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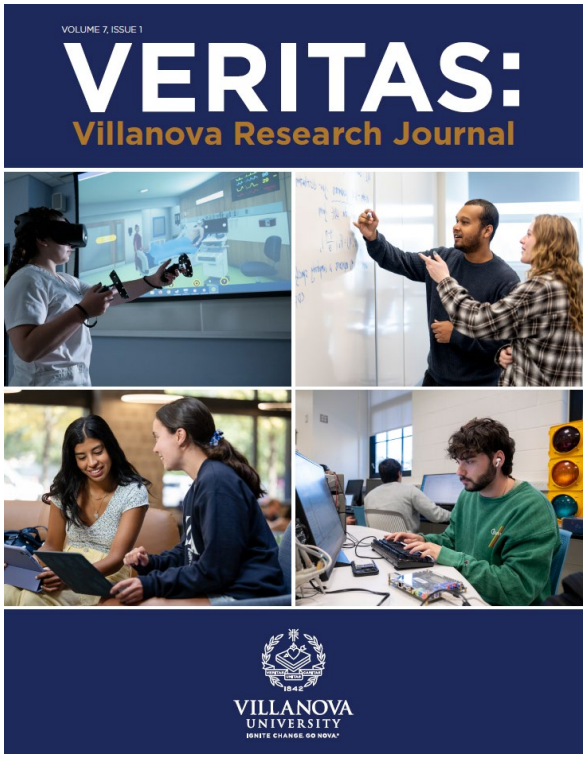

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Abstracts: Oral Presentations

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Computing Science

(1:30 p.m.)

Dissimilarity-Guided Multimodal Framework for Plant Species Classification: A Case Study on Solidago
Authors: Kazanjian, Garik; Loyson, Abigail; Kosaraju, Naren; Margapuri, Venkat
Advisor: Dr. Venkat Margapuri

Classification of the Solidago plant species, commonly known as goldenrod, presents challenges as field image quality lacks variability. Morphological similarities in Solidago species adds a further layer of complexity as standard image classification techniques fail to differentiate between different species. The computational cost behind classifying species is time-consuming and costly, as it requires specialized training on tens of thousands of data points. Different multi modal frameworks to address the high cost and differentiating between features have been suggested in overcoming these issues. Despite this, different objects in the images have interfered with the classification techniques. This approach includes image segmentation to isolate the plant structures, allowing the background interference to be minimized before classification. Additionally, inter species similarity was quantified using the mean feature vector, which increased the models' discriminative nature. Predictions from the species were included with textual descriptions of each species using a BERT-based classifier model. Between the image and text models, an ensemble approach weighs the outputs by confidence scores. The proposed methodology improves Solidago identification that pairs species for binary discrimination and combines multi modal predictions to improves classification outcomes.

English

(1:45 p.m.)

Polished Looking Glass: How Literature Reflects Irish Culture
Author: Gibson, Kaitlin
Advisor: Dr. Mary Mullen

The early Irish Free State cemented itself as a new nation through collusion with the Catholic Church, whose patriarchal standards oppressed women's roles within society. Literature from women writers who lived through these oppressions offers the emancipatory tool of recognition. These women writers speak to this culture, and its social oppressions, as bolstered by Catholic ideology. Advancing upon the theories of former scholars, I read Down by the River (Edna O'Brien) and Small Things Like These (Claire Keegan) as works which use the realist mode and free indirect discourse to reflect

and deconstruct social structures at play within the Irish state while subverting traditional narrative structures, such as omission of the first person despite the "coming of age" narratives (or, bildungsroman), and disembodied description in the form of sentence fragments. The bildungsroman and realist mode are frequently studied within women's literature, with a specific focus on the voicelessness of women in society and the subsequent loss of first person narration. I assert this voicelessness is the result of Marianism, which enshrines the Virgin Mary as the ultimate Irish woman, equating this image with an Irish national character. This Irish archetype pervades society and is most honestly represented in Irish women-centered and composed literature, a body of work which attacks those standards. These literatures empower divergent voices. They emphasize the humanity behind victims of institutional abuse, providing subversive tools of rebellion. Deconstructing these institutional standards through diverse and expansive writing offers a path forward, liberating the minds of readers.

Mathematics and Statistics

(2:00 p.m.)

Improved Imputation of Missing Values in Time Series
Authors: Nappo, Alexander; Lyudovyk, Spencer; Zhou, Showmee; Bernfield, Oscar; Zhang, Mingyu
Advisor: Dr. Alex Iosevich (University of Rochester)

Suppose a signal is transmitted via its Fourier transform, but some frequencies are lost. Can the original signal still be recovered? In 1973, Matolcsi and Szucs showed that under certain conditions, exact recovery is possible. This presentation presents Logan's recovery mechanism and how it can be utilized to better accommodate time series data and practical constraints for imputation. We also present results from numerical experiments that support and illustrate the theoretical findings.

Physics

(2:15 p.m.)

Correlations and Categories of Galactic Center H[II] Regions
Authors: Molinari, Sophia; Pare, Dylan; Chuss, David; Butterfield, Natalie
Advisor: Dr. David Chuss

The Galactic Center of our Galaxy holds a large number of H[II] Regions. These regions of ionized hydrogen gas have been catalogued in the past, one of the most extensive catalogs being the Wide-Field Infrared Survey Explorer (WISE) Catalog of Galactic HII Regions from West Virginia University. Building from this catalog, H[II] Regions labelled as "Candidates" were analyzed according to their corresponding Infrared Intensity, Radio Continuum Emission, Temperature, Polarization, and HST Paschen-Alpha Emission, and recommendations were made to which categories they should be placed in for the future, including the "Known" and "Discarded" categories. Correlations between the regions' Paschen-Alpha emission and the radio continuum have been observed and correlations using fractional polarization are currently being analyzed. From these observed relationships and

morphology, potentially new H[II] Regions have been identified. A strong case has been made for many HII Regions to be moved from the "Candidate" to the "Known" category and the relationships observed in the data as mentioned could serve as a future tool to support the recognition of new regions.

Spanish

(2:30 p.m.)

Testimonies of Kurt Chew-Een Lee: A Chinese American Experience during the Korean War, 1950 - 2014
Author: Li, Aiden
Advisor: Dr. Adriano Duque

The research investigated the overlooked involvement of Chinese American veterans during the Korean War (1950-1953) and the cultural interactions between China and America, especially how Chinese values translated to a racially homogeneous American war effort. It specifically examined the testimonies of Kurt Chew-Een Lee (1926-2014), the first Chinese American enlisted in the United States Marine Corps. By analyzing his testimonies, I uncovered his motivations for enlisting, the potential racial challenges he navigated during service, and his experiences regarding post-war reintegration (1953-2014), providing a comprehensive analysis of his wartime duties. This research also examined how Chinese culture affected Lee's service, with a specific focus on the usage of Chinese values in his military leadership through fatalism (a belief in predetermination). Lastly, the research discovered how traditional Chinese identity influenced Lee's reintegration and his efforts to establish an American identity through the military. The research hopes to deepen the understanding of how cultural values of a minority group, like the Chinese, adjust to and influence the American majority, specifically focusing on adaptation and identity-building through the lens of military engagement. Through academic databases and oral testimony, the main component of this research will revolve around remote archival documents and oral testimonies. As the U.S. Military misses enlistment goals by 20% in 2024, understanding how different cultures integrate into the military and how cultural awareness can enhance recruitment is essential. Researching the way these communities build an American identity will reveal nuances about identity building, especially how the military is used as a gateway to establish American ideals and beliefs.

Abstracts: Posters

Astrophysics and Planetary Science

A-01: A Star Reborn: A Study of the Evolutionary Significance of FG Saggitae
Authors: Chesney, Raymond; Guinan, Edward
Advisor: Dr. Edward Guinan

FG Sagittae (FG Sge), a rare late-stage variable star located 4000 light years away at the center of Planetary Nebula Henize 1-5, is one of the rarest, short-lived examples of the final stellar evolution of solar mass stars. Originally identified as a blue type B star in 1895. FG Sge has evolved from an O-type star, through B,A,F-spectral types reaching expansion to an orange late G/ K supergiant star by 1991. Starting in September 1992, FG Sge suddenly dimmed by over ~5-mag due to the formation of a Carbon-rich, dust shell. This critical stage in evolution for low-to-medium-mass stars is what is known as the Born-Again hypothesis: a process where expelled ionized gas is attracted back to the star's surface, resulting in a brief reignition of thermonuclear fusion. After 1992 , FG Sge underwent large light fluctuations resulting from clearing regions in the extensive dust shell. We present new results from unpublished photometry obtained at Villanova during 1990-1993. These data indicate a period of 120 ± 12 days in 1992 prior to the dimming.

A-02: Betelgeuse After the Fall: Evolving Light Variations and Periodicities of Betelgeuse Five Years after the Great Dimming
Authors: Tyler, Jacob; Guinan, Edward
Advisor: Dr. Edward Guinan

Betelgeuse is the brightest red supergiant visible from Earth. Betelgeuse has nearly 200 yr of visual observations as well as systematic photoelectric and CCD data that indicate semi-regular light variations. In mid-February 2020, Betelgeuse surprisingly faded to its faintest and coolest ever recorded—dubbed the "Great Dimming" (V +1.61 mag). Previously, Betelgeuse had multiple periodicities with dominant periods of 185, 380–420, and 2000–2200 days. We find that even before this dimming, a new dominant period of 208 ±12 days superseded the 400 days periodicity. Additionally present is a 2000–2200 day Long Secondary Period (LSP) that remains consistent throughout the dimming. The LSP has recently been proposed to arise from a close-orbiting binary companion star. Contrary to expectation, however, the LSP light minimum appears to be occurring several months earlier than predicted. We present results of quantitative period analyses and draw tentative conclusions.

