis will conclude if genetic incompatibility between CACH and BCCH halted reproduction before or after fertilization.

**A-10: Exploring the Role of Dynamin-1-Like Protein in *Trypanosoma Brucei***
Authors: Pereira, Alexa; Donio, Frank; Malfara, Madeline; Povelones, Megan
Advisor: Dr. Megan Povelones

*Trypanosoma brucei* undergoes morphological changes to adapt to host environments, including remodeling of their mitochondrial network. In yeast and mammals, membrane remodeling events involve both classical dynamins and dynamin-related proteins (DRPs), with DRPs mediating organelle division. In contrast, *T. brucei* have only one multifunctional dynamin-like protein (TbDLP) with roles in endocytosis and mitochondrial fission. Currently there are no known interacting proteins for TbDLP, and uncovering its molecular mechanism remains complicated by its involvement in multiple cellular pathways. Using tandem affinity purification in the related kinetoplastid *Crithidia fasciculata*, we have identified 30 putative DLP interacting proteins and are now screening these putative interactors in *T. brucei*. We have created RNAi constructs of candidates Tb927.6.3980 and Tb927.4.2990, two hypothetical proteins whose function is unknown. Knockdown of these proteins by RNAi does not seem to affect cell growth, but we are still in the process of confirming knockdown by quantitative PCR (qPCR). Additionally, we are investigating the role of a novel pyridothiazinone, Compound 1. Treatment of *T. brucei* with Compound 1 significantly impairs cell growth with parasites unable to complete mitochondrial division and ultimately arresting in the 2N2K stage of the cell cycle, prior to completion of cytokinesis. These phenotypes are very similar to those seen in cells depleted of TbDLP by RNAi leading us to hypothesize that DLP may be a potential target of Compound 1. To identify other possible molecular targets of Compound 1 we are employing an unbiased screen using a previously published inducible gain of function library to look for mutants with resistance to our compound. Pilot experiments were completed to determine the ideal concentration of Compound 1 prior to performing our gain of function screen.

**A-11: Expression of cloned pdu genes in *Salmonella enterica* serovar Typhimurium does not require known chromosomal pdu regulators**
Authors: Nguyen, Anh; Wilson, James
Adviser: Dr. James Wilson

Bacterial microcompartments (MCPs) are protein organelles that house and protect bacteria from toxic and volatile intermediates during metabolic pathways. The engineering of MCPs across different species could potentially facilitate the development of drug-delivery therapies and encapsulation of target cytotoxins or other cargo; thus, efforts have been taken to clone and transfer MCP genes from one bacterial species to another. The pdu operon encodes for an MCP that metabolizes 1,2-propanediol in a B12-dependent pathway while encapsulating the toxic propionaldehyde. The pdu system has been shown to be successfully cloned, transferred, and expressed in various bacterial species; however, the role of its known chromosomal regulators in

expression of the clone has not been addressed. Here, we knocked out each of five pdu regulators – ptsN, arcA, cpxR, FNR, and himD – in the *Salmonella enterica* serovar Typhimurium delta-pdu background, then transferred a pdu operon clone into this mutant via R995 plasmids. The cloned pdu operons were isolated from each of three different serovars: S. Typhimurium, *Salmonella enterica* serovar Enteritidis, and *Salmonella enterica* subspecies arizonae. All transfers showed robust expression and activity of the pdu MCPs as they demonstrated clear B12-dependent 1,2-propanediol utilization. These results suggest that the elevated copy number of the pdu system due to plasmid cloning overrides the pdu regulators' activity. Moreover, it is possible that not only the cloned pdu MCP but also other cloned MCPs can potentially be expressed in many bacterial species independently of their regulators.

**A-12: Friend or Foe: The Impact of Invasive and Native Plant Species on Yeast Diversity**
Author: Gruett, Mya
Advisor: Dr. Dana Opulente

Yeasts are single-celled fungi that have been isolated from various plants, environments, and animals. While yeast are widespread in their diversity, few studies analyze different ecological aspects of yeast. It is known that invasive plants modify soil microbial communities, however, little research pertaining to yeast has been conducted (Farrer *et. al.* 2021). From this, I infer yeast yeast diversity will increase in the presence of invasive plant species. I propose to observe and measure the microbial diversity of yeasts in the presence of invasive and native plant species. I will collect samples and isolate yeasts from both invasive/native plants, and observe any differences between the two environments. Furthermore, species-level identification of yeasts will be determined through the use of genome sequencing. This research provides an opportunity to expand our understanding of yeast ecology and to explore the role of invasive species in yeast microbiology.

**A-13: From leaves to landscapes: explaining interannual variability in plant growth in a long-term marsh experiment**
Author: Yedman, Bella
Advisor: Dr. Adam Langley

Nitrogen (N) is the most common limiting nutrient for plant growth, but it is also a major pollutant in estuaries. Wetlands can mitigate N pollution through N uptake and sequestration in plant biomass and accreting soils. The factors that control the balance of inputs and losses in wetlands are not fully understood, which hinders our ability to predict how wetlands may mitigate future nutrient loads. At the Smithsonian Environmental Research Center (SERC), an ongoing 16-year experiment has shown that total plant growth is limited by N availability through long-term N addition. The amount of N in the soil and plants varies widely from year to year, but this variability remains unexplained. I hypothesized that interannual variability in plant growth would be driven by fluctuations in external N loading in Chesapeake Bay. Contrary to my expectations and common assumptions in literature, I did not observe relationships between external load and soil porewater N, plant N pools, or plant biomass. Instead, interannual variation in porewater N concentrations was tightly related to variation in plant N concentrations. However, neither of those internal N concentrations appeared to relate strongly to other climatic variables, N pools, or plant growth. I conclude that unmeasured N fluxes, such as N mineralization, fixation, denitrification, or tidal flushing, are large compared to the magnitude of the pools assessed here and may obscure hypothesized relationships. In future studies,

I could measure and incorporate rates of larger N fluxes into the analysis to determine their impact on the pools assessed here and further inform the mechanism of nutrient cycling in a marsh system.

**A-14: How sticky is too sticky?: Gecko locomotor performance in high adhesion conditions**
Authors: Redpath, Julia; Stark, Alyssa
Advisor: Dr. Alyssa Stark

Geckos with adhesive toepads must retain their ability to run at high speeds when attaching and detaching their adhesive system over many stride cycles. At high ambient relative humidity (RH) and low ambient temperature, gecko adhesion is remarkably strong but running speed is slow. Because geckos are ectothermic, it is unclear if this result is simply because geckos cannot move their bodies quickly at low temperature (reducing speed), or if high adhesion at the substrate surface produces adhesive forces that are too strong to overcome (i.e., the gecko does not have enough muscular power to release their adhesive system in this context). To determine if there is a point where gecko adhesion is "too sticky", forcing geckos to slow their speed, we varied substrate surface temperature (12 and 32°C) on a 1m racetrack. Geckos were also acclimated to varying humidity (30, 70, 80% RH) to test if there was a point where adhesion was so high, due to setal softening, that the geckos were unable to run at high speeds. We also measured behavioral tendencies like stopping, slipping, and avoiding the racetrack. We predicted that gecko running speed would slow and the frequency of avoidance behaviors (e.g., jumping off the track, turning around) would increase on the highly adhesive 12°C surface temperature racetrack. The results of this work will help us understand the fundamental mechanism(s) responsible for gecko adhesion, and how this relates to locomotor performance and behavior of geckos.

**A-15: Hybridization trajectory and relict recognition of song in the chickadee hybrid zone: an experimental approach**
Author: Rauscher, Frank
Advisor: Dr. Robert Curry

Hybridization is common and can be detected by genetic differences and behavioral responses. Nolde Forest Environmental Education Center (NF) was formerly in the middle of a northward shifting hybrid zone where Carolina chickadees (CACH) possess a selective advantage over black-capped chickadees (BCCH). The migration of song tends to move more slowly relative to the movement of CACH alleles within a hybridizing population. I used the variation in CACH and BCCH song recognition to substantiate the allocation of CACH alleles within the hybrid population at NF. I conducted song playback experiments (SPEs) using pre-recorded CACH and BCCH songs at 41 artificial nest snags to assess resident NF breeders' responses and repertoire. I quantified the vocal responses to each stimulus and cross referenced these data with the ancestral genotype of resident NF breeders obtained from DNA extracted from field-collected blood samples at each individual snag. Vocal responses to the CACH playback were more frequently observed relative to the BCCH playback indicating that CACH alleles have continued to overpower the BCCH gene pool. Vocal responses to the BCCH playback were significantly less frequent but still discernible indicating that BCCH alleles still reside within the resident breeder population at NF. These genetic and behavioral data characterize the late stages of hybridization and may be applicable to many scenarios involving the introgression of two morphologically similar species.

**A-16: Identification of new molecular players in the nonstop decay pathway of germ cells in C. elegans**
Authors: Diamandi, Michelle; Brennan, Catherine; Youngman, Elaine
Advisor: Dr. Elaine Youngman

Approximately 30% of inherited genetic diseases involve gene mutations that are subject to degradation by quality control pathways. One such regulatory pathway is the nonstop decay (NSD) pathway, which targets mRNAs that lack a stop codon. In the model roundworm *Caenorhabditis elegans (C. elegans)*, the protein factors pelo-1 and skih-2 regulate nonstop decay and the mut-7 gene is required for production of all endogenous siRNAs. Previous findings that both loss of nonstop decay and loss of endogenous RNAs produce a temperature-dependent fertility phenotype in *C. elegans* offers genetic evidence for the possibility that nonstop mRNA silencing in germ cells relies on siRNAs in addition to, or perhaps even coupled with, protein factors. We seek to further this genetic observation.

**A-17: Identifying the cis elements that are sufficient for the binding of the transcription factor Pdc2 in *Candida Glabrata* in vitro**
Author: Dottor, Cory
Advisor: Dr. Dennis Wykoff

Pdc2 is a transcription factor in *Candida Glabrata* that binds promoters in the thiamine biosynthetic pathway, when the cells are starved of thiamine. Data from our lab has previously shown that these thiamine regulated promoters require Pdc2 to bind and activate them. Without Pdc2 the promoters do not transcribe and express the desired gene. We have identified important elements cis in thiamine regulated promoters necessary for transcription. Using fluorescence anisotropy we show that Pdc2 does have a high affinity for these sequences. However, the data indicate the Pdc2 does not have much specificity when it comes to binding different pieces of DNA in vitro. The results conclude that Pdc2 is a DNA binding protein, but in these in vitro conditions does not have specificity.

**A-18: Investigating Protein BTN2A2's Inhibitory Role in Lipid Droplets**
Authors: Patron, Jennifer Anne; Robinson, Sarah; Humrich, Sarah; Bamezai, Anil
Advisor: Dr. Anil Bamezai

T cells are important to the adaptive immunity against internal and external threats to the body. Defenses against these threats are mediated and regulated by CD4+ T cells. Autoimmunity occurs when self-reactive T cells begin to attack healthy cells and is often due to the loss of self-tolerance in CD4+ T cells, which is regulated by immune tolerance mechanisms. Past research in Dr. Bamezai's lab has shown that extracellular lipid droplets (LDs) were found to inhibit T cell proliferation and are present in immune tissues. BTN2A2 protein was detected on these LDs, which is known to inhibit T cell proliferation (Robinson, 2021). I hypothesize that the BTN2A2 expressed on LDs inhibits antigen-specific T cell responses, lowering T cell activation and proliferation. I plan to investigate BTN2A2's role in LDs through two approaches. The current approach involves culturing isolated LDs from murine thymus and co-culturing it with purified CD4+ T cells stimulated through the T cell receptor and CD28 co-stimulatory protein in the presence of antibodies that block BTN2A2. An MTS assay and two ELISAs (IFN-g and IL-s) will then measure T cell proliferation in

the cell cultures. If BTN2A2 on LDs is found to be inhibitory, then this study will provide insights into a novel mechanism of potential self-tolerance mechanism that keeps the T cell overactivity in check. If this occurs, the second approach will proceed, which involves using isolated LDs from BTN2A2-deficient mice.

**A-19: Too Humid to Handle: The Effect of Humidity and Substrate Hydrophobicity on Ant Adhesion, Locomotion, and Behavior**
Authors: Cai, Mandy; Yanoviak, Stephen; Stark, Alyssa
Advisor: Dr. Alyssa Stark

Ants use adhesive tarsal pads coated in a glue-like secretion to climb while foraging, escape from predators or unfavorable conditions, and defend territory. In Pennsylvania where *Camponotus pennsylvanicus* forage, variation in temperature, and humidity change the quality of the substrates they adhere to. In particular, relative humidity (RH) can range from 20-100% and substrate hydrophobicity will dictate if water layers are deposited on a substrate surface as a function of high RH. Despite highly variable RH in their environment and the ability of thin water layers to disrupt the ant adhesive system, nothing is known about how temperate ant adhesion, locomotion, and behavior may vary across substrates that range in wettability. To test for the effect of substrate wettability and RH on ant performance and behavior, we tested shear adhesion and running speed of *C. pennsylvanicus* on three substrates (hydrophilic glass, hydrophobic polypropylene, and intermediately wetting polycarbonate) in six RH setpoints (30, 40, 50, 60, 70, 80, 90%RH). We hypothesized that adhesion and running speed would reduce, and mitigating behaviors (stop, turn around) would increase on glass more than the other substrate due to elevated water layer deposition at high RH on this hydrophilic substrate. The results of this study will improve predictions about how variable climate conditions, particularly in the face of climate change, will influence this key member of most global ecosystems.