A-03: Beyond the Orbit: Decoding Triaxial Pulsations in KIC 6669809 Using LOWESS-Filtered Kepler Data
Authors: D'Amaro, Maggie; Prsa, Kelly
Advisor: Dr. Kelly Hambleton Prsa

The aim of this research is to measure the pulsations of stars in a selection of binary systems, systems with two stars orbiting a common center of mass. The goal is to find systems where the star's pulsations are directed along three axes (triaxial pulsations), demonstrating that the pulsations are impacted by the star's companion. We first implemented a technique called locally weighted scatterplot smoothing (LOWESS) on the light curve data gathered by the Kepler satellite. This allowed us to remove unwanted changes in light caused by the two stars orbiting and eclipsing each other. The remaining light variations were then analyzed to find the pulsations driven by the star's companion. We then used a tool called a Fourier transform to identify the exact pulsation frequencies. Lastly, we identified specific patterns, with frequency separations based on the orbital frequency, to find the unique signatures of triaxial pulsations. Our data shows that one of the systems, KIC 6669809, is exhibiting triaxial pulsation modes. Future work will involve a detailed analysis of the pulsation phases to determine the exact shape and orientation of these complex pulsation modes within the system.

A-04: Characterizing Magnetic Activity and Rotational Evolution in Cool FGKM Stars: Results from the NASA Astrophysics Data Analysis Program (ADAP)
Authors: Shannon, Lara; Sunderland, Julia; Micho, Matthew
Advisor: Dr. Scott Engle

In accordance with the NASA Astrophysics Data Analysis Program (ADAP), we have been studying optical and X-ray observations of nearby cool FGKM stars to confirm their rotation periods, long-term magnetic activity cycles, and flare behavior. It is well established that all cool, main sequence stars possess magnetic fields whose strengths depend on stellar rotation and convective motion. As stars age, their rotation slows due to the spindown effect, which in turn weakens their magnetic fields. However, for isolated "field stars" such as K dwarfs, ages can be difficult to determine. Consequently, rotation and magnetic activity appear to be the most reliable age indicators. Our study mainly focuses on K stars, for which we have been able to characterize several key properties. These data are important not only for understanding the stars and their hosted planets but will also refine existing age-rotation-activity relationships. Since roughly 90% of all stars are either K and M dwarfs, understanding their evolution is essential for both stellar astrophysics and planetary habitability studies.

A-05: Cool Star Evolution and Exoplanet Habitability
Author: Micho, Matthew
Advisor: Dr. Scott Engle

The majority of stellar populations consist of cool, low mass stars (K and M dwarfs). The evolutionary tracks of these stars are typically quite stagnant, since their luminosities and temperatures do not change over long timescales. However, as they age, they experience a spindown effect which gradually increases their rotation period. This in turn affects the strength of their magnetic fields, which are present in all cool main sequence stars. The ages of these stars can occasionally be difficult to determine. However, both rotation period and magnetic activity have known relationships that can be used to determine age. Due to their ubiquity, understanding the evolution of KM dwarfs is vital for both stellar astrophysics and planetary studies. Many stars have exoplanetary systems, and their potential habitability is heavily dependent on the properties of their host star; most notably, the ability to retain an atmosphere and harbor liquid water. For smaller stars (such as KM dwarfs), their low temperatures necessitate that their habitable zones (HZs) are incredibly close the stars themselves. If

a star exhibits strong magnetic activity planets in the HZ will be subject to high irradiances that could destroy their atmospheres. Therefore, understanding the evolution of these stars and how their magnetic fields evolved over time is fundamental for determining their potential habitability. For this project, we analyzed a set of 25 stars to search for rotation periods, long-term magnetic activity cycles, and flares, utilizing both optical and X-ray observations. This data will be beneficial for analyzing the potential effects experienced by any orbiting exoplanets, as well as helping refine existing rotation-age relationships.

A-06: Magnetic Activity and Rotation Evolution of Common Proper Motion Pair Ross 1050, HD 136378

Author: Sunderland, Julia
Advisor: Dr. Scott Engle

M dwarfs are the most abundant type of star in the Galaxy, yet their long nuclear lifetimes make traditional evolutionary changes, such as luminosity or radius variations, difficult to observe. Instead, their magnetic and rotational evolution provides valuable clues to stellar aging. As low-mass stars lose angular momentum through magnetized winds, their rotation slows and magnetic activity declines. Measuring these properties enables us to estimate stellar ages through "gyrochronology." To explore this relationship, we analyzed the common proper motion pair Ross 1050 (M dwarf) and HD 136378 (K dwarf). Because the two stars are physically associated, they share a common age, allowing for a direct comparison of rotation and activity across spectral types. Using photometry from the All-Sky Automated Survey for Supernovae (ASAS-SN), we obtained the light curves and applied the Generalized Lomb-Scargle periodogram to identify both long-term and short-term variability. Our results reveal magnetic-activity cycles of approximately 1700 days for Ross 1050 and 2000 days for HD 136378, along with measurable rotational modulation of small amplitude. Supplemental observations from our robotic telescope at Kitt Peak, collected as part of a NASA ADAP program, confirm these findings. Using empirical relationships between rotation, magnetic activity, and age, we find that both stars yield consistent age estimates across diagnostics, though X-ray–based ages appear systematically younger, likely due to intrinsic activity variability. Continued monitoring will refine these measurements and improve constraints on M-dwarf spin-down behavior.

A-07: Studying contact-binary formation with non-conservative mass transfer

Authors: Yang, Archer; Fabry, Matthias
Advisor: Dr. Matthias Fabry

Low-mass contact binaries, called W UMa stars, are the direct progenitors of stellar mergers. The number of detected systems will increase when new all-sky surveys, such as LSST, come online. Finding the conditions under which W UMa stars form stable contact binary systems is of interest because it helps us understand stellar mergers, blue stragglers, and transient events such as luminous red novae, while also possibly placing constraints on magnetic breaking. Red novae in particular have been connected to mergers of contact binaries, but it is suspected that a low-mass binary that undergoes unstable mass transfer (without forming a long-lived contact binary first) will also appear as a red nova. However, our current understanding of the stability of short-period binary systems is under the presumption of conservative mass transfer. Models with larger initial masses behave well when modeled with conservative mass transfer, but models with lower initial masses become unstable due to their deep convective envelopes.

A-08: Studying the Impact of Binary Formation on Massive Contact Binaries
Authors: Alikakos, George; Fabry, Matthias
Advisor: Dr. Matthias Fabry

Massive stars, approximately heavier than 8 solar masses, are progenitors of supernovae and thus play a critical role in galactic evolution. We know from observation that a vast majority of massive stars are in binary systems. About 40 percent of these systems experience a contact phase, where the two stars share common layers, which resembles a "peanut" shape. Massive contact binaries play a role in forming stellar mergers and black hole mergers, the latter of which produce detectable gravitational waves. In the literature, there is a significant discrepancy in the observed mass ratios of the systems compared to current binary-evolution models. However, they assume both stars start their evolution at the same time, which we know is inaccurate for massive stars because the formation timescale approaches the evolutionary timescale. Similarly, interactions with the birth environment have not been considered in binary evolution models. In this work, using the binary evolution code MESA, we implement methods that simulate slower formation of one star compared to the other. Additionally, we account for disk friction, which may still play a role in the formation of short-period binary systems. With this study, we can better understand the impact of the birth environment on contact binary evolution.

A-09: Unexpected Stellar Chemistry as a Marker of Atypical Stellar Evolution?
Authors: Bohlsen, Hannah; Sinha, Amaya; Zasowski, Gail
Advisor: Dr. Gail Zasowski

Accurate stellar ages are crucial for galactic archaeology, but cannot be measured directly. Evolved red giant stars offer a solution, since their lifetimes can be inferred from their masses. Mass measurements often rely on mass proxies, such as the surface carbon-to-nitrogen ratio ([C/N]) after the first dredge-up. But this relationship is not consistent for all stars. Understanding the systematics behind these [C/N] outliers is essential for improving mass and subsequent age measurements. We analyze additional elemental abundances, such as those of s-process elements, that may indicate binary interactions. We find significant differences between typical and outlier stars, suggesting atypical or binary evolution histories for outlier stars. By accounting for such complexities in this method, more accurate stellar ages and a clearer picture of the Milky Way's formation and evolution will be understood.

Biology

A-10: Establishing *Kazachstania unispora* Auxotrophic Strains via CRISPR to Create a Genetic Model System
Author: O'Donnell, Sean
Advisor: Dr. Dennis Wykoff

The *Kazachstania* yeast genus is a clade within the family of *Saccharomycetaceae* and evolved from other genuses in this family, such as *Saccharomyces* and *Nakaseomyces*. Unlike the other groups in this family, there is extremely limited published analysis on *Kazachstania* and no known genetic manipulation. *K. unispora* has shown the capability of plasmid transformation and therefore the application of

CRISPR/Cas9 method of gene inactivation was used to create auxotrophic strains. CRISPR/Cas9 is a gene editing tool that uses the help of a guide RNA to locate a certain sequence in the chromosome and initiate a cut in that sequence. Guide RNAs were used to target HIS3, HO, and LEU sequences and initiate a frameshift mutation within these sequences rendering the colony auxotrophic for that amino acid. Yeast transformation via standard lithium acetate transformation protocols were used and frameshift mutations were confirmed by PCR sequencing. The work completed on *K. unispora* allows for future manipulation of *K. unispora* by examining the impacts of transcription factors on biotin, thiamine, pyridoxine, and phosphate pathways. Additionally similar methods can be carried out with another species in the same clade *K. naganishii*, as it shows similar ability of plasmid transformation. The foundation of this genetic model for *K. unispora* was crucial for the current understanding and future experimentation of the *Kazachstania* yeast genus.

B-11: Geographic variation in parasite prevalence and its influence on feeding rates of the eastern mudsnail

Authors: Morin, Patrick; Ziegler, Shelby
Advisor: Dr. Shelby Ziegler

Parasites play key roles in ecosystems, influencing ecological interactions and often altering the behavior of their hosts. The eastern mudsnail (*Ilyanassa obsoleta*) is an abundant grazer that regulates benthic community structure and nutrient cycling in coastal ecosystems and is also an intermediate host for several trematode parasites. However, little is known about how parasite infection in these key grazers affects their feeding behavior or the variability in parasite infection across the snail's geographic range. We aimed to (1) quantify the prevalence and diversity of all trematode parasites in I. obsoleta across its range, and (2) assess how parasitism affects *I. obsoleta* feeding behavior. We collected snails from 9 sites spread across three geographic regions: the North Atlantic, Mid-Atlantic, and South Atlantic. From each site, 100 snails were dissected to quantify trematode parasite prevalence and diversity. To assess the influence of parasitism on feeding rates, snails were shed to determine infection status and were given a 1 x 1 cm square of algae. Consumption was then quantified at 1-, 2-, 4-, 8-, and 12-hour time intervals. We found that parasite prevalence and diversity was highest in the North Atlantic, with over 60% of snails infected with at least one trematode species at the three sites. In our feeding trials, we found that parasitized snails from the North Atlantic consumed ~3x more algae at 12 hours than uninfected conspecifics; however, we found no difference in feeding rates in snails from the other two regions. In conjunction, our findings suggest that high parasitism of mudsnails in the North Atlantic region may lead to increased consumption rates with the potential to shift benthic community structure.

B-12: Investigating neuronal regeneration in the absence of a central nervous system in *Clytia Hemisphaerica*

Authors: Frederick, Brooke; Lee, Elizabeth; Kirner, Joey
Advisor: Dr. Elizabeth Lee

After injury, both tissue repair and reinnervation are critical for restoring function. While regeneration in the central and peripheral nervous systems has been extensively studied, far less is known about how systems lacking a central nervous system respond to injury. Cnidarians provide a unique opportunity to address this gap, as they lack a centralized nervous system and instead rely on simple neuronal circuits. The hydrozoan *Clytia hemisphaerica* is an emerging model for studying nervous system

regeneration. Like other cnidarians, *Clytia medusae* possess a diffuse "nerve net" embedded within the contractile subumbrella layer. Previous work has shown that neurons genetically ablated in *Clytia* can recover, but whether new neurons are generated remains unknown. Using immunofluorescence, we first established a tentative baseline count of neurons in the subumbrella layer. We then removed a gonad and allowed the medusae to heal for varying time intervals, comparing neuronal counts in wounded and unwounded regions. Future studies will focus on the cellular and molecular mechanisms underlying this regenerative process. Understanding the regenerative potential of this ancient nervous system may provide new insights into the evolution of neural repair.

B-13: Investigating the age-dependent regulation of the healthspan determinant DAF-16/FOXO in *C. elegans* roundworms

Authors: Floreck, Lydia; Danner, Abigail
Advisor: Dr. Matthew Youngman

Aging is characterized by progressive decline in physiological function, leading to increased disease susceptibility and reduced healthspan—the period of life associated with robust physiological performance and freedom from disease. The FOXO transcription factor plays a key role in promoting cellular resilience and longevity across diverse species, yet its regulation during aging remains incompletely understood. This proposal investigates the regulation of FOXO activity in aging *Caenorhabditis elegans*, focusing on the role of DAF-18, the ortholog of the human tumor suppressor PTEN. Prior research from the Youngman Lab has shown that DAF-16 (FOXO) is activated in an age-dependent manner, conferring immune protection to older worms, and that this activation requires DAF-18. However, the mechanism by which DAF-18 regulates DAF-16 remains unclear. Aim 1 will determine whether DAF-18 expression increases as animals age, using qRT-PCR and western blotting to assess daf-18 mRNA and protein levels across aging cohorts. Aim 2 will investigate whether neuronal DAF-18 modulates intestinal DAF-16 in a cell non-autonomous manner, employing tissue-specific RNAi and transcriptional reporters. Contributing to our understanding of FOXO regulation and its potential as a therapeutic target, this study will uncover molecular mechanisms that sustain cellular integrity during aging, with broad implications for extending human healthspan.

B-14: Optogenetic Activation of retn+ Abdominal Neurons Induces a Nociceptive-Like Bend in *Drosophila melanogaster* Larvae

Author: Kim, Kelly
Advisor: Dr. Troy Shirangi

During the development of a juvenile animal to an adult, the animal will gain adult-specific behaviors through neural circuit remodeling. Previously, the Shirangi Lab identified Dsf-Dsx Abdominal Ganglion neurons (DDAG) in adult *Drosophila melanogaster*, that express dissatisfaction (dsf), a sex determination gene, and doublesex (dsx), a sexual differentiation gene. There are 5 anatomical subtypes of DDAG neurons, where the DDAG_A subtype was found to induce an abdominal bend in adult flies, used during copulation. Previous RNA-sequencing data with UPenn's DING lab uncovered corresponding genes to the subtypes of DDAG neurons, where DDAG_A corresponded to the gene, retn. Over the summer, I conducted optogenetic activation experiments on larval retn+ abdominal neurons, which induced a sharp bend of the larval body. It was noticed that the sharp bending phenotype resembled a nociceptive escape response that larvae perform when they get stung on their abdomen by their predators. Additional optogenetic experiments were conducted using well-

studied nociceptive neurons, called DnB (Down-and-Back) neurons and cIV sensory neurons, which induced a similar bending phenotype. My findings connect parallel bending behaviors seen in larval retn+ abdominal neurons and adult DDAG_A neurons. I further hypothesize that the retn+ abdominal neurons are part of the nociceptive pathway, where I intend to test this by performing GCaMP functional imaging of retn+ abdominal neurons when sensory neurons are activated. These findings will reveal the function of retn+ abdominal neurons in larvae, further contributing to the understanding of the reprogramming of neural circuits during maturation in different circuit contexts.

B-15: Spatio-Temporal Expression Patterns of ARID-1 in *C. elegans*

Author: Santee, Jackson
Advisor: Dr. Matthew Youngman

During development, cells take on specific identities through specification in which processes like chromatin structure impact gene expression. Chromatin landscape is dysregulated over time, and a predominant contemporary theory suggests that this leads to loss of cellular function and tissue deterioration. Preserving chromatin structure is therefore important to lengthening healthspan. *C. elegans* are the premier model organism for aging studies as they exhibit evolutionarily conserved signs of aging shared with humans, a genome highly homologous to humans, genetic determinants of aging in worms have corresponding alleles associated with longevity in humans, and they have a short 3-week lifespan. Chromatin structure is primarily determined by proteins like ARID4A that interact with histones and modulate their association with DNA. ARID4A is the mammalian ortholog of *C. elegans* ARID-1, which has a function in innate immunity. ARID4A binds to transcription factors and recruits histone deacetylases that remove acetyl groups causing DNA to bind to histones more tightly, closing chromatin and repressing gene expression. The goal of this project was to understand when and where ARID-1 is expressed. This was defined using a strain of *C. elegans* with an RFP-tagged version of ARID-1 and using fluorescence microscopy to observe qualitative expression patterns. Previous studies observed ARID-1 in the head and tail neurons. Using synchronized cohorts, images were taken in-vivo.

B-16: The influence of sediment type on the behavior of Atlantic mud fiddler crabs

Authors: Gibbs, Peyton; Dioguardi, Amelia; Ziegler, Shelby
Advisor: Dr. Shelby Ziegler

Atlantic mud fiddler crabs, *Munica pugnax*, are ecosystem engineers that play a vital role in aeration and nutrient cycling in salt marsh ecosystems due to their burrowing activity. *M. pugnax* are known to prefer muddier habitats and are believed to have increased burrowing activity in areas with finer sediment. In this study, we aimed to understand how sediment type, salt marsh mud and a mixture of 50% sand and 50% mud sediment, influenced fiddler crab behaviors such as burrowing, feeding, climbing or interacting with conspecifics. Additionally, we sought to understand how sex or body size may affect fiddler crab behaviors in these varying sediment types. Interestingly, we found no differences in the proportion of time fiddler crabs performed different behaviors among sediment types; however, there was a clear interaction between sex and body size on burrowing activity. This study allowed us to create a methodological framework to understand changes in fiddler crab behavior when exposed to different environmental conditions. Future research will build upon this methodology to assess how visual versus chemosensory cues of predators such as the blue crab, *Callinectes sapidus*, influence mud fiddler crab behavior.