# Chemical Engineering

**A-20: Expression of Recombinant LtEc as a Blood Substitute**
Author: Rahlfs, Jack
Advisor: Dr. Jacob Elmer

Efficient delivery of oxygen with a red blood cell substitute has the potential to save countless lives. However, previous attempts of creating a blood substitute have failed due to nitric oxide scavenging, tetramer dissociation, and low autoxidation rates. These problems arise from previous blood substitutes being mammalian hemoglobins taken out of the cell. LtEc is a naturally extracellular protein that can efficiently transport oxygen in hamsters and mice. The goal of this project was to express a recombinant form of LtEc that can be produced at will and mutated to improve its properties. To express recombinant LtEc, the sequence of the seven genes associated with LtEc needed to be determined. Whole genome sequencing revealed multiple copies of each gene, but subsequent analysis of mRNA extracted from the worms revealed some copies were not expressed, while others were mixed. Once the sequence of genes was determined, we tried expressing the D1 subunit first because it is the most stable. Recombinant LtEc expression was not seen in adherent

CHO cells, so we are trying a new type of CHO-S cells. Once the D1 subunit is expressed the other three subunits and four linkers will be expressed individually. Then all the subunits and linkers will be expressed together to form the entire LtEc structure. It is hypothesized that if recombinant LtEc can be synthesized in CHO cells, the protein can be mutated to further improve its properties.

**B-21: Investigation of the Role of Glycans in Facilitating the Binding of Gut Bacteria to Mucin**

Authors: Sharo, Catherine; Zhai, Tianhua; Graham, Josh
Advisor: Dr. Jacky Huang

The human gut microbiome is an essential component of human health. Mucus plays a key role in the functioning of the intestinal tract and is composed of highly glycosylated proteins known as mucins. These mucins consist of protein cores and o-glycans, with the most common mucin in the intestine being MUC2, though there are multiple mucin types present throughout the human body. The o-glycans serve as attachment sites for surface proteins and are necessary for the functioning of gut bacteria. Therefore, this project focused on investigating how mucins bind to bacteria, specifically how the glycans were involved in the process. Possible glycans were identified and evaluated for how they interact with the mucin binding proteins using computational methods. Due to the essential nature of mucins, mucin synthesis methods were also investigated, as current commercial options are expensive and require complicated purifications processes, inhibiting research possibilities. To this end, the bacterial growth rates with both the commercial and synthetic mucins were evaluated, as well as how the addition of glycans impacted the growth.

**B-22: Surface Functionalized Macro-beads for Isolation of IFN-γ High Producing CAR-T Cells**

Author: Sullivan, Joseph
Advisor: Dr. William Kelly

Isolation and selection of CAR-T cells represent an important factor to ensure robust and effective cell therapies. Previous investigation has determined that the release of the cytokine Interferon Gamma (IFN-γ) from CAR-T cells positively correlates with greater efficacy of the cells as immune effectors. Thus, we proposed the development of macro-sized (0.3 – 3 mm) beads for cell isolation in packed bed bioreactors and columns. With beads of this macro size, T cells (6 -7 um in diameter) would be able to flow through beds packed with such beads and not plug. These agarose beads were coated with streptavidin allowing for immobilization of biotinylated goat anti-rabbit IgG secondary antibody to the beads. This will enable the stabilization of an immune complex to capture IFN-γ high expressing CD4+ CAR T-cells via utilization of a novel IFN-γ:CD19 fusion protein. We performed initial binding assays to determine a saturation curve for the binding of biotinylated goat anti-rabbit IgG to the streptavidin macrobead resin. Saturation was determined to occur as antibody addition approached ~40 ug of protein/mL of resin. Characterization efforts were also performed to evaluate expression and purification of the IFN-γ:CD19 fusion protein. These initial findings indicate effective capabilities to immobilize antibodies to functionalized macro sized agarose beads. Effective capture of IFN-γ via the immobilized antibodies will represent important subsequent steps towards establishing a mechanism for T cell selection and isolation.

**B-23: Using Co-Expression Plasmids Containing Virokines to Improve Gene Therapy Methods**
Authors: Forte, Ryan; Marfo-Sarbeng, Kojo
Advisor: Dr. Jacob Elmer

Gene therapies offer promise in the treatment of cancer and genetic diseases. The practice involves the delivery of genes to a patient's cells to grant some therapeutic effect. Unfortunately, when using non-viral vehicles, the expression of these genes is often low in certain cell lines due to the cell's innate immune response to the delivered gene. This hard-wired response to the delivered DNA, which the cell mistakes for foreign DNA from a virus, presents a significant roadblock to the expression of therapeutic genes in these treatments. The goal of this project is to increase therapeutic gene expression through co-expressing a therapeutic gene (as indicated by the reporter gene GFP) with some viral genes (virokines such as vIL-6, ORF45, VP22 from herpesviruses KSHV, HSV-1, HCMV) known to inhibit the host cell's innate immune response. The viral genes were amplified by PCR, cloned into a GFP expression plasmid via Gibson Assembly, and miniprepped to a sufficiently high concentration. Transfections of the co-expression plasmid were then performed on PC-3 and Jurkat T cells, which have clinical relevance but also boast particularly strong innate immune responses to delivered genes. GFP delivery and expression levels were determined via flow cytometry. Comparisons to cells transfected with the same plasmid without the viral gene insert were made to determine whether GFP expression was significantly higher for cells transfected with the GFP-viral gene co-expression plasmid.

# Chemistry

**B-24: A general, efficient, and stereoselective method of synthesizing biologically relevant chiral C2-substituted azetidines**
Authors: Zelch, Daniel; O'Reilly, Matthew
Advisor: Dr. Matthew O'Reilly

Saturated nitrogen-containing heterocycles are common components of biologically active molecules and are often considered privileged structures, a term that implies their ability to bind a broad range of biological targets while also being exquisitely selective for those targets if adorned with ideal chiral substitution. Chiral substituted azetidines, saturated 4-membered aza-heterocycles, are less explored, but, when properly substituted, they can potently bind a broad array of biological targets. Despite this, general methods toward the enantioselective synthesis of chiral C-2 substituted azetidines are lacking in efficiency, generalizability, and scalability. To meet this need, we harnessed Ellman's inexpensive (< $1/gram) and broadly available tert-butyl sulfinamide chiral auxiliary with 1,3-bis-electophile, 3-chloropropanal. Condensation of these two components in the presence of copper sulfate yielded the 3-chlorosulfinimine, which was used without purification in a diastereoselective Grignard addition, which produced a variety of stable chlorosulfinamides in 40-78% yield over two steps with diastereomeric ratios as high as 17:3. This intermediate is poised to complete a 4-exo-tet cyclization by a backside displacement of the chlorine leaving group, and this allowed for the production of a range of azetidines in 48-78% yield, providing the C-2 functionalized azetidines in good overall yields over three steps (as high as 61%). This method is applicable to a broad array of

Grignard reagents, allowing for the production of a diverse set of C-2 functionalized azetidines, and the optimization process and details of the results will be presented herein.

**B-25: Copper(I) CNC Pincer Complexes as Catalysts for Isoprene Polymerization**
Author: Rongo, Austin
Advisor: Dr. Deanna Zubris

Polymers are present in all aspects of modern society. From plastics and proteins to adhesives and pipes, our daily biological and societal functions revolve around them. However, less active monomers (LAMs), such as isoprene and N-vinylpyrrolidone, prove much harder to polymerize with traditional conditions and catalysts. Research into Atom Transfer Radical Polymerization (ATRP) conditions is ongoing in the Zubris lab and may prove fruitful in polymerizing LAMs. In support of this aim, three CNC pincer ligands and their corresponding copper (I) complexes have been synthesized and fully characterized. The multi-step synthesis used to prepare these copper (I) complexes is presented here along with characterization data for each step of the synthesis. Studies are underway to use these copper (I) complexes as catalysts for polymerizing isoprene and other LAMs via an ATRP mechanism.

**B-26: Determination of ΔpKa Values Using an NMR Titration in Binary Mixtures**
Author: Caron, Tyler
Advisor: Dr. Jared Paul

Accurately determining pKa values is critical for research involving the thermodynamics of Proton Coupled Electron Transfer (PCET). Much of the work involving PCET involves both aqueous solutions and organic solvents. This work presents a method of using 1H NMR titrations to determine differences in equilibrium constants of two phenols, phenol and 4-methoxyphenol, in aqueous solutions containing cosolvents at various concentrations. By tracking the movement of selected peaks in the NMR spectra over the course of the titration, it is possible to determine the difference in equilibrium constant (Ka) for proton dissociation and the ΔpKa of the two species in solution. To test the limits of this method, titrations were conducted using varying levels of dimethylsulfoxide-D6 and acetonitrile-D3 as cosolvents. A titration conducted in D2O yielded a Ka value of 0.5078±0.033 and a ΔpKa of 0.2934±0.028. Subsequent titrations were conducted in 20%, 25%, and 30% D2O/cosolvent solutions. Data analysis reveals that as the cosolvent concentration increases to 25% and 30%, the accuracy of the data decreases. For the purpose of studying the thermodynamics of PCET, cosolvent concentrations above 20% are not viable.

**B-27: Double BAC and Triple BAC: A Systematic Analysis of the Disinfectant Properties of Multicationic Derivatives of Benzalkonium Chloride (BAC)**
Authors: Toles, Zachary; Wu, Alice; Thierer, Laura; Minbiole, Kevin
Advisor: Dr. Kevin Minbiole

The limitations of established quaternary ammonium disinfectants have been recognized throughout the years. While benzalkonium chloride (BAC) has protected human health through surgical preparation, home use, and industrial applications for nearly a century, increasing levels of bacterial resistance have substantially decreased its effectiveness. As research over the past decade reveals that

multicationic amphiphilic disinfectants exhibit higher activity and decreased susceptibility to resistance, we prepared three dozen multicationic QACs in an attempt to clearly document structure-activity relationships of next-generation BAC structures. With simple synthetic paths, consistently high yields (averaging ~80%), and strong biological activity, potent structures with clear SAR trends have been established.

**B-28: Electrochemical Analysis of Novel Solid Oxide Fuel Cell Anode Materials**
Authors: White, Daniel; Giannini, David; Eigenbrodt Bryan
Advisor: Dr. Bryan Eigenbrodt

Sr2Fe1.6Mo0.4O6-δ (SFMO) is a double perovskite used as an anode in solid oxide fuel cells (SOFCs). Due to the formation of graphite, most SOFC anodes are deactivated when fueled by methanol or ethanol. However, SFMO tolerates alcohol fuels, allowing it to produce carbon-neutral energy. To improve its performance as an anode, nickel was incorporated into SFMO in two ways. First, nickel was doped into SFMO's crystal structure, forming Sr2Fe1.6-xNixMo0.4O6-δ (SFNMO). Second, nickel particles were infiltrated into SFMO's microstructure, forming Ni/SFMO. Next, SOFCs were constructed using SFNMO and Ni/SFMO as anodes. These SOFCs were heated at 800 °C while fueled by hydrogen, methanol, or ethanol. The electrochemical performance of these cells was analyzed using linear sweep voltammetry (LSV) and electrochemical impedance spectroscopy (EIS). The LSV data showed that the addition of nickel improved the power density of the SFNMO and Ni/SFMO SOFCs across all fuels, except for when Ni/SFMO was fueled by methanol. Further, EIS showed that the addition of nickel resulted in improved catalytic and charge-transfer properties for both materials across all three fuels. Finally, in certain cases, increasing amounts of nickel correlated with improved cell performance.

**B-29: Examining the Extent of Heavy Metal Contamination: Dairy Farm Use of Copper Sulfate Footbaths**
Author: Burwell, Samuel
Advisor: Dr. Vanessa Boschi

Copper sulfate is used in footbaths by the dairy industry to combat hoof lesions such as digital and interdigital dermatitis as well as foot rot. Footbath waste is cleaned out with barn waste and then spread on crop fields for fertilizer. Levels of copper (Cu), chromium (Cr), zinc (Zn), arsenic (As), cadmium (Cd), and lead (Pb) were tested in surface water, crop field soil, and corn/hay sileage at three dairy farms of varying sizes in north central Pennsylvania. Cu and Zn concentrations were found to be statistically higher in fields where biosolids from bovine were spread. The corn sileage analyzed had Cu and Zn concentrations at an average of 55 and 333 ppb, both exceeding the recommended toxicity levels in feed for farm animals of 35 and 150 ppb respectively. Manure fields from farms with differing number of cattle, and thus differing amounts of footbath solution, did not show a difference in the concentration of copper or other metal contaminants. Surface waters had a lower heavy metal concentration than that of the field soil samples. Heavy metal concentrations in surface waters were dependent on the proximity to the contaminated field. These results demonstrate the use of copper sulfate footbaths impact soil, water, and food quality in areas that are surrounding ground that has spread with manure captured from the farm.

**B-30: Identification and Characterization of First Bacterial Prostaglandin Synthase**
Authors: Rotolo, Teresa; Selinsky, Barry
Advisor: Dr. Barry Selinsky

Three constructs of the *Mycobacterium* enzyme believed to exhibit cyclooxygenase activity were purified and characterized. Substrates used to demonstrate enzymatic activity were arachidonic acid, linoleic acid, and α-linolenic acid. The constructs are HisLicMyco, containing an N-terminal 6-histidine tag, Trxt-Myco, with an N-terminal thioredoxin fusion partner, and SUMO-Myco, with an N-terminal small ubiquitin-related modifier fusion partner. The expression and purification of these constructs was confirmed through SDS-PAGE. Dioxygenase and peroxidase assays were performed on each construct and compared. Enzymatic products were analyzed using LC/MS, which confirmed the enzyme demonstrates cyclooxygenase activity. This is the first confirmed identification of a bacterial ortholog to prostaglandin synthase.