B-17: The Power of Steric Hindrance: Exploring UPF1(D351F)'s Effect on Target Selection for the Nonsense-Mediated Decay Pathway

Authors: Thomas, Emma; Gunderson, Sophia; Holzinger, Lillian; Blake, Michael; Fritz, Sarah
Advisor: Dr. Sarah Fritz

Nonsense-mediated decay (NMD) is the leading cause of approximately one-third of human genetic diseases and results from the targeted decay of RNAs with premature stop codons by the RNA helicase UPF1. UPF1 contains a conserved structural element known as the regulatory loop that sterically clashes with the helicase core and causes UPF1 to dissociate from RNA upon ATP hydrolysis, which decreases the chances for the NMD pathway to occur on non-targeted or protected RNAs. An open question is how the regulatory loop modulates the binding of UPF1 to RNA in the presence of ATP. Here, we investigated the role of a conserved aspartic acid residue in the regulatory loop (D351) and its interaction with an arginine residue in the helicase core on regulating the binding of UPF1 to RNA. We show that mutation of D351 to a bulky phenylalanine (D351F) enhanced the dissociation of UPF1 from nucleic acid upon ATP hydrolysis. In contrast, mutation of D351 to a leucine residue (D351L) reduced the rate of UPF1 dissociation from nucleic acid upon ATP hydrolysis. Faster dissociation of UPF1 correlated with enhanced translocation activity in an ensemble in vitro unwinding assay, likely due to increased rebinding events on the substrate nucleic acid by D351F and D351W. We propose that the regulatory loop is optimally tuned in sequence, structure, and length to modulate the binding UPF1 to RNA and consequently NMD target selection.

B-18: The role of phosphorylated dynamin-like protein in cytokinesis and mitochondrial fission in *Trypanosoma brucei*

Authors: Shaheen, Sarah; Miller, Jade; Malfara, Madeline; Povelones, Megan
Advisor: Dr. Megan Povelones

Trypanosoma brucei is a single-celled eukaryotic parasite that is transmitted to mammals by tsetse flies. In humans, *T. brucei* causes Human African Trypanosomiasis, also known as Sleeping Sickness. To complete their life cycle, the parasites have to adapt to host environments that can differ in pH, temperature, and available nutrients. To do this, they regulate both the structure and activity of metabolic organelles, including the mitochondria and the glycosomes. Enzymes in glycosomes break down glucose, while mitochondrion is required for the production of energy from amino acids. We are examining the role of a dynamin-like protein called TbDLP in mitochondrial fission. In other eukaryotes, dynamin-related proteins assemble around the mitochondria during cell division to help split the organelle into two. In *T. brucei*, TbDLP appears to have multiple functions, including endocytosis and the division of both mitochondria and glycosomes. Since TbDLP is known to be phosphorylated, we hypothesize that phosphorylation regulates the localization and/or function of TbDLP. To test this hypothesis, we created inducible, epitope-tagged over-expression constructs for three different versions of TbDLP: wild-type, phospho-null (not phosphorylated), and phospho-mimic (always phosphorylated). We found that overexpression of the TbDLP phospho-mimic construct blocks both mitochondrial division and cytokinesis, providing further evidence that these two processes may be coupled, and suggesting that dephosphorylated TbDLP may be required. These results may help improve our understanding of organelle dynamics in these important parasites and provide insights into how organelle biogenesis pathways evolved within eukaryotes.

B-19: The Role of TMEM65 in Cortical and Hippocampal Mouse Neurons

Authors: Lesniak, Hailey; Kennedy, Liam; Berezhnaya, Elena; Stevens, Tyler; Elrod, John
Advisor: Dr. John Elrod

Alzheimer's Disease (AD) is a neurodegenerative disease that affects millions of Americans, characterized by cognitive decline, loss of memory and motor function, and neuronal death. Our lab has found that mitochondrial calcium (mCa2+) overload promotes AD pathology, including excessive production of reactive oxygen species, metabolic derangement, and cell death. One path for mitochondrial calcium efflux is through the mitochondrial sodium/calcium exchanger (NCLX). NCLX reduction in cortical and hippocampal neurons has been shown to correlate with and trigger AD pathology, while its increase mitigates AD development in a mouse model. TMEM65 has been recently identified as an NCLX modifier that is necessary for its activity (Garbincius et al., 2025). To better understand the role this protein plays in the brain and development of AD pathology, we generated a mouse model with TMEM65 absent in cortical and hippocampal neurons using cre-lox recombination under the Camk2a promoter. We validated TMEM65 loss by western blotting and tested these mice in behavioral assays to assess their cognition as they age. At 3 months of age, mice without TMEM65 showed increased activity in the open field test but exhibited poorer performance in the novel object recognition test. As these mice aged to 6–12 months, these distinctions faded; however, TMEM65-deficient animals began to display tendencies toward reduced memory abilities based on results from the Fear Conditioning test. Based on previous studies of NCLX-deficient animals, a more pronounced behavioral phenotype is expected to develop once the mice are over one year old.

B-20: Validation of scRNA-Seq Identified Candidate Genes Using in situ Hybridization Chain Reaction in whole-mount larval CNS of *Drosophila melanogaster*

Authors: Ramirez, Jeremy; Miller, Kara; Leal, Jesus; Shirangi, Troy
Advisor: Dr. Troy Shirangi

Characterizing mRNA expression with spatial resolution is a valuable component of nearly every developmental study. Here, we describe a protocol of in-situ Hybridization Chain Reaction (HCR) used to map the expression of candidate genes in the larval central nervous system (CNS) of *Drosophila melanogaster*. Building on prior work that identified *dsf*-expressing neurons reprogrammed for mating behavior, our lab performed a single-cell RNA sequencing experiment where three transcriptionally distinct neuronal clusters (tey, ptx1, and retn) were marked as candidate genes, further categorizing the *dsf* neurons. To validate and localize the expression of these genes, we applied in-situ HCR to whole-mount 3rd instar larval CNS tissue, using dsf-GAL4 > UAS-NLS-GFP, which fluorescently labels *dsf*+ neurons. Probes targeting tey, ptx1, and retn were used with Alexa Fluor 647 labeled hairpins and visualized alongside native GFP signal using confocal microscopy. Preliminary results from the in-situ HCR reveal distinct spatial patterns: retn is highly expressed in two neurons in A7 and in four neurons in A8 and in the mushroom bodies; tey is broadly expressed in two neurons per segment across A1-A7, and in A8 it's expressed in four neurons; ptx1 shows localized expression in the thoracic segments. These results illustrate the spatial context for molecular differences between *dsf*+ neurons and lay the foundation for future functional studies. Future work will be focused on refining and confirming localization, as well as identifying potential co-expression or spatial overlap between candidate genes to gain a better understanding of how these genes define subtypes within the *dsf*+ population.

C-21: The *Abdominal-B* and *broad* transcription factors function in *dsf*-expressing neurons to regulate egg laying in mated *Drosophila melanogaster* females
Author: Park, Sophia
Advisor: Dr. Troy Shirangi

In our lab's previous research, we identified a set of neurons in *Drosophila melanogaster* that co-express the genes, *dissatisfaction (dsf)* and *doublesex (dsx)*. These neurons are localized to the abdominal ganglia (AG) of the ventral nerve cord (VNC) and have been named the DDAG neurons, for the *dissatisfaction-doublesex* abdominal ganglia. Previous results have shown that the DDAG neurons regulate sex-specific behaviors, such as mating and egg-laying. For my summer project, I wanted to investigate genes that may initiate *double-sex* activation in DDAG cells. In previous research, our lab used a $dsf^{Gal\text{-}4}$ to drive a UAS-*dsx*-RNAi, which blunted *dsx* mRNA transcripts in *dsf* cells. When females of this genotype were tested in an egg-laying paradigm, they significantly decreased egg laying compared to their wild-type counterparts. Using data from a recent single-cell RNA sequencing experiment, we identified thirteen highly expressed genes in the DDAG population, which could potentially initiate *dsx* activation. I used the egg-laying paradigm to test each of these identified genes with a $dsf^{Gal\text{-}4}$ driver. I found that two genes, *Abdominal-B* (*Abd-B*) and *broad* (*br*), led to a statistically significant decrease in egg-laying. Our lab hypothesizes that *Abd-B* and *br* may contribute to *dsx* acquisition in *dsf* cells and the proper development of DDAG neurons.

Biomedical Engineering

C-22: KRAS-TRuC Engineering for Enhanced Neoantigen Targeting in Solid Tumors
Authors: Miller, Jade; Liu, Jiageng
Advisor: Jiageng Liu

We previously developed a KRAS G12V-specific binder and demonstrated that CAR-T cells incorporating this binder effectively eliminate solid tumors both in vitro and in vivo. Emerging studies suggest that reprogramming CAR recognition domains onto TCR subunits can enhance CAR sensitivity to antigen and increase antitumor responses in vivo while attenuating the release of proinflammatory cytokines. To directly compare this strategy (referred to as TRuC) with our existing CAR-T product, we aim to tether our binder to the TCR epsilon (CD3ε) subunit, which is present in two copies per TCR complex, potentially improving expression stoichiometry. We constructed a lentiviral vector encoding the binder-epsilon fusion and transduced primary human T cells but observed suboptimal engineering efficiency. We hypothesize that ectopic transgene expression may interfere with endogenous TCR complex assembly or regulation. To address this, we are pursuing a knock-in approach targeting the endogenous CD3ε locus. Currently, we are generating homologous recombination templates with varying homology arm lengths to optimize HDR efficiency. KRAS TRuCs demonstrate the potential for enhanced anti-tumor activity in vitro models and potentially induce less pro-inflammatory responses in vivo. This strategy seeks to advance the therapeutic capability of our KRAS-targeting T cell platform. Future studies will focus on integrating KRAS TRuCs with inducible modules such as IL-12 to enhance anti-tumor responses in vivo.

Chemical and Biological Engineering

C-23: Computational Identification of Neuroprotective Plant Compounds in Targeting Neuroinflammation in Alzheimer's Disease

Authors: Navarro, Magally; Cross, Jonathan; Huang, Zuyi (Jacky)
Advisor: Dr. Zuyi (Jacky) Huang

Alzheimer's disease (AD) remains one of the most pervasive neurodegenerative challenges of the 21st century, with no available therapy capable of completely halting or reversing its progression. Increasing evidence implicates chronic neuroinflammation and oxidative stress as key drivers of AD pathology. This study investigates the anti-neuroinflammatory and neuroprotective potential of *Eriodictyon californicum* (Yerba Santa), a California-native plant traditionally used as an anti-inflammatory. A total of 43 bioactive flavonoids, flavones, and phenolic acids identified from Yerba Santa were computationally screened against 30 inflammation-related protein targets implicated in AD using the protein-ligand docking features of MolSoft ICM. The protein targets, which included complement cascade components (C3, C4b, C5, C9), neurotransmitter receptors, and GPCRs, were selected based on their known roles in AD-associated neuroinflammation and neuronal signaling. Docking simulations generated thousands of protein–ligand conformations, from which the lowest-energy binding poses were analyzed. Several Yerba Santa compounds demonstrated strong, simulating binding-affinities (Delta G < –32 kcal/mol), with melitric acid A, rosmarinic acid, sterubin, and luteolin emerging as top performers across the different binding sights. These compounds exhibited multi-target engagement, suggesting synergistic modulation of oxidative and inflammatory pathways. Principal component analysis (PCA) of phytochemical data further revealed chemotypic variation within *E. californicum*, with sterubin-rich chemotypes displaying distinct clustering patterns that may correlate with bioactivity. Collectively, these results highlight Yerba Santa's polypharmic potential to mitigate neuroinflammation and mitochondrial dysfunction, both central to AD and aging. While these computational simulations require experimental validation, the findings support Yerba Santa as a promising source of pharmacy agents for neurodegenerative disorders.

C-24: Engineering Yeast to Detect Heavy Metals and Other Environmental Contaminants

Authors: Mueller, Daniel; Vento, Justin
Advisor: Dr. Justin Vento

Heavy metal contamination of water sources poses significant environmental and public health risks due to high toxicity and health complications. Conventional detection methods such as atomic absorption spectroscopy and colorimetric assays are limited by high costs, operational complexity, and variable sensitivity, particularly for on-site applications. To address these limitations, we are engineering the robust yeast strain *Saccharomyces cerevisiae* to detect heavy metals such as copper and aluminum. First, we construct a yeast strain capable of copper detection by integrating the native CUP1 inducible promoter upstream of green fluorescent protein (GFP). This baseline strain will be further engineered for improved detection and specificity by testing homologous promoters from other yeast or bacterial strains. Finally, a prototype biosensor will be constructed that will use freeze-dried engineered yeast to detect copper in environmental water samples. Detection will be extended to other heavy metals, such as aluminum, by leveraging transcriptional responses in yeast strains. This work expands the biosensing potential of yeast, providing a versatile, scalable, and sustainable framework for environmental monitoring of key pollutants and toxins.

C-25: Granular Hydrogels: The Influence of Stiffness on Structural and Biological Properties
Author: Bacino, Lexy
Advisor: Dr. Gabriel Rodriguez-Rivera

Granular hydrogels play a crucial role in biomaterial engineering, with applications ranging from wound care to cardiac tissue repair. This study examined how hydrogel stiffness influences mechanical properties, fragmentation size, porosity, and cell infiltration. It was hypothesized that stiffer, more brittle hydrogels would fragment more easily and exhibit higher porosity than softer ones. Microgels were created through extrusion fragmentation, where crosslinked hydrogels were extruded through needles of varying gauges. Stiffness was measured via rheometry using 0.7 kDa and 20 kDa PEGDA solutions at approximately 1–10% oscillation strain. At 9.998900% strain, the 0.7 kDa hydrogel showed a storage modulus of 0.004121 kPa, while the 20 kDa sample measured 0.002573 kPa, confirming that the 0.7 kDa was stiffer. After extrusion through a 27G needle, the 0.7 kDa hydrogel averaged a fragment size of 6.93E-5 μm^2, while the 20 kDa averaged 2.13E-4 μm^2, supporting the hypothesis that stiffer gels break into smaller pieces. Confocal microscopy revealed minimal porosity differences, indicating a need for further testing. Cell infiltration was evaluated using spheroids to observe sprouting. Limited sprouting and sparse hydrogel fragments prevented definitive conclusions. Overall, results suggest stiffer hydrogels fragment more readily and are smaller, though their effects on porosity and cell behavior warrant deeper investigation.

C-26: Improving Sterilization of a High-Molecular Weight Red Blood Cell Substitute (LtEc)
Author: Whitesell, Claire
Advisor: Dr. Jacob Elmer

Donor blood faces significant limitations, including storage constraints, short shelf life, and compatibility requirements, necessitating the development of effective substitutes. A promising alternative is *Lumbricus terrestris erythrocruorin* (LtEc), a large, acellular, high-molecular weight hemoglobin sourced from earthworms. Before clinical use, LtEc must be sterilized by 0.22 μm filtration, a process hindered by its tendency to form aggregates. This study aimed to identify methods to disaggregate LtEc into single hemoglobin molecules to enable effective sterilization. We first hypothesized that chemical treatments could disrupt the hydrophobic and electrostatic interactions stabilizing the aggregates. Agents including Triton X-100, EDTA, and pH adjustments showed some improvement, but did not sufficiently reduce aggregate size for filtration. Subsequently, a specialized mechanical method was applied. This approach successfully disaggregated the LtEc, as confirmed by Dynamic Light Scattering (DLS), which showed a significant reduction in particle size. Structural integrity was maintained throughout this process, as verified by Size Exclusion Chromatography, UV-Vis spectroscopy, and thermal shift assays. The treatment dramatically improved filter sterilization, allowing 22.5 mL of concentrated LtEc to pass through a 0.22 μm filter, compared to only 2.5 mL for untreated controls. Next steps include observing disaggregation with electron microscopy or Atomic Force Microscopy (AFM) and repeating previous animal studies to ensure the treated product remains safe and effective.

Chemical Engineering

C-27: Acid Neutralization and Copper Adsorption Using Sustainable Food Waste/Brewer Spent Grain Adsorption Experiments

Authors: Faris, Tyler; Raknis, Dan; Punzi, Vito; Skaf, Dorothy; Kitchens, Chris
Advisor: Dr. Vito Punzi

This research investigates the use of eggshell waste (ESW) and shrimp tail waste (STW) as cost-effective, sustainable alternatives for neutralizing acidic wastewater. Acidic runoff from mining exposes sulfur-bearing rocks to air and water, harming ecosystems and infrastructure. Conventional treatments, such as adding limestone, increase costs and environmental impact. ESW and STW, primarily composed of calcium carbonate ($CaCO_3$) like limestone, can neutralize acidity while diverting waste from landfills. Batch and fixed-bed experiments tested the neutralization capacity of different ESW/STW types, sizes, and preparation methods across various acids. Results show comparable performance to limestone, with ongoing studies on fixed-bed systems. This approach advances circular resource use and sustainability across industries. Additional research examined methylene blue adsorption using hydrochar derived from brewer's spent grain (BSG), a brewing byproduct that often generates methane and odor in landfills. Converting BSG into hydrochar repurposes waste into a low-cost adsorbent for organic and inorganic pollutants. Batch tests established adsorption isotherms for various hydrochars, allowing comparison with commercial materials. Results demonstrate that hydrochar from BSG offers an environmentally friendly, cost-effective solution for water purification.

C-28: Development of a Mobile App for Antimicrobial Resistance Surveillance for American Livestock

Authors: Sobol, Daniel; Huang, Zuyi (Jacky); Margapuri, Venkat; McMahon, Isabella
Advisor: Dr. Zuyi (Jacky) Huang

Antimicrobial resistance (AMR) is the development of natural defenses against antimicrobial treatments in pathogens, most commonly bacteria. The overuse of prophylactic antimicrobial treatments in American livestock has accelerated the development of new AMR-resistant bacterial strains, including otherwise common and treatable infectious bacteria like *Campylobacter* and *E. Coli*. Our research seeks to identify trends in AMR growth in the US and develop a mobile application for the organization and presentation of this data in a manner accessible to agricultural professionals. A Principal Component Analysis (PCA) method was developed to cluster data from the NCBI Pathogen Isolates Database, reducing dimensionality from 119 to two dimensions. This data was analyzed to visualize the occurrence trends of pathogens, antimicrobials, and livestock, with a focus on the most common foodborne pathogens and antimicrobial treatments. Additionally, an emphasis was placed on connecting resistance data to the specific genetic and most common genetic markers of AMR. A mobile application was then built in React Native, which allows users to easily find data in three formats - a histogram, heatmaps, and profile plots by year for their desired inquiry. The goal of the application primarily being to bolster AMR knowledge and promote stronger data-driven decision-making processes surrounding antimicrobial use in the microbial community.