**B-31: Improved synthesis of pseudoxylallemycin A and analogues toward general tools of optimizing tetrapeptide macrolactamization**
Authors: Roberts, Raymond; Fumo, Vincent; Zhang, Jieyu; O'Reilly, Matthew
Advisor: Dr. Matthew O'Reilly

Cyclic tetrapeptides (CTPs) have broad ranging bioactivities and proteolytic stability, which often translates to enhanced bioavailability, biostability, and membrane permeability compared to linear peptides. Pseudoxylallemycins are a class of naturally occurring N-methylated CTPs with a symmetrical [phenylalanine–N-methylleucine]2 primary sequence. Psuedoxylallemycins have displayed antibacterial activity against disease-relevant strains of Gram-negative bacteria, representing a promising development in antibacterial research. However, synthesis of CTPs is complicated by the final macrolactamization reaction. This low yielding desired cyclization is often accompanied by polymerization to octa- or dodecapeptides and other decomposition pathways. For pseudoxylallemycin synthesis, cyclization was accompanied by C-terminal epimerization of the linear tetrapeptide. Our studies demonstrated that traditional phosphonium and uronium peptide coupling reagents caused full C-terminal epimerization while less utilized propylphosphonic anhydride (T3P®) uniquely modulated the diastereoselectivity depending on the accompanying organic base. Structure activity relationships were assessed with pseudoxylallemycin A analogues with either unnatural stereochemistry or alanine incorporation. These unveiled the temperamentality of tetrapeptide ring closure, having enormous impact on the yield and stereocontrol. This led to the development of a high-throughput optimization system whereby combinations of peptide coupling reagent, organic base, and solvent are analyzed using LC-MS. This system was further applied to the rapid construction of other CTP natural products and analogues thereof.

**B-32: Investigation of Phenanthroindolizidine Alkaloids in Invasive and Eurasian Vincetoxicum species**
Authors: Wu, Alice; Bryant, Quaadir; Liede-Schumann, Sigrid; Minbiole, Kevin
Advisor: Dr. Kevin Minbiole

Phenanthroindolizidine alkaloids, or PIAs, are plant-based compounds that provide substantial therapeutic, medicinal, and cytotoxic effects. While they may exhibit certain behavior beneficial to humans, PIAs primarily serve as many plants' chemical defense system against predators via their

toxicity. The purpose of this experiment is to explore the reasons for recent temperate radiation of the dogbane family Apocynaceae by analyzing one of its youngest lineages: the Eurasian Vincetoxicum. The qualitative presence of PIAs and their relative amounts in invasive and native species of Vincetoxicum will be used as a proxy to determine the correlation between the success of a species and its chemical defense system. This method will serve as a tool to monitor the biodiversity of Eurasia. From the family of approximately 60 PIA compounds, 9 were investigated with Liquid Chromatography-Mass Spectrometry (LC-MS) methods for their presence, as well as their relative concentration, in 54 samples of invasive and native species of the Vincetoxicum. By utilizing exact mass accuracy and retention time comparison, compounds were identified and their relative peak areas recorded to compare the chemical defense system of the invasive and native species.

**B-33: Lipid Quantification and DOM Characterization of *Nannochloris eucaryotum* and *Leptoplyngbya sp.***
Authors: Clayton, Emily; Watt, T'Naysia; Degenhart, Luke
Advisor: Dr. Bryan Eigenbrodt

This research presents the findings following the cultivation of colonies of the algae *Nannochloris eucaryotum* and *Leptolyngbya sp.*, both of which were analyzed under various metrics for the two facets of this study. The first facet investigates the role of photochemistry in the production and conversion of dissolved organic matter (DOM) in algal systems. DOM will be characterized using FTICR-MS in future studies to evaluate lipid versus lignin content at various points in the growth cycle. The second facet of this research investigates the potential of *Nannochloris* as a potential source of biomass for biofuel production based on lipid content using growth media adjusted to pH values ranging from 7.5 to 8.5.Quantitative methods and instrumentation used to monitor production and yield of five different lipids include cell counting, fluorescence spectroscopy, and GC/MS. These two studies were performed in conjunction to identify potential correlations between lipid content and DOM characterization in algal systems.

**B-34: Measuring the Proteasomal Unfolding Ability of pCMH39 and pCMH44**
Authors: Baul, Panchatapa; Kraut, Daniel
Advisor: Dr. Daniel Kraut

The proteasome is a protein complex that degrades abnormal, misfolded, and regulatory proteins. Proteins to be degraded are tagged with a chain of ubiquitin proteins on one or more substrate lysines. The goal of this research was to determine the impact of ubiquitin chain length and number on proteasomal unfolding ability. To examine unfolding ability, we used substrates also featuring an N-terminal Neh2Dual degron followed by an easy-to-unfold barnase domain and a difficult-to-unfold DHFR domain; unfolding ability can be calculated based on the extent of degradation of the two domains. The experimental substrates also contained different chain attachment point - one with a single lysine within the degron (pCMH44) and another with seven lysines (pCMH39). To obtain different chain lengths, ubiquitination reactions were halted at five minutes and an hour. A degradation assay was conducted on the substrate and gel electrophoresis images were used to determine how much degradation was occurring in the proteasome. Unfolding abilities were calculated based on degradation assay results. The study concluded that there were no unfolding

ability differences between 5-minute and 1-hour ubiquitination of pCMH39; however, in pCMH44, the 1-hour ubiquitination yields a much higher unfolding ability than the 5-minute ubiquitination.

**B-35: Modeling Glyme Mixtures for Sodium-Ion Electrolytes: Are Monomers and Oligomers Interchangeable?**

Authors: Park, Eileen; Jorn, Ryan
Advisor: Dr. Ryan Jorn

The discovery of solvate ionic liquids has renewed interest in the study of ether-based sodium electrolytes for energy storage. It has recently been shown that the ethers built from the dimethoxyethane monomer (glymes) have peculiar transport properties as a function of chain length and salt concentration. However, less is known about the ability for glyme mixtures to form solvate ionic liquids and the impact of concentration on their transport characteristics. We have applied classical molecular dynamics simulations to compare the behavior of a mixture of glyme-based sodium electrolytes as a function of composition and concentration. Sodium triflate (CF3SO3Na) along with monoglyme (C4H10O2), diglyme (C6H14O3), and a mixture of monoglyme and diglyme were modeled in the bulk phase as well as in the presence of a graphite electrode held at constant bias voltage. Our results for the solvation structures in monoglyme and diglyme match previous reports, however, the behavior of the mixture is unexpected upon binning the solvation structures. We show that in a 2:1 mixture of monoglyme to diglyme (equal numbers of monomer units), the average coordination consists of a single monoglyme, a single diglyme, and 1.5 salt anions. However, this average arises from a small set of weighted structures consisting of the pure monoglyme form, the pure diglyme form, and a relatively small percentage consisting of the mixture of the two glymes. An intriguing area for future work is to consider the impact of this trimodal distribution on the formation of solvate ionic liquids.

**B-36: Multi-objective Deep Data Generation with Correlated Property Control**

Authors: Petersen, Ashley; Leitgeb, Austin; AlKhalifa, Saleh; Minbiole, Kevin; Wuest, William
Advisor: Dr. Kevin Minbiole

The intersection of next-generation artificial intelligence and organic chemistry is vital to the discovery of novel antimicrobials in combatting evolving populations of antimicrobial-resistant strains of bacteria. In this study, artificial intelligence was developed in two phases, a learning phase and a generation phase, to analyze quaternary ammonium compounds (QACs) for biological efficacy. A dataset of over 700 published quaternary ammonium compounds were processed in ChemDraw® from their skeletal structure to a Simplified Molecular-Input Line-Entry System (SMILES) string. The SMILES string was inputted to CorrVAE, a deep generative model, which correlated properties of bioactivity data, such as chain length, molecular size, and overall charge to the organic structure. Thus, the antimicrobial ability of QACs can be predicted before synthesis and biological testing. In future studies, the structures provided by CorrVAE will be used to generate unique models of promising antimicrobial QACs to be synthesized.

**B-37: Philadelphia Subway Air Particulate Matter effects on 16HBE cells**
Authors: Eng, Sydney; Eggler, Aimee; Shakya, Kabindra
Advisor: Dr. Aimee Eggler

Public transportation is a necessity in a city like Philadelphia; however, the accumulation of air particulate matter in subway systems can induce adverse health effects. In collaboration with the Shakya lab, our lab investigates the cellular lethal and sublethal effects of air particulate matter in Philadelphia's subway station in comparison to the above-ground city locations and a suburban area. 16HBE human bronchial epithelial cells were used as lungs have the highest exposure of the particles. This summer, I made significant progress toward developing a triplexed assay to assess three cellular effects of air particulates simultaneously—cytoxicity, activation of antioxidant response element (ARE) and xenobiotic response element (XRE) pathways—for the limited sample size of particulate matter. Nrf2 is a transcription factor that regulates expression of cytoprotective enzymes by binding to copies of ARE and can be activated by metals and electrophiles in particulate matter. Similarly, polyaromatic hydrocarbons (PAH) in particulate matter activate the aryl hydrocarbon (Ah) transcription factor, which binds to copies of its cognate XRE. This upregulates expression of xenobiotic-metabolizing enzymes, which convert PAHs to electrophiles for detoxification. This conversion to electrophiles creates a link between ARE and XRE pathways. Successful end points included demonstrating the effectiveness of cytotoxicity in this cell line and the ability to multiplex cytotoxicity and ARE. Diesel exhaust particles (DEP) were used to replicate the particulate matter and preliminary results show that DEP activates the ARE pathway and 0.25 mg/mL DEP is not a high enough concentration for cell death.

**B-38: Preparation and Characterization of Ru(II) Metal Complexes with a Series of Aryl-Butanediimine Ligands**
Authors: Lopez-Espinoza, Daniel; Kassel, Scott
Advisor: Dr. Scott Kassel

A series of five aryl-butanediimine ligands (R-bdi) were prepared as primary ligands in a series of associated ruthenium metal complexes. All ligands were characterized using 1H NMR and Infrared Spectroscopy. [(Ru(cym)Cl)Cl]2 and [(Ru(bz)Cl)Cl]2 dimers were used to synthesize metal complexes of each ligand resulting in ten distinct Ru(II) metal complexes. Isolated products were then characterized using 1H NMR, UV-Visible, and Infrared spectroscopy, which was used to investigate the effects of the primary ligand on each Ru(II) complex.

**B-39: Progress Towards the Syntheses of Isogemichalcone Analogs**
Authors: Johnston, Josephine
Advisor: Dr. Eduard Casillas

Isogemichalcones B and C are natural products that function as moderate inhibitors of the enzyme aromatase, which catalyzes the biosynthesis of estrogen. Guided by the recently completed syntheses of isogemichalcones B/C, progress was made towards syntheses of trifluoromethyl and fluoro

analogs that replace the phenols on the D ring. A vinyl stannane was successfully synthesized in five steps in good overall yield, which was then used in a Stille coupling with a prepared benzyl halide. Efforts are being made, thus far unsuccessfully, to react this Stille product with 2,4-difluorobenzaldehyde and 2,4-difluoromethylbenzaldehyde in a Claisen-Schmidt condensation. Model reactions are being utilized to aid in the understanding of this unexpected lack of reactivity.

**B-40: Surface Selectivity: The Importance of the Electrode Interface in Steering Electrolyte Stability**

Authors: Silen, Leilani; Jorn, Ryan
Advisor: Dr. Ryan Jorn

This study focused on the breakdown of ethylene carbonate (EC) and propylene carbonate (PC) solvent molecules at carbon electrode surfaces common to lithium-ion energy storage. It has been shown that electrolyte stability can be improved by using mixtures of EC and PC and adding a high concentration of lithium salt to the solution. The analyses of these experiments have focused on the importance of bulk solvation structures; however, our previous studies have shown the importance of the electrode surface in modifying the solvation structure surrounding lithium ions in solution. Hence, we have performed molecular dynamics simulations on liquid electrolytes of similar composition to those studied in the experiments. We considered solutions made from varying ratios of EC, PC, and lithium hexaflurophosphate (LiPF6) at an idealized graphite surface. By including an applied bias voltage, we have shown that the electrode interface plays an important role in altering composition from bulk structure and could explain the changes in electrolyte performance. Hence the observed stability changes might have more to do with exclusion of PC rather than a solvation preference on behalf of the lithium ion. Similarly, our results show that the prevalence of salt at the electrode surface switches at sufficient concentration, which connects with the seemingly universal behavior seen for electrolytes with more than 3.0M salt concentration.

**C-41: Synthesis, Characterization, and Metalation of Two Oxygen-Functionalized N-Heterocyclic Carbene (NHC) Ligands with Silver**

Author: Huwar, Jessica
Advisor: Dr. Deanna Zubris

Coordination complexes have important roles as industrial catalysts for a broad range of chemical reactions, including polymerizations. A coordination complex consists of a central atom or ion, which is usually a transition metal called the coordination center, and a surrounding array of bound molecules or ions, known as ligands or complexing agents. An N-heterocyclic carbene (NHC) ligand is a cyclic carbene species with two neighboring nitrogen atoms that can be functionalized in many ways to vary the ligand's sterics and electronics. NHC ligands have a high coordinating ability caused by their strong electron-donating property and steric bulk that is easily tuned through their nitrogen atom substituents. One previously reported oxygen-functionalized NHC ligand and one novel ligand were synthesized through multi-step synthesis, and their characterization and metalation attempts with silver are described here. In future studies, these silver complexes will serve as catalyst precursors for polymerization.

**C-42: Synthesis and Characterization of a family of Ruthenium-based complexes with a hydroxyanthraquinone ligand**
Authors: Ricca, Gray; Kassel, Scott
Advisor: Dr. Scott Kassel

Ruthenium complexes of hydroxyanthraquinone (abbreviated HAQ), a derivative of anthraquinone, were prepared and characterized by 1H NMR and mass spectrometry. Complexes of this type have potential use as therapeutics. Four metal complexes were isolated as the hexafluorophosphate salts: bis(2,2'-bipyridyl)(hydroxyanthraquinone)ruthenium(II), bis(4,4'-dimethyl-2,2'-bipyridine)(hydroxyanthraquinone)ruthenium(II), bis(5,5'-dimethyl-2,2'-bipyridine)(hydroxyanthraquinone)ruthenium(II), and bis(1,10-phenanthroline)(hydroxyanthraquinone)ruthenium(II). The starting materials were combined with triethylamine in a 5:1 Et(OH)2 : H2O solution and heated to reflux. Each complex was isolated by precipitation with the addition of excess ammonium hexafluorophosphate in water. Complexes were characterization by 1H-NMR, IR, and UV-Visible spectroscopies, mass spectrometry, and electrochemistry.