C-29: Establishing Genetic Tools in *Staphylococcus epidermidis*
Authors: LaMothe, Alyssa; Vento, Justin
Advisor: Dr. Justin Vento

The skin microbiome plays a crucial role in overall skin health. On the skin's surface, there is a large diversity of organisms that all play a role in protecting the skin from pathogens and breaking down essential metabolites. Key bacterial species such as *Staphylococcus epidermidis* have shown immense therapeutic potential in fending off pathogens such as *Staphylococcus aureus* and preventing diseases such as eczema and some skin cancers. However, *S. epidermidis* contains a large variety of genetically diverse clinical isolates, with some even being pathogenic. Probing S. epidermidis strains to identify strains with probiotic potential requires genetic manipulation techniques that have proven difficult to implement in part because DNA delivery (termed DNA transformation) into *S. epidermidis* strains is often blocked by host defense systems. Restriction-modification (R-M) systems are the most prevalent bacterial defense system and have been shown to prevent DNA transformation in *S. epidermidis* strains. The goal of this work is to characterize the role of R-M systems on DNA transformation in a range of clinical isolates, and then to systematically boost transformation using *in vitro* methylation with cell-free systems.

C-30: Investigation of Lithium Orthosilicate Using Ramp Rate Testing and X-Ray Diffraction
Author: Caldwell, Rowan
Advisor: Dr. Michael Smith

Lithium orthosilicate (Li_4SiO_4) is a promising material for high-temperature CO_2 capture and hydrogen production due to its excellent thermochemical stability and reversible carbonation behavior. This study examines how thermal ramp rate and surrounding atmosphere influence the synthesis and phase evolution of Li_4SiO_4. Samples were subjected to controlled heating under various ramp rates and gas environments, and the resulting products were characterized using X-ray diffraction (XRD) to determine phase composition, crystallinity, and impurity formation. Results show that slower ramp rates promote changes in structure at a lower temperature than those under a higher ramp rate. Also, variations in ambient gas composition further affected transformation pathways. These findings demonstrate the critical role of thermal processing conditions in optimizing the structural integrity and performance of Li_4SiO_4 for energy and environmental applications.

D-31: Magnesium Oxide Based Cements as a Sustainable Alternative Building Material
Authors: Goldsborough, Nate; Guerrero, Catarina
Advisor: Dr. Chris Kitchens

Magnesium oxychloride (MOC) cement is a growing alternative to traditional Portland cement due to its faster setting, greater CO2 uptake during curing, and good fire performance. This project involves two related approaches that analyze the physical durability, micro strain, and chemical stability over time of magnesium-oxide cement (MOC). First, MOC blocks were created from raw materials that were purified. Blocks were created with various ratios of H_2O, MgCl, and MgO, and left to cure for 1,2-,3-, or 4-week intervals. These samples were analyzed for physical compression strength, free chloride content, elemental composition, and crystalline phases. A "cold-then-warm" curing pattern

(refrigeration followed by 50 °C) consistently produced the most durable, phase-stable MgO cement with lower free chloride retention and improved strength. The second approach examined industry MgO boards. Six unique boards were tested for chloride content and XRD patterns. Industry boards showed various free chloride composition but was generally low and increased up to 72 hours. At a scale, these results are significant for MgO cement products, as curing history is a comparable component to large scale stability and reduced corrosion risk. Early-stage screening, similar to the 24—72 hour screening here, offers a practical quality metric for procurement and acceptance. The results of this experiment can provide recommendations for both MgO cement manufacturers and purchasers, strengthening the reliability of MgO boards in building applications.

D-32: Optimization of KOH Activation Parameters for Brewers' Spent Grain Hydrochar
Authors: Le, Dennis; Bazrafshan, Hamed
Advisor: Dr. Chris Kitchens

Brewers' spent grain (BSG), the primary byproduct of the brewing industry, represents a low-cost and abundant lignocellulosic waste rich in carbon precursors, making it a promising feedstock for producing high-value activated carbon. Repurposing BSG into adsorptive carbon materials contributes to circular economy goals by reducing waste and generating sustainable alternatives for environmental remediation. This study investigates the optimization of KOH activation parameters for BSG-derived hydrochar to enhance adsorption performance and carbon yield. Three key activation variables were systematically examined: KOH-to-hydrochar ratio (R_1–R_3), activation temperature (600–800 °C), and dwell time (1–3 h). Methylene Blue (MB) adsorption capacity, BET surface area, and yield were evaluated, and the product of MB adsorption capacity and yield was used as the decision criterion. Increasing the KOH/HC ratio improved both surface area and MB uptake: R_1, R_2, and R_3 exhibited BET surface areas of 1767 ± 25, 2404 ± 28, and 2579 ± 32 $m^2\ g^{-1}$, respectively, with corresponding adsorption capacities of 175, 272, and 328 mg MB g^{-1}. However, higher ratios led to significant yield losses, identifying R_2 (KOH/HC = 2:1) as the most balanced condition. Temperature variation for R_2 showed a rise in surface area from 1091 $m^2\ g^{-1}$ (600 °C) to 2389.5 $m^2\ g^{-1}$ (800 °C), accompanied by an increase in adsorption from 114 to 239 mg MB g^{-1}, but with decreased yield. Dwell time (1–3 h) produced minimal improvements. Overall, the optimal activation condition—KOH/HC = 2:1, 700 °C, and 1 h—achieved superior textural and adsorption properties compared to commercially produced activated carbon, demonstrating an effective hydrothermal carbonization route for brewery waste.

D-33: Rheo-Impedance Mapping of Ionically Conductive Hydrogels
Authors: Bailey, Benjamin; Rodriguez Rivera, Gabriel
Advisor: Dr. Gabriel Rodriguez Rivera

Hydrogels are versatile biomaterials widely used in tissue engineering due to their ability to mimic the physiological environment and support cell growth. For cardiac and musculoskeletal applications, both mechanical and electrical properties are critical for functional integration with native tissue. While rheological testing and electrochemical impedance spectroscopy (EIS) are standard methods for evaluating these respective properties, few studies have examined how they interact under simultaneous deformation. This work aimed to investigate the coupling between shear strain and impedance in hydrogels of differing charge chemistries using a combined Rheological–Impedance

Spectroscopy (RheoIS) approach. Two hydrogel formulations – nonionic (PEGDA, control), and anionic (AMPS) – were synthesized using N,N'-Methylenebisacrylamide (MBAA) as a crosslinker and tested on a TA Instruments rheometer equipped with impedance measurement capability. RheoIS data were collected across polymerization stages (liquid, gelation, and solid) and through a strain sweep from 0.1% to 100%. Both hydrogels exhibited comparable complex modulus values (12–14 kPa) under fully formed conditions. PEGDA displayed the higher impedance (~900 Ω), while AMPS exhibited lower values (~550 Ω). Calculated gauge factors (1.5–2.5) agreed with literature values for low-sensitivity conductive gels. No significant correlation was observed between applied strain and impedance for any formulation, indicating that ionic hydrogels maintained stable electrical properties even under large deformations. These findings suggest that such materials are suitable for load-bearing tissue scaffolds where mechanical flexibility is required without compromising electrical performance, though their low gauge factors limit utility in strain-sensing applications.

D-34: Tracking the Health of CAR-NK Cells
Author: Carbone, Christopher
Advisor: Dr. William Kelly

Chimeric antigen receptor–natural killer (CAR-NK) cells represent a promising cancer therapy due to their targeted cytotoxicity and reduced risk of cytokine release syndrome. This study investigated how CAR-NK cell metabolism, growth, and function change over time under varying culture conditions. CAR-NK cells were cultured with interleukins IL-2, IL-15, and IL-21, and flow cytometry was used to assess activation, exhaustion, and CAR expression. Cells derived from freshly thawed vials in fresh media showed the highest expansion and function. Over time, activation and CAR expression declined, accompanied by a temporary increase in exhaustion. RNA sequencing revealed changes in metabolic and immune-related gene expression across culture days. Together, these findings demonstrate how culture conditions and duration affect CAR-NK cell performance and provide insights for optimizing their therapeutic potential.

Chemistry and Biochemistry

D-35: A Tug-of-War Between NaCl and Phosphate: Environmental Effects on Calf Intestinal Alkaline Phosphatase
Authors: Gutiérrez-Pagán, Mariana; Palenchar, Peter
Advisor: Dr. Peter Palenchar

Alkaline phosphatase (ALP) is an essential enzyme involved in skeletal mineralization, liver function, and immune modulation, and serves as an important biomarker for bone and liver disease. ALP activity can be conveniently monitored by measuring the conversion of p-nitrophenyl phosphate (pNPP) to p-nitrophenol (pNP). Previous work showed that *E. coli* ALP is activated by high NaCl concentrations and inhibited by phosphate, with NaCl having little effect on phosphate inhibition. This study aimed to determine whether similar behavior occurs in calf intestinal ALP. Reaction rates were measured across different pNPP concentrations in the presence and absence of NaCl and phosphate, using both HEPES and bicarbonate buffer systems. From these data, KM and kcat were determined under each condition. Consistent with *E. coli* ALP, NaCl activated the enzyme and phosphate acted as an inhibitor. However, the nature of the activation by NaCl is dependent on the

buffer. Moreover, unlike *E. coli* ALP, our results suggest that NaCl can impact the inhibitory effect of phosphate on calf intestinal ALP activity under some conditions.