**C-43: Synthesis and Characterization of Analogs of a Uniquely Inert [3.2.1]-Bicyclooctanone**
Authors: Heltz, Allison; Forelli, Nicholas
Advisor: Dr. Eduard Casillas

During a synthesis of an ACAT-inhibiting natural product analog, deoxyprehelminthosporol, an unusual lack of electrophilicity of a [3.2.1]-bicyclooctanone was observed. Even upon treatment with methyllithium, the ketone would remain inert but allow attack on a pendant ethyl ester. The project described here is intended to probe the chemoselectivity of this bicyclic ketone while considering at least two major factors; 1) steric hinderance in the approach of the nucleophile and/or 2) dominant generation and contribution of the enolate resonance form. A series of [3.2.1]-bicyclooctanones that vary in steric constraints are being synthesized. Once prepared, these ketones are alkylated with methyl lithium, then quenched with deuterated methanol. The extent of alkylation vs. deuteration will allow an estimation of the steric and enolization effects. The methylation attempts thus far have shown that substitution at C-5 and C-8 has permitted for a difference in stereoselectivity while a variation in temperature during methylation has shown a difference in chemoselectivity.

**C-44: Synthesis and characterization of ruthenium(II) acetylacetonate complexes with polypyridyl ligands**
Authors: Coyne, Maxwell; Kassel, Scott
Advisor: Dr. Scott Kassel

A series of ruthenium(II) acetylacetonate complexes with 2,2'-bipyridine, 2,4-pentanedione with varied substituents, and 2,2':6',2"-terpyridine were investigated. Separately, the temperature and solvent dependence of the conversion of [k2-(OPpy3)Ru(bz)Cl]+ to [k3-(OPpy3)Ru(solvent)2Cl] were examined by 31P NMR. These complexes have potential application as catalysts for water oxidation. Isolated complexes were characterized by 1H and UV-Visible spectroscopies, electrochemistry, and mass spectrometry.

**C-45: Synthesis and Characterization of tetrapyrido[3,2-a:2',3'-c:3",2"-h:2‴,3‴-j]phenazine-Bridged Polypyridyl Ruthenium (II) Complexes Utilizing a Microwave Reactor**
Author: Bierling, Hailey
Advisors: Dr. Jared Paul, Dr. Scott Kassel

Bimetallic complexes where two metal centers are joined by a bridging ligand have shown promise in catalysis as their two metal sites increase the electrons available for multi-electron processes. This work reports the synthesis of the bimetallic complex [(bpy)2Ru(tpphz)Ru(bpy)2]4+ (bpy = 2,2'-bipyridine; tpphz = tetrapyrido[3,2-a:2',3'-c:3",2"-h:2‴,3‴-j]phenazine) by the reaction of two equivalents of Ru(bpy)2Cl2 and one equivalent of tpphz ligand using both conventional and microwave methods. [(phen)2Ru(tpphz)Ru(phen)2]4+ (phen = 1,10-phenanthroline), [(bpy(OMe)2)2Ru(tpphz)Ru(bpy(OMe)2)2]4+ (bpy(OMe)2 = 4,4'-dimethoxy-2,2'-bipyridine), and [(dmbpy)2Ru(tpphz)Ru(dmbpy)2]4+ (dmbpy = 4,4'-dimethyl-2,2'-bipyridine) were prepared similarly using a microwave reactor. The complexes were characterized using 1H NMR, UV-Visible spectroscopy, and mass spectrometry.

**C-46: Synthesis of amino pyridine ligands for use in iron (II) polymerization catalysts**
Authors: Farry, Kimora; O'Donnell, Katelynn; Garcia, Nicole; Zubris, Deanna
Advisor: Dr. Deanna Dubris

To preserve natural rubber, synthetic polyisoprene can serve as a replacement. Controlling the ratio of isomers in synthetic polyisoprene can improve the polymer's overall properties. Making subtle structural changes to a metal-ligand catalyst can produce polyisoprene with varied isomer ratios, and these isomer ratios regulate polyisoprene properties such as elasticity and durability. Our research group is exploring bidentate amino pyridine ligands with earth-abundant metals, such as iron, to favor the trans-1,4 isomer of polyisoprene, which is rarely observed in synthetic polyisoprene. The attempted synthesis and characterization of three different bidentate amino pyridine ligands is described here. In future work, we will continue to optimize the ligand synthesis and move forward to prepare and test the corresponding organometallic catalysts for polyisoprene formation.

**C-47: Synthesis of Efflux Pump Inhibitors (EPIs) that can overcome antibiotic resistance of *Pseudomonas aeruginosa***
Author: Howey, Kelsey
Advisor: Dr. Matthew O'Reilly

*Pseudomonas aeruginosa*, a gram-negative bacteria and pathogen, is known for its high antibiotic resistance by membrane efflux pumps, which are transport proteins involved in the expulsion of toxic substrates, including antibiotics. Efflux Pump Inhibitors (EPIs) are a current subject of medical research because of their ability to act as an adjuvant for antibiotics, such as Levofloxacin, in pathogens, such as *Pseudomonas aeruginosa.* A type of EPI, namely phenylalanine-arginine beta-naphthylamide (PABN), is a popularly used EPI; however no efficient laboratory synthesis of the molecule has been reported. Due to PABN being costly as well, developing a simple and reproducible procedure for synthesizing it and its analogues, phenylalanine-arginine anilide (PAA) and phenylalanine-arginine alpha-naphthylamide (PAAN), in the laboratory at a larger scale (1 to 5 grams) was a major goal of this research. In order to analyze the structural activity relationships

(SAR) of PABN and its analogues, a chromatography-free and high yielding synthesis was created. Depending on whether PABN, or its analogues, PAAN or PAA, was being synthesized, the process was begun with beta-naphthylamine, alpha-naphthylamine, or aniline. HATU, which is a coupling reagent, and protecting groups 2,2,4,6,7-pentamethyldihydrobenzofuran-5-sulfonyl group (Pbf), 9-fluorenylmethoxycarbonyl- (Fmoc), and tert-butyloxycarbonyl (Boc) were used during multiple condensation reactions that are commonly used in peptide synthesis. This research, which included liquid-liquid extractions, vacuum filtration, rotary evaporation, and NMR spectroscopy, concluded in all stereoisomers of PABN, and its analogues, being synthesized. These molecules were then assayed to determine how well they could perform as EPIs and potentiate antibiotics, such as Levofloxacin, in *P. aeruginosa* bacteria.

**C-48: Thermodynamic Parameters and Excited State Behavior of [Ru(tmp)2(bpy(OH)(OMe))][PF6]2**
Authors: Moffa, Katherine; Koehne, Sydney; Schmehl, Russell
Advisor: Dr. Russell Schmehl (Tulane University)

Fossil fuels are non-renewable, and their use contributes significantly to pollution and global climate change. One avenue that results in clean fuels involves the oxidation of water. Molecular catalysts that encourage efficient water oxidation are a preliminary step in reducing fossil fuel dependence. Water oxidation is an example of a proton-coupled electron transfer (PCET) reaction, and an understanding of what influences the favorability of excited state proton transfer (ESPT), excited state electron transfer (ESET), and excited state proton-coupled electron transfer (ESPCET) processes can lead to the thoughtful design of catalysts that facilitate ESPCET. This work reports the free energies of ESPT, ESET, and ESPCET and the excited state behavior of the chromophore [Ru(tmp)2(bpy(OH)(OMe))][PF6]2 in the presence of multiple quenching agents.

# Chemistry and Biochemistry

**C-49: Determining the lethal dose of a novel combination of small molecules to target cancer cells**
Author: Lalo, Margueritte
Advisor: Dr. Aimee Eggler

Current cancer treatments, such as radiation and chemotherapy, do not exclusively target cancer cells, and they thus cause debilitating side effects to patients. To reduce side effects, treatments should target cancer cells. Several promising cancer treatments take advantage of higher levels of oxidative stress in cancer cells, compared to normal cells, which make cancer cells more susceptible to a damaging burst of reactive oxygen species. Our lab recently found that combining a manganese porphyrin (MnP) with tert-butylhydroquinone (tBHQ), an oxidizable phenol and commonly used food preservative, was highly toxic to Jurkat leukemic T cells. The MnP catalyzes the oxidation of the tBHQ to produce the reactive oxygen species, superoxide, and then in another step, reduces superoxide to molecular oxygen and hydrogen peroxide. Because cancer cells experience higher levels of oxidative stress compared to normal cells, higher levels of hydrogen peroxide should induce apoptosis in the cancer cells, with normal cells having the means to withstand the assault. In this

work, I optimized a cell viability assay (CellTiter-Fluor) to determine the LC50 of tBHQ in combination with Mn(III) meso-tetrakis(N-n-butoxyethyl-pyridinium-2yl)porphyrin, MnTnBuOE-2-PyP5+, an MnP in cancer clinical trials, both in Jurkat CD4+ cells and in matched normal primary CD4+ cells. Considerations that arose and were accommodated included optimal cell number, concentrations of fetal bovine serum in the plasma and assay incubation time. The LC50 of the tBHQ treatment in combination with 2 μM of the manganese porphyrin MnTnBuOE-2-PyP5+ on Jurkat leukemic T cells was 1.06 μM. Importantly, we find that the combination treatment is much less toxic to primary CD4+ cells, indicating promise for this combination as an anticancer intervention.

# Chemistry and Geography and the Environment

**C-50: The Cellular Effects of Particulate Matter (PM) from Philadelphia Subway on Human Lung Cells**
Authors: Hong, Caryn; Shakya, Kabindra; Eggler, Aimee
Advisors: Dr. Aimee Eggler, Dr. Kabindra Shakya

Exposure to air particles containing particulate matter (PM) in subways has been linked to adverse cellular and health effects. Most studies on the effects of air pollution in subways have been conducted in European and Asian cities. Philadelphia is the 6th largest city in the U.S., with 90.3 million riders on the SEPTA in 2018. The overall goals of this project are to 1) measure levels and composition of PM2.5 in an underground subway system in Philadelphia and 2) to explore correlations between composition (metals, ultra-fine particles (UFP), and black carbon (BC)) and cellular effects (cytotoxicity, oxidative stress, XRE and ARE pathways activation) in 16HBE (human bronchial epithelial cells. In this work, the results of developing a method to gently and effectively extract PM from these filters are presented. In addition, a DCFDA assay was developed in the 16HBE cell line, as an indicator for oxidative stress. Upon entering cells, the DA moiety is cleaved by cellular esterases, and the H2-DCF is oxidized to DCF by oxidative species and fluoresces in the green channel. The assay was optimized in this cell line in a 96-well plate format. We expect this assay will show differences in cellular effects in PM2.5 from the three different locations, with the subway PM2.5 having the largest effect.

# Computing Sciences

**C-51: Automated GUI Test Refactoring for Android: Are We There Yet?**
Author: Cheung, Alan
Advisor: Dr. Xue Qin

Software testing is a crucial step of the software design process to ensure quality and stable applications are delivered to its users on a timely basis. Eliminating this step can result in an unfinished dysfunctional application and dissatisfaction with users. Recently, techniques to automatically generate test cases have been developed to increase the efficiency of software

development. However, those techniques mostly apply to non-GUI (graphical user interface) testing; GUI testing, which involves actions like clicking a button, has not been afforded quite the same developments and is still largely manual. Because the user interface contains the elements the user interacts with, it is extremely vital that their function is not compromised. In this study, we explore the potential obstacles that block automated GUI test development. More specifically, we analyzed the GUI test code commit histories of 39 Android applications from GitHub repositories to discover the challenges to write and maintain an efficient GUI test method. Through comparing the differences between their commits using a tool called RefactoringMiner and parsing through the data, we found that 15 of the repositories had 2,001 GUI test method refactorings spread across 407 commits, there were 53 different types of refactorings, and the most common type of refactoring was renaming a method, comprising 22.44% of the refactorings (449 out of 2,001 occurrences).

**C-52: Evaluating Price-Performance of Cloud FPGAs for HPC Benchmarks**
Authors: Perez, Daniel; Robson, Michael
Advisor: Dr. Michael Robson

The application of FPGAs as a method of accelerating parallelized applications has been shown to provide performance similar to or exceeding that of a traditional multicore systems while consuming less power. However, the complexity of developing or modifying applications to run on FPGAs makes using FPGAs difficult for those who do not already have prior experience. In this project, we examined existing HPC benchmarks by running them on cloud FPGAs, documented the process of modifying applications to run on the AWS Platform, and evaluated their performance in comparison to a multicore system using price as a metric. The results of our testing using FPGA-based AWS F1 instances show that in the High-Performance Conjugate Gradient (HPCG) benchmark, the F1 instance is only outperformed at the smallest problem size in comparison to a similarly priced general-computing AWS C9 instance. At the largest problem size, the F1 instance demonstrated a greater than hundred-fold increase in gigaflops over the C9 instance at essentially the same instance price per hour. Our research demonstrates that certain kernels are viable for acceleration on cloud FPGAs. Future works will apply this process to existing non-FPGA kernels to verify the generalizability and overhead of this approach.

**C-53: Graph representation learning for the mitigation of IoT-based DDoS attacks**
Author: Bui, Khang
Advisor: Dr. Ebelechukwu Nwafor

In this paper, we focus primarily on DDoS attacks, which obstruct network availability by overburdening the victim with excessive amounts of anomaly traffic. We generate graphs from the dataset by different connections: time connection between two consecutive traffic and signal connection between the source and the destination. In addition, we use node2vec to embed the graph in order to use unsupervised machine learning methods to train two cluster models for detecting DDoS on IoT devices and on the CAN bus protocol. The data we used is primarily from the CAIDA dataset and the University of Queensland dataset (NF-BoT-IoT dataset) and the CAN-intrusion dataset (OTIDS) from HCRL - Hacking and Countermeasure Research Lab.

**C-54: Privacy Preserving Techniques and Medical IoT**
Author: Molina, Maria Alejandra
Advisor: Dr. Ebelechukwu Nwafor

An important tradeoff when dealing with medical data is that of privacy and utility. It is important to preserve the privacy of patients, but not alter the data too much so that it loses all of its utility when it comes to research. There are different privacy preserving techniques that can be applied to data to make the data more private. The utility rests primarily on what degree of privacy is applied. As more data is privatized, the utility of said data decreases significantly. The main objective of this research is to determine which technique is the most efficient at preserving privacy, and to what extent the technique can be applied before it loses too much utility. The benchmark used to determine this is accuracy.

# Economics

**C-55: Setting the Table: How Order Affects Outcomes in The Great British Bake Off and its International Versions**
Authors: Sabbadini, Rachel; Rego, Eric
Advisor: Dr. Maira Reimão

Social scientists frequently rely on data provided by respondents, and there is a body of literature on the role of survey question ordering on the reliability and pattern of responses given. Several studies have shown that people tend to choose the first item they are presented with as opposed to the second; and have better memories and be more attached to first experiences rather than subsequent ones (see Carney and Banaji 2012 for references). In this project, we gather and analyze data from The Great British Bake-Off and its international versions to further explore this tendency and measure the extent to which having one's product tested towards the beginning of the group influences outcomes in a single competition and over the course of several rounds. This study contributes to the fields of both psychology and business. The concept of a primacy effect (as well as a recency effect) derives from psychology, and here we test whether expert judges exhibit them. We find evidence of the primacy effect in the "technical challenge" portion of the The Great British Bake-Off throughout all seasons, highlighting that judgements of taste quality – even by experts – are not fully objective measurements. This has implications for the ratings and marketing of products that rely on assigned quality attributions based on expert judgements (e.g., wine).

# Electrical and Computer Engineering.

**C-56: Measuring Classical Fisher Information For Estimation of Laser Propagation Direction**
Author: Brown, Shannon
Advisor: Dr. Jonathan Habif (Ming Hsieh Department of Electrical and Computer Engineering at University of Southern California - Information Sciences Institute)

Determining the location of a laser via measurements of intensity for angle dependent light is an increasingly important safety precaution in the fields of aeronautics, astrophysics, and professional sports. By using the Mie solutions to Maxwell's equations, a Python code was composed to analyze photographic data of a 520nm laser beam horizontally propagating over various angles from 70 degrees to 120 degrees across a non-reflective surface. From these data reductions, the Classical Fisher Information (CFI) of the measurements was derived, ultimately allowing us to determine the location of a laser based upon its intensity. Creating a well-documented series of CFI measurements for lasers of varying wavelengths and their associated angle locations will enable scientists to quickly determine the source of a laser beam within the atmosphere.

**C-57: Structurally Aware Logic Locking**
Authors: Walker, Giavanna; Juretus, Kyle
Advisor: Dr. Kyle Juretus

While most security focuses on software bugs, the underlying hardware is also vulnerable to various attacks, including the possibility of adding malicious functionality, stealing intellectual property, or recovering secret information from otherwise secure software. Current tools that attempt to secure circuits against these attacks are inadequate since they fail to secure circuits due to their inability to properly add secure logical structures to the original design. The objective of the proposed VURF project is to develop novel algorithms to ensure mixing of the secure and original circuit logic based on De Morgan's laws. The circuit transformations based on De Morgan's laws will provide the different, yet logically equivalent logic, which will allow the security logic to be mixed into the original logic of the benchmark circuit. The methodology for this project includes running the structural FALL attack on the set of unmixed benchmarks to collect data for the baseline vulnerability of the benchmarks. After developing algorithms for different De Morgan's transformations, the benchmarks can be mixed accordingly. Repeating the FALL attack on the mixed benchmarks will provide data for the points of failure after the mixing of the security and original logic, with the goal being a low success rate for the FALL attack.

**C-58: SynPYosys Python Framework**
Authors: DeMarco, Matthew; Juretus, Kyle
Advisor: Dr. Kyle Juretus

In contrast to other hardware synthesis tools, Yosys is a free open-source project that takes certain hardware description languages as inputs and outputs an optimized circuit description. However, the underlying code base for Yosys is difficult to understand and adapt. The goal of this project is to create an application programming interface (API) on top of Yosys, in order to create a software library for hardware design that is easy to use and modify. The ease of use will allow for faster development of novel algorithms in areas like energy efficiency and security and will allow for broader and more accessible education in hardware design. In addition to the potential impacts this project enables, it also has a high feasibility of success. I have spent the past semester working with Professor Juretus to learn the background information and perform initial development. Should I earn the privilege of entry into this program, I will build on my semester work in the areas of hardware design and software development. These are two areas of study where my enthusiasm and passion are growing everyday.

# Electrical Engineering.

**C-59: Single Electron Transistors (SETs) on SiN membranes for measuring Quantum Dots**
Authors: Adesanmi, Moboluwagbe; Rahaman, Mohammad Istiaque; Orlov, Alexei; Snider, Gregory
Advisor: Dr. Gregory Snider (University of Notre Dame)

Single electron transistors (SETs) have the highest charge sensitivity of known detection methods, and can be used to measure individual electrons, making them very useful as electrometers. This has led to the development of SET based scanning probe systems. Scanning SET methods are currently intended for use to measure composite fermion and majorana zero mode states in quantum electron droplets (QEDs) which could be useful for the realization of fault tolerant topological quantum computing. One possible implementation of an SET based scanning probe system involves fabricating a probe tip with SETs on a silicon nitride (SiN) membrane to be used with an atomic force microscope. To form the membrane, 300 nm of SiN is deposited on a silicon wafer, and then the wafer is etched away from the back in patterned areas. SETs were fabricated on separate die using electron beam lithography. Each sample had 16 die, with each die having 20 pads leading to hundreds of SETs, so that manual measurement of each SET was a very time intensive task. A system was set up to automate measurements using a computer-controlled custom built switch matrix, that reduces device testing time significantly. In the best sample so far, 2 in 16 dies have devices that show resistance values within the expected range of 10 kilo ohms to 50 mega ohms for the devices for a yield of 12.5%. Once the fabrication processes for the SETs has been adjusted to increase the yield, SETs can be fabricated on the SiN membranes.

# Geography and the Environment

**C-60: Analyzing Trends in Heavy Precipitation Events and Vulnerability in the Philadelphia Metropolitan Region from 1973 to 2021**
Author: Walsh, Sydney
Advisor: Dr. Stephen Strader

Prior research on climate change and precipitation has suggested that 100-year precipitation events will increase in frequency (+20%) and magnitude (+100%) by 2100. Similarly, a growing area of impermeable surfaces will also amplify the risk for flooding as rainfall becomes more concentrated over time. Together, heavier precipitation, altered flood behavior, land use change, and increasing societal vulnerability set the stage for more future disasters. In this study, historical heavy precipitation and social vulnerability data from 1973 to 2021 for the Philadelphia metropolitan region was spatiotemporally analyzed to determine trends in precipitation and social vulnerability. Daily precipitation data for seven surface weather stations in the Philadelphia region was gathered from the NCEI's NOWData for the period of 1950-2021 and analyzed by number of rain days per year and threshold amounts per day. Hourly precipitation for three stations was acquired from NOAA's ISD Lite database for 1973-2021 and analyzed using precipitation per event and average hourly precipitation rates. For the Philadelphia region (select counties in PA and NJ), a geographic information system (GIS) was utilized to map historical land cover data from the USGS of built and

natural land over time; building footprints and the 100- and 200-year floodplain areas; and indices from the U.S. Center for Disease (CDC) Social Vulnerability Index (SVI). Results illustrate that Philadelphia's most vulnerable populations live with a growing amount of built land and precipitation, raising their disaster odds. Analyzing how precipitation trends are changing, as well as where it changes and what types of populations live in those areas, is important for risk assessment and disaster mitigation.

**D-61: Effectiveness of point of use (POU) water filter pitchers at removing sodium from tap water**
Author: Arnold, Lauren
Advisor: Dr. Steven Goldsmith

Recent studies have documented salinization of freshwater resources, several of which are utilized as a drinking water source. As a consequence, many U.S. municipalities have reported tap water sodium concentrations in excess of the 20 mg/L threshold for individuals restricted to a total sodium intake of 500 mg/day, with some reporting values up to ~13x this threshold. Thus, a need exists for consumers at risk of sodium related health issues, such as hypertension, to limit sodium ingestion from drinking water. Here we examine the efficacy of a low price point solution, point of use (POU) water pitcher filter units, for reducing sodium concentrations in drinking water. Filtered water samples were analyzed for select elements using the ion chromatography (IC). The POU water pitcher filter units exhibited different efficacies throughout their advertised lifespan for removing sodium chloride at the various sodium concentrations. Decreasing the sodium concentration in drinking water will ultimately decrease an individual's risk of hypertension and other cardiovascular diseases.

**D-62: Effects of road environments and ventilation settings on in-cabin air quality**
Authors: Brown, Lauren; Shakya, Kabindra
Advisor: Dr. Kabindra Shakya

It is widely known that vehicular emissions are a major air pollution source, specifically particulate matter and carbon oxides which lead to adverse effects on human health. Commuting through busy roadways is one of the significant ways we are exposed to high levels of air pollutants. In order to determine the commuting exposure to air pollutants, particulate matter (PM2.5 and PM10), ultrafine particles (UFP), carbon dioxide, and black carbon were measured inside the cabin of one vehicle in different road environments (highway vs. urban backroad) and under three different ventilation conditions (air conditioning, air conditioning with recirculation, and natural ventilation) from June 13 to July 8, 2022. The vehicle was driven from Villanova University to the Philadelphia International Airport down the selected road environments of highway roads and urban backroads. Results suggest that utilizing air conditioning with recirculation combined with driving on urban backroads will best reduce exposure to PM. Exposure to PM can be detrimental as it can travel into human lungs and infiltrate bloodstreams, putting people at greater risk of experiencing irritation to the respiratory system, asthma, and heart attacks.

**D-63: Exposure of ultrafine particles in Philadelphia subway**
Authors: Malone, Maeve; Bruno, Alex; Eggler, Aimee; Shakya, Kabindra
Advisor: Dr. Kabindra Shakya

Particulate matter is a widely known air pollutant that can be damaging to human health and is of heightened concern in a subway environment. Particulate matter can become lodged in the lungs and cause various respiratory and cardiovascular problems. This is especially a concern with ultrafine particles (UFPs) which are particles that have an aerodynamic diameter of 100 nm or less. They cause more respiratory inflammation and are retained longer in the lungs when compared to PM2.5. The number concentration and lung deposit surface area (LDSA) of UFPs were measured using Naneos Partector 2 in an underground urban Philadelphia subway station. The 15th and Market subway platform was chosen because of its high foot traffic, train frequency, and relatively high levels of PM. These data were compared with the location directly above-ground and a suburban location (Villanova University) during the summer of 2022. The number concentration and LDSA of the UFPs were higher in the underground subway when compared to the above-ground measurements and the suburban levels. We will present the daily variation of UFPs at the underground subway and above-ground locations as well as daily and diurnal variation at the suburban location.

**D-64: Exposure to PM 2.5 and PM 10 at Philadelphia Underground Subway**
Authors: Bruno, Alex; Malone, Maeve; Shakya, Kabindra; Eggler, Aimee
Advisor: Dr. Kabindra Shakya

Exposure to high levels of particulate matter pollution has been associated with numerous health risks to humans. This study was done to compare particulate matter concentrations in an underground Philadelphia subway station to ambient concentrations near a busy road as well as to concentrations at a suburban background location at Villanova University. To measure particulate matter (PM 2.5 and PM 10) concentrations, a DustTrak Aerosol Monitor Model 8533 was used. Concentrations for the underground subway and above ground traffic site were recorded concurrently using two DustTrak monitors over a six hour stretch from 8 a.m. to 3 p.m. on five different days from July 13-22, 2022. Concentrations at the suburban background site located at Villanova University were measured for 24 hours on three consecutive days from June 21-23, 2022. On average subway level concentrations of PM 2.5 and PM 10 exceeded above ground concentrations. Concentrations of PM 10 at the subway level exceeded ambient air concentrations by 165.7 ug/m3.

**D-65: Life in the Plastisphere: Biodegradation of Plastic Debris by *Sargassum spp.* Algae on a Southwest Puerto Rican Beach**
Author: Wilm, Corrine
Advisor: Dr. Lisa Rodrigues

Plastic debris is often found in marine environments and takes hundreds of years to decompose while releasing toxins. Sargassum spp., floating brown algae, can become entangled with plastic debris, and both are often deposited on beaches throughout the Caribbean, including Las Pardas Beach in Guánica, Puerto Rico. To examine the interactions between plastics and *Sargassum* algae, we collected 15 samples of plastic containers that were partially buried in *Sargassum*. In the laboratory,

we determined plastic type using Fourier Transform Infrared (FTIR) analyses and determined tensile strength on both sides of the plastic container associated with and without *Sargassum*. We analyzed total chlorophyll, lipid, and biomass of *Sargassum* from each plastic sample and compared values with S*argassum* found on the beach without debris. FTIR analyses indicated that plastics were polypropylene (PP), polyethylene glycol terephthalate (PETG), or polyethylene (PE) types. Average biomass of *Sargassum* was similar with and without plastic. Based on tensile strength, clear plastic, like PP, degraded more quickly with *Sargassum* than clear plastic without *Sargassum*, and lipids from PP were more readily absorbed by the algae. Furthermore, the half of the plastic containers without algae were flexible and stretched more on average, while the halves with algae stretched less, suggesting that *Sargassum* enhanced plastic degradation. Algae with PP had higher concentrations of chlorophylls c1 and c2 compared to both PETG and PE plastics, suggesting healthier photosynthetic potential with clear plastics. Future studies could assess if algae with plastic waste can be used as a biofuel to clean beaches and reuse oils from plastics.