D-36: Biofuels from Algae: Optimization of Lipid Extraction Methods using Quaternary Ammonium Compounds
Authors: Weiss, Amelia; Tobin, Catherine; Arcati, Vincent; Clayton, Emily; Minbiole, Kevin; Eigenbrodt, Bryan
Advisor: Dr. Kevin Minbiole

Algal biofuels have been gaining traction as a potential alternative energy source for over a decade, and as such, standard mechanical and non-mechanical processes for the breakdown of the algal cell wall have emerged. One such non-mechanical process involves the introduction of certain compounds to assist in disrupting the cell wall. This research primarily focuses on the introduction of various quaternary ammonium compounds (QACs) into the algae *Nannochloris eucaryotum* to determine the effectiveness of not only the compound type, but structural characteristics of the QACs that may increase recovery of extracted oils. Algal liquid cultures were exposed to different classifications of QAC, for prolong periods of time. Each sample was then filtered, reconstituted, and esterified for lipid extraction. Samples were quantified as fatty acid methyl esters via gas chromatography, and further characterized via light microscopy. Of the four primary lipids that appear in *Nannochloris eucaryotum* – linoleic, oleic, palmitic, and stearic acids – linoleic acid appeared in the highest quantities, recovered in levels up to 170.8 ppm, over twice the measured level of a simple reflux procedure. Accordingly, data suggest an increased recovery of fatty acids using QACs as algae cell wall disrupting agents.

D-37: Bolaamphiphilic Bisimidazoles - Potent QAC Disinfectants
Authors: Coster, Kai; Minbiole, Kevin; Asante, Johanna
Advisor: Dr. Kevin Minbiole

With rising resistance to traditional monocationic quaternary ammonium compounds (QACs), which have long served as key disinfectants, there is an urgent need for structurally novel alternatives to effectively address infectious threats. To address this challenge, our group has worked to develop novel cationic biocides with varied architecture, focusing on multicationic QACs. Bolaamphiphilic structures, compounds with multiple cationic groups separated by long and flexible alkyl linkers, have been shown to have strong bioactivity, particularly when facing extensively resistant bacterial strains. Further, some bolaamphiphiles have demonstrated a distinct mechanism of action, selectively targeting the inner membrane of gram negative bacteria. In light of these observations, biscationic ammonium compounds featuring a variety of imidazolebased head groups linked by a variable alkyl chain were designed to expand the scope of traditional cationic biocides and evaluate their potential as novel disinfectants. Nearly four dozen bolaamphiphilic compounds were synthesized and evaluated for their bioactivity against a panel of bacterial pathogens for structure-activity relationship analysis, leading to the identification of multiple promising disinfectant candidates.

D-38: Characterization of a Dual-Function Dioxygenase from *Crocosphaera subtropica*
Authors: Adiheti, Nethuli; Selinsky, Barry
Advisor: Dr. Barry Selinsky

The cyanobacterium *Crocosphaera subtropica* produces an enzyme (CSU-Diox) that exhibits both dioxygenase and peroxidase activities with lipid substrates, performing similarly to other dual-function enzymes such as Prostaglandin Synthase. This study aims to further understand the reactivity of CSU-Diox with lipid substrates by investigating its specificity with lipids of varying chain lengths in dioxygenase assays. Additionally, the formation of reaction products including aldehydes, alcohols, and hydroperoxides are monitored by LC-MS analysis. The dioxygenase assays demonstrated that lipid substrates with longer chain lengths yielded lower Km values and higher kcat values when reacting with CSU-Diox, indicating higher affinity and catalytic efficiency with increasing lipid carbon chain lengths. The LC-MS analyses demonstrated the production of three reaction products: 2-OH carboxylic acid, 2-OOH carboxylic acid, and aldehydes. The LC-MS analyses also showed that aldehyde formation increased significantly in the presence of a reducing agent, suggesting that the aldehyde was formed from the 2-OH carboxylic acid intermediate in the reaction rather than the hydroperoxide intermediate as previously believed. Future experimentation is needed to understand the enzyme-substrate specificity between different saturated and unsaturated lipid substrates. Additional LC-MS analyses with different starting materials will be performed to allow for better understanding of the factors contributing to the formation of aldehydes.

D-39: Constructing a UBL Substrate for the Proteasome
Authors: Stuart, Jacqui; Kraut, Daniel
Advisor: Dr. Daniel Kraut

In eukaryotes, the Ubiquitin Proteasome System (UPS) is responsible for the bulk of intracellular protein degradation. Protein substrates are selectively targeted by proteasomes for degradation to maintain protein homeostasis and to eliminate unneeded proteins in the cell. Typically proteins are tagged with Ubiquitin that is recognized by the proteasome for degradation. My goal is to develop a model protein for unfolding ability studies that does not need to be ubiquitinated and instead contains an internal Ubiquitin Like (UBL) Domain which serves as the tag for protein degradation. This avoids the need to ubiquinate proteins of interest which typically requires additional steps and potentially introduces variability in the success of ubiquitination. In addition to the UBL domain, our proteins utilize Green Fluorescent Protein (GFP), a fluorescent protein to monitor degradation. Three versions of GFP with different stability were initially constructed. Additional experiments will include constructs that contain sequences that have been shown to impair or decrease degradation.

D-40: Correlation of charge density and disinfectant activity in quaternary phosphonium compounds (QPCs)
Authors: Brouwers, Leoma; Martin, Kristen; Leatherbury, Moneya; Minibole, Kevin; Mistrot, Brody; Bezold, Elise; Zdilla, Michael; Wuest, William
Advisor: Dr. Kevin Minbiole

Quaternary ammonium compounds (QACs) have been widely used for nearly a century as surface disinfectants. However, bacteria are developing resistance mechanisms, due in part to the persistence of QACs in the environment. An emerging class of disinfectants that could represent an alternative to QACs are quaternary phosphorus compounds (QPCs). Compared to nitrogen, the larger atomic radius and lower electronegativity of phosphorus leads to stronger polarization, giving phosphonium a higher cationic charge than what is typically found in QACs. This increased positive charge may better facilitate interactions with the net-negative bacterial cell membrane, potentially increasing

antimicrobial activity. To probe this hypothesis, we have constructed a series of biscationic QPCs derived from triphenylphosphine analogs, with charges separated by an extended carbon chain. Subtle charge differentiation in the phosphonium center was introduced via substituent groups on the aromatic residues and correlated to antimicrobial activity. Structural studies were led by compound crystallization, X-ray structural determination, and charge density analysis, to further refine structural insights and generate a Hammett-style plot.

E-41: Development of a General Method for Tri-Heteroleptic Ruthenium(II) Complexes Incorporating BIAN Ligands

Authors: Moore, Gavin; Kassel, Scott; Paul, Jared
Advisors: Dr. Scott Kassel; Dr. Jared Paul

The purpose of this project was to develop a simple method to make tri-heteroleptic Ru(II) complexes with three different ligands: 2,2'-bipyridine (pp), 1,10-phenanthroline (pp'), and 4-methyl-2,2'-bipyridine (pp''). Using several BIAN ligands with varied aryl substituents (phenyl, 4-methylphenyl, 3,5-dimethylphenyl, and 2,4,6-trimethylphenyl) was explored as well. Complexes were prepared from [(η6-C6H6)RuCl2] 2 with pp, followed by the sequential addition of pp', and finally using microwave heating in 50% ethanol–water to add pp''. The resulting [Ru(pp)(pp')(pp'')]2+ complexes were confirmed by 1H NMR spectroscopy. Initial attempts to add BIAN ligands using similar microwave methods were not successful, but modified procedure are being investigated to improve yields. Future work will explore how different ligands affect the electrochemical properties of these complexes.

E-42: Effects of Caprolactam and Lysine on Algae *Pseudochloris wilhelmii* for Biofuel-Compatible Lipid Production

Authors: Amapani, Joseph; Arcati, Vincent; Serinese, Augustine; Tobin, Catherine; Weiss, Amelia
Advisor: Dr. Bryan Eigenbrodt

Fossil fuels are an extremely demanding energy source derived from the breakdown of fossilized organisms. They are non-renewable and contribute to global warming and climate change by releasing greenhouse gases like carbon dioxide. These demerits have motivated researchers to find a more carbon-neutral energy substitution. These 3rd generation algal biofuels represent a promising alternative, as their photosynthetic mechanism allows the storage of energy in lipids, which can be harvested to generate clean-burning biodiesel. The production of lipids in algae can be optimized by stressing their growth conditions, such as reducing their nitrogen source. The research outlines the cultivation of the algae *Pseudochloris wilhelmii* and the measurement of four intracellular lipids. Algae from a 25% nitrate-based colony were split into two groups, caprolactam and lysine, where two trials were run for both nitrogen sources. The laboratory utilized cell counting, GCMS, and fluorescence techniques to monitor weekly progress in order to identify which nitrogen source resulted in the greatest production of lipids in the algal cells.

E-43: Effects of pH on Algae *Pseudochloris wilhelmii* for Biofuel-Compatible Lipid Production

Authors: Tobin, Catherine; Arcati, Vincent
Advisor: Dr. Bryan Eigenbrodt

Fossil fuels, which come from the breakdown of ancient plant and animal material found in the Earth's crust, are in high demand. However, their limited supply, nonrenewable nature, and significant carbon emissions have shifted attention to more carbon-neutral energy alternatives. One promising option is algal biofuels, as its photosynthetic process allows it to store energy in the form of lipids, which can be extracted to produce clean-burning biodiesel. The amount of lipids in algae can be optimized by adjusting growth conditions, such as pH. The research shown outlines the cultivation of the algae *Pseudochloris wilhelmii* and the measurement of four intracellular lipids. Algae from a 25% nitrate-based colony were split into three groups: two colonies were grown at each pH level of 5, 6, and 7. The lab used cell counting, GCMS, and fluorescence techniques to track each group's weekly progress to identify which pH led to the highest lipid accumulation in the algal cells.