**D-66: Managing Campus Trees Using GIS and Remote Sensing**
Authors: Conway, Kevin; Stroud, Colleen
Advisor: Dr. Jennifer Santoro

Trees provide a variety of benefits to all aspects of life through beautification, climate regulation, and building ecological resilience. In residential areas, trees and green spaces provide positive mental health benefits and an improved quality of life. Additionally, trees regulate climate and build ecological resilience through various means such as carbon sequestration, air pollutant filtration, cooling as a result of evapotranspiration and shading, and stabilizing soil structure to decrease erosion and water runoff. Proper care and management of trees in urban and suburban landscapes is crucial to ensuring these benefits are sustained. In this study, we collected data about trees on Villanova's campus to build a more cohesive and dynamic management plan. Remote sensing, specifically a combination of Unmanned Aerial Systems and Pix4Dmapper, were utilized to build 3D models and aid in campus tree mapping and management. The goal of this project is to create a foundational dataset that includes a breadth of data that gives insight into the state of each individual tree and allows for exceptional upkeep and care so that Villanova can maintain the benefits of a healthy tree canopy.

**D-67: Waste Management in Puerto Rico: The Issue of Illegal Dumping Sites**
Author: Goertz, Sophia
Advisor: Dr. Lisa Rodrigues

As a small island nation, most products are imported to Puerto Rico and solid waste accumulates relatively quickly. Several landfills on the island have reached capacity and illegal dumping sites are prevalent. Overcapacity puts stress on landfills, resulting in less oversight, delayed collection services, and potentially negative health and ecosystem effects. To assess illegal dumping, we collected global positioning system (GPS) points at dumping sites, mapped them and known landfills, and conducted research on local landfill policies and available waste management information. We observed both small and large household items at illegal dumping sites ranging from plastic water bottles to couches, indicating local problems with solid waste management. Although some waste management policies do exist, more emphasis should be placed on enforcement and public education strategies. Potential solutions include: (1) use of more signs,

advertisements, and disposal options in public places to encourage a reduction of trash through positive incentives; (2) make disincentives more evident, including fines and explanations of negative health and environmental consequences; and (3) promote more environmental awareness programs in schools to encourage proper waste disposal at young ages. Illegal dumping sites cause environmental degradation as leachate and toxic chemicals contaminate the soil, and trash can easily travel into the ocean becoming marine debris. Therefore, it is important to have appropriate waste management to keep the environment clean and residents healthy.

# Marketing

**D-68: Flavor Behavior**
Authors: Biscuitwala, Rohan; Haas, Thoma
Advisor: Dr. Aronte Bennett

While numerous studies have focused on associations between emotion and other forms of sensory experiences, limited research has been done on the association with gustatory (or taste) experiences, specifically flavor and emotion. Sweet and bitter tastes have opposite effects on emotions: Sweet taste causes positive product and social ratings, with bitter causing negative emotions and significantly lower product ratings (Gayler et al., 2019). Consumption of a bitter flavor has been found to lead to emotional disgust and harsh moral judgment (Eskine et al., 2011).
This project uses empirical research methods to investigate the impact that gustatory experiences related to specific flavors have on emotional reactions. Pretests (n=118) identified foods most closely connected to sweet, sour, bitter, and neutral flavors. Emotional responses are captured via survey using an adapted version of the EsSense25 Profile® (King & Meiselman, 2010). This method measures 25 unique emotions and their association with foods. 200 respondents were recruited using MTurk, an online survey platform, and paid $1.75; on average the survey took 5 minutes 29 seconds to complete. Those with incomplete responses or failed manipulation checks were removed; the final dataset included 180 respondents. Primary results indicate the emergence of sweet flavors in certain emotions including warm, secure, and calm among others. The next phase of this study will include gathering alternative methods to priming flavors, and later observing how these emotional responses influence consumer behavior.

# Mathematics

**D-69: The Normalized Distance Laplacian**
Authors: Johnston, Jacob; Tait, Michael
Advisor: Dr. Michael Tait

The normalized distance Laplacian of a graph $G$ is defined as $\mathcal{D}^\mathcal{L}(G)=T(G)^{-1/2}(T(G)-\mathcal{D}(G))T(G)^{-1/2}$ where $\mathcal{D}(G)$ is the matrix with pairwise distances between vertices and $T(G)$ is the diagonal transmission matrix. In this project, we study the minimum and maximum spectral radii associated

with this matrix, and the structures of the graphs that achieve these values. In particular, we prove a conjecture of Reinhart that the complete graph is the unique graph with minimum spectral radius, and we give several partial results towards a second conjecture of Reinhart regarding which graph has the maximum spectral radius.

# Mechanical Engineering

### D-70: 3D Printed Ceramic Hybrid Structures with High Porosity Using Direct Ink Writing Technology

Authors: Flynn, Aidan; Li, Yun
Advisor: Dr. Bo Li

3D printing, also known as additive manufacturing, has emerged as an advanced technology with promising applications for multifunctional technologies. Among 3D printing technologies, direct ink writing (DIW) stands out as an inclusive technology feasible for a wide selection of materials. Ceramic materials with excellent mechanical properties have been widely used in biomedical engineering and have had profound impacts. Biomedical engineering is being used to revolutionize the fabrication of biocompatible implants, however, the defects of uncontrollable porosity and disordered structure of ceramic materials will inevitably lead to the weakening of their mechanical properties, thus preventing their potential applications. In order to solve these limitations, we took advantage of the flexible design and controllable microstructure characteristics of DIW technology and studied the effects of different nanomaterial sizes on the density, porosity and mechanical properties of 3D-printed ceramics through unique ink formulation design. We use polydimethylsiloxane (PDMS) and different sizes of SiO2 nanoparticles as a demonstration system and the printed samples are sintered at high temperature to convert the gel link ink to porous ceramics. Our results showed that the density, porosity, and mechanical properties of 3D printed ceramics can be controlled by the size and content of nanoparticles in the ink. This research contributes to the fundamental understanding of structure-property relationships in complex 3D printing systems and will provide a guideline for the further development of inorganic non-metallic materials in 3D printing and applications in future energy storage, carbon capture and medical devices.

### D-71: Data Center Environmental Burden Reduction Through On-Site Renewable Power Generation

Author: McMullen, Matthew
Advisor: Dr. Aaron Wemhoff

The energy demands from data centers contribute greatly to water stress and carbon pollution in specific locations. Understanding the use of on-site renewable power generation is an important step to gaining insight into a potential solution for more sustainable data centers. This study proposes using Water Scarcity Usage Effectiveness (WSUE), and Carbon Usage Effectiveness (CUE) at a US county scale to determine the extent that data center energy demands can impact water and carbon resources. We examine the potential savings in water resources and carbon pollution that can be achieved with on-site renewable power production for data centers, as well as assess the dependence

of data center location on WSUE and CUE. The results show that on-site renewable energy sources have significant potential to improve the CUE of data centers, as well as the potential to improve WSUE in specific locations. The results suggest that significant improvements can be made in reducing water stress and carbon pollution from data centers in many counties around the country.

**D-72: Development of a classroom activity to promote integration of engineering with other academic disciplines**
Authors: Hall, Olivia; Seth, Deeksha
Advisor: Dr. Deeksha Seth

This research assesses an engineering classroom activity featuring integration. Engineers are a part of a broad community that contributes to the rapidly changing and growing technological innovations demanding involvement from multiple branches of engineering and academic disciplines. Therefore, the ability to recognize and understand interdisciplinary connections between engineering and all academic disciplines is critical for students' academic success and professional preparedness. There is a need to develop novel classroom activities that enable students to recognize such connections. To that end, the objective of this research was to (a) develop a hands-on, student-led, classroom activity that can help students make interdisciplinary connections and (b) assess the impact of the activity on students' perception about the interdisciplinary connections. A two-session classroom activity was designed in which students worked in teams and mapped different areas of study within mechanical engineering (ME) as well as seven non-engineering academic disciplines (NEAD) to real world, complex technological innovations. A total of 49 sophomore, ME students from a four-year university participated in the activity and associated assessments. All students participated in two surveys administered at the beginning and end of the activity to rate their motivation and excitement towards ME areas of study and seven NEAD, and their believed level of importance and relevance of the ME areas of study and NEAD to product development. The quantitative data analysis showed statistically significant increases in multiple survey items, showing an overall success of the activity in increasing students' awareness of connections within and outside of engineering.

**D-73: Effects of Cannabis Grow Facility Location on Regional Water Scarcity Footprint**
Authors: Margenat, Victoria; Wemhoff, Aaron
Advisor: Dr. Aaron Wemhoff

Most cannabis grow facilities are located in water scarce areas, suggesting that ample opportunities exist to reduce the water scarcity footprint of the industry through strategic siting. This study surveys the geographical distribution of the cannabis grow industry in the U.S. and estimates the potential savings that could theoretically garnered if all existing facilities were relocated to the least water scarce state (per area of floral canopy) containing existing facilities: New York. The estimate suggests a 99% reduction in the cannabis grow industry's water scarcity footprint in this theoretical exercise. This result suggests a significant positive benefit in locating future cannabis grow facilities away from water stressed areas.

**D-74: Enhancement of Two-Phase Immersion Cooling using Submerged Synthetic Jet Impingement on Simulated High-Power Electronic Components**
Authors: Youssef, Elsaid; Schofield, John
Advisor: Dr. Alfonso Ortega

Electronics used in data centers include high-performance servers which contain CPUs, GPUs, and power distribution elements. As the processing units get faster, their power dissipation increases in direct proportion. Liquid cooling has emerged in two primary methods as the next step in the evolution of cooling technologies. (1.) Indirect cooling involves placing a cold plate on top of the hot component and circulating liquid through it. (2.) Direct cooling involves immersion cooling in which the server is immersed in dielectric fluid. This project investigates the improvements to two-phase immersion cooling in which the fluid boils on the component surface, causing vapor bubbles to form. The bubbles leave the surface by their own buoyancy, and fresh liquid flows in to replace the departing vapor. This research enhances the performance of immersion cooling by forcing a liquid jet to impinge on the surface using a synthetic jet approach. The figure of merit is the heat transfer coefficient on the boiling surface, $h = \frac{q''}{(T_s - T_{fluid})}$. A synthetic jet is formed by providing a time-dependent flow into and out of a nozzle submerged in the fluid. The hypothesis is that the impinging jet will force the bubbles off the surface at a faster rate, thus accelerating the bubble formation cycle which controls pool boiling. The objective is to evaluate the efficacy of jet impingement on increasing heat transfer by documenting the increases in the heat transfer coefficient as a function of heat flux, synthetic jet frequency and amplitude, and distance from jet to target.

**D-75: Experimental Investigation of Water Evaporation on Porous Media with Metallic Oxides Coatings by Atomic Layer Deposition**
Author: van Vliet, Alexander
Advisor: Dr. Calvin Li

Porous media, such as polypropylene (PP) and carbon foam, have been previously studied for enhancing water evaporation by their strong capillary forces and capabilities of heat localization when being exposed to solar radiation. Meanwhile, it is reported that enhancing hydrophilic properties of a porous surface allows greater water evaporation rate than untreated porous surfaces. For example, the contact angle of water on nitric acid-activated PP is decreased from 110° to 66° and 76°, and the total water evaporation rate on a bare PP membrane is more than doubled from 250 L h-1 m-2 bar-1 to 487 - 509 L h-1 m-2 bar-1. We would like to propose a treatment of porous metal media by atomic layer deposition (ALD) of metallic oxides, including titanium dioxide (TiO2) and aluminum oxide (Al2O3), to induce superior hydrophilic properties and investigate the water evaporation enhancement on the treated porous media. This work will focus on establishing a quantitative correlation between various ALD coatings and the enhanced water evaporation on porous media that are exposed to various heating. It is expected that a greater thermal efficiency of metal porous media will have a better heat transfer to support the water evaporation than that on non-metal porous media, and a hydrophilic ALD coating will yield a smaller contact angle and greater water evaporation flux due to the combined effects of enhanced hydrophilicity on the surface of porous media and heat transfer in the skeleton of porous media by more than two times of that on untreated porous media when being exposed to the same heating conditions.

**D-76: Influence of Bone Metastases on the Fracture Process of the Proximal Femora**
Authors: Fragetta, Kendall; Ural, Ani
Advisor: Dr. Ani Ural

Metastatic cancer lesions are a cause of pathological fractures in bones. A pathological fracture is a bone fracture caused by the weakening of bone structure or change in material property of a bone due to cancer or a result of cancer treatments. A metastatic lesion is caused by the spread of cancer cells to different parts of the body including bones. Clinicians currently use Mirel's scoring system, CT scans and radiographs to evaluate the size and appearance of metastatic lesions in femur bones to determine if surgical intervention to provide bone fixation is appropriate. On their own, however, the current approaches do not evaluate whether the lesions compromise the mechanical integrity of the bone. A systematic approach is urgently needed, with the addition of new measures to guide decision making of medical professionals when determining whether fracture fixation surgery is appropriate. The goals of this study are to model the fracture process caused by femoral bone metastases, replicate differences in the mechanical impacts of metastatic lesions on bone, and determine the fracture process of femoral bones affected by metastatic lesions. The strength of the metastatic bone will be analyzed by measuring changes in the material properties of the femoral bone and in the location and size of the lesions. The study will quantify the effect of the metastatic lesions and produce parameters for fracture risk assessments in the medical field.

**D-77: Novavent Project Sensor Development**
Authors: Schofield, John; Elsaid, Youssef; Thomas, Samuel
Advisor: Dr. Alfonso Ortega

During the initial phases of the COVID-19 pandemic, the NovaVENT project was initiated to address the shortage of ventilators. In the present phase, of which this study is a part, the continuing development of the ventilator pivoted towards developing a rugged, field deployable ventilator for use in developing countries and in harsh environments. As part of the NovaVENT ventilator, a sensor package was to be designed and integrated into the inspiratory and expiratory flow lines, with the primary objective of measuring and providing feedback on CO2 concentration in the expiratory flow. After assembly and testing of the prototype using a small air pump to increase the flow rate, CO2 concentration was not detected fast enough to produce an accurate Capnogram, a plot of CO2 Concentration (PPM) vs Time (s). As such, the purpose of this work was to determine if flow to the sensor could be reconfigured so that it can be made to impinge normal to the sensor's active surface to reduce the CO2 sensor response time, thus eliminating the need for an air pump. Therefore, various housings were designed and 3D printed and experiments were performed to determine if variations in the flow direction would affect the time response of the sensor measurement. It was found that flow direction did not have significant effect on sensor response. Furthermore, it was found that flow rate had the greatest influence, and hence it was shown that the air pump is a necessary component for the sensor package to operate properly.

**D-78: The Difference in Blue Water Usage of Meals Prepared at Home versus Meals Prepared Away from Home**
Author: Sices, Schuyler
Advisor: Dr. Aaron Wemhoff

Fresh and drinkable water, otherwise defined as "blue" water, is the least prevalent of all water sources. Due to agriculture using 85% of all accessible blue water and populations and demand for food ever increasing, it is integral we understand all of the ways to mitigate blue water usage especially when it comes to producing food. We sought to determine if there was a meaningful difference in blue water usage depending on the location of meal preparation in order to inform decisions on meal compositions. To do this, we utilized a survey from the USDA to define the composition of food prepared at home (FAH) and food prepared away from home (FAFH). The 146 meal components listed were sorted into 133 more accessible categories whose individual blue water footprints could then be calculated from a list of known food item water footprints. FAFH does consume 33L or about 16% more blue water per kilogram of food consumed than FAH. The difference in water usage comes mainly from the incredibly high consumption of beverages, making up nearly 50% of the meal composition, with protein-based meals also making up much more of the water footprint than FAH. What brings the blue water usages closer together is the increased consumption of high water-consuming snacks at home such as nuts and dried fruits as well as meal ingredients like processed oils. This research offers insights into blue water usage for many food items as well as preparation location and can serve to inform decisions on meal composition in order to reduce water footprints related to food production and consumption.

# Nursing

**D-79: Child Maltreatment/Abuse and Native American Indigenous Children: A Literature Review**
Authors: Nguyen, Lily; Dsouza, Aidan
Advisor: Dr. Elizabeth Dowdell

Background: The numbers of children and adolescents who are exposed to abuse is a widespread problem in the United States (US). Compared to other nations, the American Indian/Alaskan Native (AIAN) or indigenous people of the US, tend to have higher rates of violence and homicide, which contribute to the issue of missing and murdered indigenous children, specifically girls. Methods. A systematic literature review was conducted on English language articles that were searched through CINAHL and PubMed from scholarly journals published in between 1979 to 2022. Eligible articles were selected based on inclusion criteria and PRISMA guidelines were followed. Results: The studies revealed that child maltreatment and abuse is proportionately reported more often in the population of MMIWG than other populations due to certain circumstances and factors. Major findings include the identification of risk factors for victimization of IPV and child maltreatment. One article detailed the tools in child abuse prevention, specifically the Escape Form and the Training Toolkit, and interventions, such as laws. Conclusion: Despite recently published articles in the past 5 years, there is a scarcity of research in the US regarding NAI exposure to child maltreatment. From the findings, prevention of violence would be crucial in lowering rates of child maltreatment victimization and perpetration, which can be done through

raising awareness of child maltreatment and increased application of the tools and interventions. Understanding that trauma is universal, healthcare professionals must use trauma-informed care when screening NAI children and adolescents routinely for exposure to violence and maltreatment.

**D-80: Comparing Male and Female Perpetrators of Murdered Native and Indigenous Girls: A Correlational Study**

Authors: D'Souza, Aidan; Nguyen, Lily; Jimenez, Chantal; Gurleen, Sindhar
Advisor: Dr. Elizabeth Dowdell

Background: Native American and Indigenous (NAI) peoples of the United States have high rates of violence and homicide contributing to the issue of missing and murdered indigenous women and girls (MMIWG). More than four in five NAI adults (83%) have experienced some form of violence in their lifetime and for many, their exposure to violence began during childhood which contributes to increased risk of morbidity and mortality. Methods: This study used a descriptive, correlational design of public access data of 64 murdered NAI girls living in 18 states. Ages ranged from 14 months – 18-years with year of death ranging from 1960 to 2020. Results: The majority of girls were killed by a member of their household, 45% by a family member and 12% identified as murder by a member of the household not related by marriage (domestic violence). Non-family events were overwhelmingly committed by males rather than females (95.5% vs 4.5%; $p < .002$) as were those involving domestic violence (83.3% vs 16.7%; $p < .002$). Child age and perpetrator sex was associated with girls under 5-years of age more likely to be murdered by a female perpetrator (52% vs 47.6%; $p < .002$). Those over 6-years more likely to be murdered by a male perpetrator (male 81.3% vs female 18.8%) and girls 11-years and older 100% were male ($p < .002$). Conclusions: Nurses have an integral role in recognition and education for evidence-based guidelines to handle maltreatment of Indigenous girls.

**E-81: The Role of Education in Cases of Murdered Native/Indigenous Girls: A Comparative Case Analysis**

Authors: Jimenez, Chantal; Dsouza, Aidan; Sindhar, Gurleen
Advisor: Dr. Elizabeth Dowdell

Introduction: Native/Indigenous people have long experienced poor health outcomes and many have experienced violence in their lifetime. Children are frequently identified as a vulnerable and high-risk population. Educational gaps and barriers from deficits in funding limit resources and curricular offerings that impact overall health and safety. The lack of programs such as violence prevention and emergency response programs often leads to negative outcomes. Education is identified as a social determinant of health that, when coupled with the higher rates of exposure to violent and traumatic events, makes Native/Indigenous children especially vulnerable to becoming victims of violent crimes. Methods/Results: Utilizing a public access data set with a sample of 63 murdered Native/Indigenous female adolescents this study used in a comparative case design. Two cases, occurring in New Mexico in 2016, were used to compare similarities and differences of risk with subsequent outcomes. Conclusion: Professionals who work with vulnerable children need to take steps to address the social determinants of health specific to resources and opportunities for Native/Indigenous children. Collaboration among professionals on and off reservation, a dynamic clinical team that collaborates with various allied healthcare professionals, and screening of all children for exposure to and experience with violence in concurrence with supportive and culturally appropriate services to Native/Indigenous families with children operate to provide more continuity

and leverage resources. The two cases examined in this study demonstrate how vital education and resources are for all professionals who work with NAI children to assess safety at home, at school, and in the community.

# Physics

**E-82: A Multiprong Approach to the Study of Heteropolymer Ferritins**
Authors: Gorun, Boran; Vizzoni, Marissa; Zarta, David
Advisor: Dr. Georgia Papaefthymiou

Ferritin is the iron storage protein comprised of 24 amino acid subunits that encapsulate an iron biomineral core. There is variation among which of the subunits are most prevalent in the ferritin. There are H-rich ferritins and there are L-rich ferritins, meaning that the respective amino acid chain is more abundant within the protein. There is also variation as to the contents of the core, in this experiment reconstituted ferritin is studied with both 1000 Fe/shell and 500 Fe/shell.
Three different techniques were used to study the ferritin proteins, Mössbauer spectroscopy, Atomic Force Microscopy, and Transmission Electron Microscopy. Mössbauer spectroscopy based on the recoil-free emission and absorption of nuclear γ-rays in solids can uniquely characterize the structure of the core. It uses radioactive 57Co that decays into 57Fe at an excited energy state with subsequent emission of a 14.4 KeV γ-ray. Atomic Force Microscopy utilizes a cantilever and tip to create an image of the surface of a substrate on the nanometer scale. There are three main modes that are utilized: Non-Contact Mode, Contact Mode, and Tapping Mode. The Transmission Electron Microscope operates within an evacuated tube by directing a beam of electrons, generated by an electron gun and focused by electromagnetic lenses, onto the sample deposited on a TEM grid.

**E-83: Automating Veto Algorithms for Application to the Search for Burst Gravitational Waves with LIGO**
Authors: Davis, Michael; Stuver, Amber;
Advisor: Dr. Amber Stuver

This research has applied automated veto (glitch rejection) tools to evaluate their potential to improve the search for burst (unmodelled) gravitational waves with LIGO (Laser Interferometer Gravitational-Wave Observatory). During the process of data acquisition, transient noise from environmental and instrumental sources creates glitches in the data. The impact of these glitches on the search for gravitational waves can be mitigated by removing (vetoing) these glitches from the data. Auxiliary channels, data streams that are unable to detect gravitational waves, are used to generate glitches and minimize the chance that a glitch may be a true gravitational wave. Omicron is an algorithm that is currently used to automatically identify data segments likely to be glitches. Two different statistical algorithms evaluate data quality when Omicron glitches originating from different auxiliary channels are vetoed: hierarchical veto (Hveto) and Used Percentage Veto (UPV). We have developed software to collect the daily results of Hveto and UPV and apply those candidate vetoes to the burst search algorithm, Coherent WaveBurst (cWB). The results are evaluated by the Veto Evaluation Tool (VET) to measure a veto's efficiency (fraction of the background events that were vetoed) in removing cWB triggers, deadtime (amount of time removed by the veto), and the ratio of

efficiency to deadtime. The higher this ratio, the more effective the veto. Results of this research show that Hveto and UPV provide vetoes that identify unique glitch features, and both have the potential to improve data quality for burst gravitational wave search. New features have been added to assist data scientists in identifying problematic channel sources.

**E-84: Gravitational Wave Data Quality Analysis**
Author: Bevins, Nathaniel
Advisor: Dr. Amber Stuver

The Laser Interferometer Gravitational-Wave Observatory (LIGO) measures gravitational waves from astrophysical sources with amplitudes on the order of a thousand times smaller than a proton. Because of the high precision of the detector, it's very sensitive to disturbances from the environment which can cause glitches in the data. These glitches are often confused with candidate detections of unmodelled (burst) gravitational waves. Normally, glitches are removed (vetoed) from the data by performing data quality studies and compiling a list of times that are known to contain glitches to exclude from analysis. However, these glitches can overlap with true gravitational waves causing them to also be removed. This research studies the feasibility of applying a machine learning algorithm (iDQ), which measures the likelihood that a glitch is present, and uses this to proportionately reduce the significance of a contaminated time instead of completely rejecting it through traditional vetoes. We show the distribution of iDQ likelihood measurements during known accidental burst gravitational-wave events and propose investigations needed to implement the method in the future.

**E-85: Mapping Galactic Center Magnetic Fields: Observing Mode Comparison**
Authors: Karpovich, Kaitlyn; Guerra Aguilera, Jordan; Chuss, David
Advisor: Dr. Jordan Guerra Aguilera

Our Milky Way's Galactic center is a region with dense molecular clouds, high temperatures, and dynamic magnetic fields. Studying this region can reveal information about the characteristics of our Galactic center that are also relevant to other galaxies that are much more difficult to observe due to their distance from us. However, the Galactic center is surrounded by a cloud of dust that obscures visible light. At far-infrared wavelengths, the High-resolution Airborne Wideband Camera Plus (HAWC+) on NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) is able to detect the polarization of magnetically aligned dust particles within the Galactic center molecular clouds and therefore provide insight as the role that the magnetic field plays in the dynamics of this unique region. The Far Infrared Polarimetric Large Area CMZ Exploration Legacy Survey (FIREPLACE) is an ambitious survey of approximately 150 pc across the Galactic center at a resolution of 20". This survey, led by Villanova, will provide magnetic field measurements in all of the clouds in the central 150 pc of the Milky Way. The production of these maps requires a novel "scan mode" observing strategy that requires validation. In this work, we compare data from the FIREPLACE observing strategy with data obtained from several individual fields measured using the observatory's well-understood chop-nod observing method.

**E-86: Spectral Variability in the Obscured State of GRS 1915+105**
Authors: Parrinello, Kaitlyn; Neilsen, Joey; Homan, Jeroen; Steiner, James; Uttley, Phil, Cackett, Edward
Advisor: Dr. Joseph Neilsen

GRS 1915+105 is an X-ray binary consisting of a stellar mass black hole in a wide 33.5-day orbit around a K giant. After nearly 30 years in a bright outburst, GRS 1915+105 underwent a significant drop in luminosity between 2018 and 2019, down to ~1% of its former peak. Likely caused by Compton-thick obscuration, this new state has been named the "obscured state." NICER has been monitoring the obscured state on a weekly basis. We report our X-ray spectral analysis of 470 NICER observations from the early obscured state, with a focus on quantifying the obscuration and characterizing emission lines. We find a broad range of partial covering fractions (0.4-1) and obscuring column densities (20-300)x10^22 cm^-2, along with a strong correlation between these quantities. In addition, we find that the average strength of the iron emission lines decreases with the obscuring column density. We discuss the implications of these results for the location and geometry of the obscuring medium.

**E-87: X-ray Spectroscopy of Ionized Obscuration in GRS1915+105 with Chandra and NuSTAR**
Authors: Karavangelas, Georgia; Neilsen, Joseph
Advisor: Dr. Joseph Neilsen

After a bright, 26-year-long outburst, the black hole binary GRS1915+105 dimmed considerably in 2018 and dropped sharply in flux in 2019. The system has remained in this new, faint "obscured state" ever since. We utilize observations of GRS1915+105 from Chandra and NuSTAR, all performed in July of 2021, to conduct X-ray spectral analysis and photoionization modeling of the obscuring medium. The smooth continuum is consistent with disk emission and Compton scattering from an optically thick hybrid plasma, along with a smeared absorption edge. We find dozens of absorption lines in our Chandra grating spectra, but our measured Doppler shifts show no evidence for a significant outflow. To study these absorption lines further, we perform photoionization modeling using the XSTAR analytic model warmabs; our best fit model requires two partially-covered warmabs components that differ in column density and ionization parameter. Our photoionization analysis suggests that the absorption regions lie in the outer accretion disk. We discuss the implications of this model for the structure of the obscuring medium.

# Physics and Astronomy

**E-88: The DESI Peculiar Velocity Survey: Calibrating the Tully-Fisher Relation for Year 1**
Authors: Nofi, Hayley; BenZvi, Segev; Douglass, Kelly
Advisors: Dr. Segev BenZvi; Dr. Kelly Douglass (University of Rochester)

We live in an expanding Universe which is governed by Hubble's Law. However, certain areas of the Universe, such as galaxy clusters, have a higher mass density than other regions, leading galaxies near these regions to exhibit peculiar velocities in addition to the Hubble expansion rate. These peculiar

velocities affect the observed redshifts of distant galaxies which in turn affects distance measurements. Peculiar velocities of spiral galaxies can be measured using the Tully-Fisher relation, a scaling law that correlates the luminosities and maximum rotational velocities of spiral galaxies. Using Year 1 data from the Dark Energy Spectroscopic Instrument (DESI) Peculiar Velocity Survey, we calibrate the Tully-Fisher relation to measure peculiar velocities in the Year 1 data set. The rotational velocities are defined as the differences in velocities at the galactic center and a distance 0.4R26 along the major axis. The Abell 2151 and Virgo clusters are used to calibrate the slope of the relation and the independent distances used to calibrate the zero point are taken from the Extragalactic Distance Database (EDD). With our calibrated Tully-Fisher relation, we can now measure the peculiar velocities of over 8000 spiral galaxies in DESI Y1.

# Psychological & Brain Sciences

**E-89: A potential approach for reducing hearing difficulty by improving perception of intensity changes in speech**
Authors: Maguire, Aisling; Toscano, Joseph
Advisor: Dr. Joseph Toscano

Many listeners report hearing difficulty, especially for speech in noisy environments, despite having normal audiometric thresholds. Recent work suggests that such cases may be caused by disruptions in coding of suprathreshold sounds at early stages of auditory processing. Specifically, differences in the function of auditory nerve fibers with lower spontaneous firing rates could disrupt coding of intensity changes for sounds in the typical range used for speech communication. In turn, this could affect perception of acoustic cues in speech that are dependent on intensity changes over time, such as voice onset time (VOT). The current study investigated a speech sound manipulation designed to counteract the effects of such disruptions by making intensity differences in the signal more pronounced. Listeners heard speech sounds varying along two acoustic dimensions that provide information about word-initial voicing, VOT and f0 onset, and categorized sounds as either voiced or voiceless. Results showed that the intensity manipulation reduced listeners' use of f0 for voicing categorization and also affected their use of VOT. This suggests that intensity manipulations can make acoustic cues like VOT more salient, providing a potential treatment approach for listeners who have difficulty coding intensity differences in speech.

**E-90: Antecedents of Antiracism Self-Efficacy**
Authors: Reilly, Adriana; Broussard, Kristin; Quigley, Narda; Vickers, Kamil
Advisor: Dr. Kristin Broussard

This study aims to assess antecedents of antiracism self-efficacy. In other words, we are measuring if and to what extent an individual's antiracism self-efficacy changes after undergoing external stimuli. From research based in Social Cognitive Theory, we know verbal persuasion is a category of antecedent of general efficacy beliefs. To test its implications on antiracism self-efficacy, 277 participants were given an antiracism self-efficacy scale (author-developed) and modern racism scale. Then, each participant was randomly assigned to one of three conditions: verbal persuasion regarding the importance of antiracism activism (experimental condition), verbal persuasion

regarding the importance of the history of racism in the U.S. (active control condition), and verbal persuasion on an unrelated topic (control condition), and later re-tested with the same antiracism self-efficacy scale (author-developed). Across all video conditions, participants' antiracism self-efficacy increased after watching the video, however, the content of the video did not have an effect on this change. Both racial identity and modern racism scores had a strong effect on antiracism. However, when modern racism was included as a moderator, we found that anti-racism self-efficacy significantly improved after watching the antiracism video versus the control video, but only for those low in modern racism. This study shows that antiracism self-efficacy is malleable and can change within individuals. These findings can potentially contribute to building antiracism self-efficacy and allyship.

**E-91: Brain serotonin deficiency but not gut dysbiosis confers heightened anxiety-like behavior in female mice**

Authors: Miller, Elise; Sachs, Benjamin
Advisor: Dr. Benjamin Sachs

Previous research suggests that antibiotic regimens significantly increase the risk of psychiatric disorders such as depression and anxiety. This may be through alterations in the microbiota-gut-brain axis, a bidirectional pathway of communication between the brain, gut, and microorganisms within the gut. While it remains unknown what factors leave some individuals vulnerable to antibiotic-induced depression, serotonin (5-HT) deficiency has been implicated in depression and anxiety. The present study sought to determine whether low brain 5-HT alters susceptibility to antibiotic-induced differences in depression- or anxiety-like behavior. To do so, we induced dysbiosis via a 10-day antibiotic regimen in female wildtype (WT) and low 5-HT mice (N=46) and subsequently subjected them to a panel of behavioral tests. Our results show that dysbiosis is insufficient to induce behavioral changes in the tests run. However, WT mice showed significantly less anxiety-like behavior in the Elevated Plus Maze (EPM) and Light Dark Emergence (LDE) tests compared to their low-5HT counterparts. These results indicate that dysbiosis is insufficient to induce behavioral changes or alter the effects of low 5-HT on anxiety- and depressive-like behavior and cognition in the tests run, but low 5-HT alone is sufficient to induce more anxiety-like behavior in the EPM and LDE. Future studies should include a stressor to examine whether low brain 5-HT exacerbates the effects of dysbiosis on depression.

**E-92: Decoding syntactic class from EEG during spoken word recognition**

Authors: Montañez, Olivia; Sarrett, McCall; Gonzale, Alexa; Toscano, Joseph
Advisor: Dr. Joseph Toscano

A fundamental issue in spoken language comprehension involves understanding the interaction of linguistic representations across different levels of organization (e.g., phonological, lexical, syntactic, and semantic). There is debate about when different levels are accessed during spoken word recognition. Under serial processing models, comprehension is sequential, while under parallel processing models, simultaneous activation of representations at multiple levels can occur. The current study investigates this issue by isolating neural responses to syntactic class distinctions from acoustic and phonological responses to identify the earliest time during which listeners distinguish syntactic class information in speech. We collected electroencephalography (EEG) data while participants (N=26) listened to words varying in syntactic class (nouns vs. adjectives) that were

controlled for acoustic differences via cross-splicing. Participants determined whether the auditory word and subsequent visual words shared the same syntactic class (match vs. mismatch). EEG was timelocked to the presentation of the auditory word, and machine learning techniques were used to decode syntactic class. Results showed that syntactic class is decodable approximately 200 ms after the average syntactic point of disambiguation during which listeners are still processing acoustic information. This supports the prediction that different levels of linguistic representation have overlapping timecourses. Overall, the results are consistent with a parallel, interactive processing model of spoken word recognition, in which higher-level information—such as syntactic class—is accessed while acoustic analysis is still occurring.

**E-93: Exploring the Impact of Brain 5-HT Deficiency on Exercise-Induced Alterations in Hippocampal Neurogenesis in Adult Mice**
Authors: Iskander, Lauren; Sachs, Benjamin
Advisor: Dr. Benjamin Sachs

Preclinical studies suggest that low levels of brain 5-HT can prevent some behavioral responses to antidepressants like Prozac, but whether exercise can achieve antidepressant-like effects in animals that fail to respond to traditional antidepressants remains unknown. Consistent with this, low 5-HT also blocks the ability of Prozac to enhance neurogenesis. The current study was conducted to determine whether low levels of brain 5-HT impacted exercise-induced increases in hippocampal neurogenesis in adult mice. Immunohistochemistry for the cell proliferation marker, bromodeoxyuridine (BrdU), revealed that exercise leads to a nearly 50% increase in cellular proliferation in the dentate gyrus of wild-type males, but that it is associated with a nearly 50% decrease in 5-HT-deficient males. In females, however, exercise did not lead to a significant increase in cellular proliferation in wild-types, but is associated with more than a 100% increase in 5-HT-deficient females. To confirm that the BrdU results truly reflect neurogenesis, follow up studies using a marker for immature neurons, doublecortin, are also ongoing, but technical difficulties still need to be troubleshooted. Regardless, the results obtained to date suggest that brain 5-HT deficiency impacts the ability of exercise to promote cellular proliferation in the hippocampus in a sex-dependent manner. These results could have important implications for individuals seeking to enhance their mental health through exercise.

**E-94: Salivary Cortisol Measurement to Assess Stress Reactivity and Regulation among Infants Experiencing Family Homelessness**
Authors: Attah-Gyamfi, Jennifer; Knight, Abigail; Herbers, Janette
Advisor: Dr. Janette Herbers

Effective physiological regulation of stress in infants develops in the context of positive parent-child relationships. Understanding how parents can support stress regulation with their infants can inform efforts to increase these factors for infants facing risk and adversity. Unfortunately, very little research exists evaluating physiological stress reactivity in infants living in high-stress situations, such as those experiencing homelessness. Stress responses are regulated by cortisol. Cortisol is a steroid hormone produced by the adrenal cortex in response to stress and fight, flight, or freeze responses. This study investigates patterns of cortisol reactivity in infants experiencing family homelessness in relation to measures of the quality of parent-child relationships. The sample includes 47 infants who were recruited with their parents from family shelters in the Philadelphia area. Participants

completed interview sessions that included parent-report measures as well as behavioral tasks for infants and an observational parent-infant interaction session. Infant saliva samples were taken up to 4 times during the sessions, at 20 minutes intervals, to assess response to stress-inducing tasks. The immunoassay was a plate reading immunoassay of saliva samples from babies using the Salimetrics™ cortisol kit. The saliva samples were expressed from oral swabs into centrifuge tubes and incubated in microtiter plates. They were read on a standard plate reader. Different patterns of reactivity across the session in response the stress-inducing tasks emerged among the infants in the sample. We present these patterns in relation to observational measures of parent sensitivity, parent non-hostility, and parent intrusiveness assess during free play interactions.

**E-95: Sustainable Story Transfer Research**
Author: Coogle, Joshua
Advisor: Dr. Deena Weisberg

Although children have opportunities to learn about the environment and sustainability, there is no research on how educational media influences a child's knowledge about sustainability or self-efficacy for conservation. It is important to ensure that the current generation of children understand the importance of sustainability and its effects on the environment as this generation will experience the repercussions of our mismanagement of resources. My research project looks at the effectiveness of children's media, particularly of a television show, in teaching children about sustainability and conservation. The study uses a pre- and post-test design with two comparison groups of children aged 4 to 5 years old (target N=108). The experimental group watches an episode from the PBS Kids show Nature Cat about water conservation (titled "Water Woes), while the control group watches an episode from Nature Cat about dragonflies (titled "Enter the DragonFly"). In the pre-test, all children are asked multiple questions regarding their knowledge about sustainability, their self-efficacy in conservation, and their personal environmental worry. Then, children watch their assigned episode from Nature Cat. The post-test consists of the same questions from the pre-test and a memory check to ensure they were paying attention to the media. Although the research is still ongoing, the expected pattern of results is that children in the experimental group, but not in the control group will show increases in knowledge about water conversation and in self-efficacy.

**E-96: Talk to Me: The Role of Parent Language in Free-Play Interactions in Shelter**
Author: Bajada, Allison
Advisor: Dr. Janette Herbers

When it comes to children's early language exposure, language quantity (number of words) and quality (lexical complexity and diversity) are foundational for language and literacy skills (Romeo et al., 2018). Disparities in language exposure differ drastically by socioeconomic status (SES; Rowe, 2008), with a 30-million-word gap between children in low-SES environments and those in high-SES environments by the time they reached age four (Hart et al., 1995). The goal of the present project was to analyze the relationship between parent language use and quality of the relationship between parent and infant for families in shelter. Transcripts were created for 51 15-minute free play interactions featuring parent-infant dyads who were recruited while living in family homeless shelters

in the Philadelphia area. The four measures used in transcript analysis were total number of words spoken (M=608.69, SD=318.08), total number of unique words spoken (M=147.77, SD=79), total number of negative words spoken (M= 11.42, SD=10.8), and total number of parent vocalizations (M=81.37, SD=50.96). A statistically significant positive correlation was found between total number of words spoken and total number of unique words spoken ($r(50) = 0.87$, $p<0.001$). The relationship between these four measures and relationship quality indicators of of mutual responsiveness, parental sensitivity, parental structuring, child responsiveness, and child involvement was evaluated, with statistically significant correlations between total words spoken and parental sensitivity ($r(48) = 0.30$, $p = 0.033$), total words spoken and parental structuring ($r(48) = 0.34$, $p = 0.016$), total vocalizations and child responsiveness ($r(48) = 0.25$, $p = 0.085$), and total vocalizations and child involvement ($r(48) = 0.39$, $p = 0.005$).

**E-97: Testing the What-Where-When episodic-like memory using object recognition methodology with rats**

Authors: Xiong, Siyan (Nicole); Pluck, Ryan
Advisor: Dr. Michael Brown

Episodic memory has historically differentiated humans from animals, leading several comparative psychologists to study whether animals are capable of recalling the what, where, and when components of a particular event. Previous research has found evidence of what-where episodic-like memory in rodents. This study investigates the what-where-when representation in rats using a three-part object recognition task indicated in previous research. The behavioral task consists of three phases, a first exposure presents four identical objects located among eight radially positioned stands for the rat to explore, a second exposure with four new identical objects, and a memory test with two objects from the first exposure and two from the second. In test trials, one object from each exposure is in the same location the subject experienced, whereas the other two are in new locations. By varying the interval between the second and third trials, we aim to study the effect of time decay on rats' object recognition. We predict our subjects to prefer the displaced objects to the stationary objects in test trials. However, this preference will decrease or disappear when the interval between the second exposure and test increases from one hour to two hours.