E-44: Expression, Purification and Characterization of a Putative Cyclooxygenase from Roseobacter denitrificans

Authors: Garg, Tanvi; Selinsky, Barry
Advisor: Dr. Barry Selinsky

Prostaglandin synthase is a membrane protein located in the endoplasmic reticulum that contains both cyclooxygenase and peroxidase activities. The Selinsky Lab is searching for bacterial homologs to prostaglandin synthase that possess the same activities. My specific research focuses on a bacterial homolog from *Roseobacter denitrificans* (Rden-POX). Initial attempts to express Rden-POX in soluble form have been unsuccessful. The goal of the study is to express Rden-POX using three different expression vectors, one with an N-terminal SUMO fusion partner, one with an N-terminal $(His)_6$ tag, and one with a C-terminal $(His)_6$ tag. Expression was attempted using three different expression methods: Isothiopropyl galactoside, self-inducing media, and leaky expression. The C-terminal $(His)_6$ construct produced the highest amount of soluble enzyme using the self-inducing media. Purified Rden-POX exhibited strong peroxidase but no cyclooxygenase activity. Future work will focus on detailed characterization of the enzyme with the C-terminal $(His)_6$ construct.

E-45: High-throughput experimentation facilitates expedient determination of cyclization conditions for the synthesis of cyclic tetrapeptide natural product massiliamide and stereoisomers thereof

Authors: Sharafi, Edreece; Minbiole, Luke; O'Reilly, Matthew
Advisor: Dr. Matthew O'Reilly

Cyclic peptides are a captivating interest in pharmaceutical chemistry due to their unique bioactivities. Current FDA-approved cyclic peptide pharmaceuticals demonstrate antiviral, anticancer, and antibacterial effects. Cyclic tetrapeptides (CTPs) are among the smallest macrocyclic peptides and display promising "drug-like" properties. However, synthesis of CTPs is an unsolved problem for organic chemists. Current approaches of CTP production often generate the molecules in low yields using time consuming approaches that lead to configurational inconsistencies while cyclizing the linear precursor. To further optimize this process, massiliamide, a cyclic tetrapeptide isolated from the bacterium *Massilia albidiflava* with potent tyrosinase inhibiting activity, was chosen as a model system to test a high-throughput experimentation (HTE) approach. Arrays of cyclization conditions with various coupling reagents, bases, solvents, and reaction temperatures were first explored on small-scale. LC-MS reaction analysis allowed for the rapid screening of hundreds of conditions, which

revealed the most promising reaction conditions when compared to previous reports of isolation of massiliamide's stereoisomers. The successful conditions were then increased in scale, which ultimately provided cyclizations of the natural products in reproducibly high yields. In the end, the HTE approach further optimized the synthesis of massiliamide's natural products, delivering higher yields with more standard synthetic methods.

E-46: Investigating N- versus C- Terminal Degradation Efficiency of the Proteasome
Authors: Pham, Kristi; Palta, Arushi
Advisors: Dr. Daniel Kraut; Dr. Edwin Ragwan

The ubiquitin-proteasome system in eukaryotic cells plays a vital role in regulating protein levels. Proteins are marked for degradation by the addition of ubiquitin, which is recognized by the 19S regulatory subunit of the proteasome. Ubiquitinated proteins are then unfolded, pulled through the core subunit, and degraded. Our lab has previously shown that the insertion of poly-G sequences leads to deficits in degradation from the N-terminus direction. This project investigated degradation from the C-terminus to determine the effects of direction on the proteasome's ability to unfold substrates. Using designed model proteins, we compared how efficiently the proteasome can unfold and degrade substrates from each direction. We found that, while the pattern of the unfolding ability profile was similar for the N- and C-terminus, overall unfolding was less effective from the C-terminus. Results from degradation experiments and modeling have suggested that this overall lower unfolding is likely due to the asymmetry of the substrate and the translocation pathway. The aromatic paddles on the Rpt subunits of the 26S proteasome are arranged in a clockwise staircase configuration, and the different substrate orientations cause different angles of the side chains and carbonyl oxygens. This combination of factors likely allows the proteasome to generate stronger force while pulling substrates from the N-terminus. These findings highlight that the proteasome's mechanics depend on the orientation of the protein it's degrading, providing new insight into how cells control protein quality and stability.

E-47: Liquid Chromatography–Mass Spectrometry (LC-MS) Quantification of Sulforaphane in Human Plasma and Commercially Available Supplements
Authors: Barrera, Alan; Pan, Vincent; Traustadottir, Tinna; Lagalante, Anthony; Eggler, Aimee
Advisor: Dr. Anthony Lagalante

Sulforaphane, derived from cruciferous vegetables, has the potential to manage a wide array of chronic diseases, with ~90 clinical trials on broccoli sprout extracts in progress or completed. A major target of sulforaphane is the NRF2 transcription factor, which upregulates transcripts that enhance the body's defenses against oxidative stress and toxins. Driven by public interest, there are a wide array of commercially available supplements containing either sulforaphane or its shelf-stable precursor, glucoraphanin. Conversion of glucoraphanin to sulforaphane requires the enzyme myrosinase, either inherent to the plant or in gut microflora. To our knowledge, there are no studies that compare commercially available sulforaphane supplements to blood plasma sulforaphane levels following consumption. The plasma level can vary among individuals due to several factors, including an individual's metabolism and whether the supplement contains sulforaphane or glucoraphanin. Recently, we developed a tandem mass spectrometry method that quantifies bioavailable sulforaphane in blood plasma through the release of electrophilic sulforaphane from thiol conjugates and plasma proteins using iodoacetamide. In this work, bioavailable sulforaphane was quantified in the blood

plasma of study participants taking either of two supplements: EnduraCell, reported by the manufacturer to contain 8 mg/dose of available sulforaphane in the form of glucoraphanin, or BrocElite, reported to contain 10 mg/dose of sulforaphane, stabilized by a proprietary technology. Surprisingly, blood plasma levels of 10 participants that consumed one dose of EnduraCell averaged 150±xx nM sulforaphane, while 3 participants who consumed one dose of BrocElite averaged 80±xx nM over baseline (1.0±xx nM sulforaphane, n=10). This significant difference ($p<0.05$) was unexpected as the glucoraphanin in EnduraCell must be converted by myrosinase in gut bacteria to sulforaphane. Participant's plasma sulforaphane levels were measured at 1, 3, 5, and 7 h where a temporal decrease was observed indicating the half-life in blood plasma is approximately 2 h. An ongoing area of investigation is whether the enterically-coated BrocElite capsules containing stabilized sulforaphane, which presumably delivers sulforaphane to the small intestine, may reduce its bioavailability.

E-48: Microwave Synthesis and Spectroscopic Study of Salen-Type Ligands and Select Metal Complexes

Authors: Wickham, Grace; Kassel, William Scott; Paul, Jared
Advisor: Dr. Scott Kassel

This work focuses on synthesizing two complementary series of salen ligands, sal-pda and sal-dam, using microwave-assisted methods. These ligands are derived from 1,2-phenylenediamine (pda) or diaminomaleonitrile (dam) with a series of substituted salicylaldehydes. A unique feature of the sal-dam series is an irreversible "Z" to "E" isomerization that is activated by UV or ambient light. Metal complexes M(sal-pda) and M(sal-dam) were prepared with Zn(II), Co(III), Ni(II), and Cu(II) centers. All compounds were characterized by UV–Visible, photoluminescence, IR, and 1H NMR spectroscopies. Future work will explore the use of these complexes, particularly Al and Co derivatives, for polymerization catalysis.

E-49: NRF2 activator kynurenine-carboxyketoalkene (Kyn-CKA) cyclizes spontaneously and reversibly at low pH to indoline kynurenine

Authors: Titzer, Patrick; Jung, Hannah; Vitturi, Dario; Lagalante, Anthony; Eggler, Aimee
Advisor: Dr. Aimee Eggler

The NRF2 transcription factor plays a critical role in the cytoprotective response to oxidative and electrophilic stressors. Activation of NRF2-regulated cytoprotective gene expression by electrophiles derived from dietary or pharmacological sources helps prevent and treat an expansive range of chronic diseases. An endogenous electrophilic tryptophan metabolite, kynurenine carboxy-ketoalkene (Kyn-CKA), was recently shown to activate NRF2, which largely explains the cytoprotective functions previously ascribed to its precursor kynurenine. Our intent was to study the kinetics of Kyn-CKA reaction with KEAP1 Cys151, a known electrophile sensor, using fluorescence spectroscopy. Unexpectedly, Kyn-CKA fluorescence at pH 7.5 (excitation/emission 370/480 nm) slowly but significantly decreased, reaching equilibrium within ~1.5 h. Molecular oxygen quenching and photodegradation were found to have a minor contribution to these changes. However, the fluorescence decrease was pH dependent and reversible, with low pH stabilizing the fluorescent form and an excited state pKa of 5.6. Exploring the possibility of a protonation-dependent chemical change, negative ESI mass spectrometry revealed that after ≥2 h incubation at pH 7.5, a single compound is present, with a 7 min retention time (RT) and the expected mass-to-charge ratio ($m/z=190$), while

after incubation at pH 4 two peaks of similar area and identical m/z=190 were observed at RT 6.5 and 7 min. The late peak had the expected absorbance of Kyn CKA (λmax 390 nm), while the early peak had a λmax of 370 nm and did not correspond to either Kyn-Yellow or a dimeric product. Thus, we propose that while Kyn-CKA has low fluorescence and is stable at pH 7.5, acidic conditions favor its reversible cyclization to a fluorescent 5-membered ring—indoline kynurenine. In this regard, while the indoline is unlikely to be present under homeostatic conditions, its formation could be favored under conditions of digestive or metabolic acidosis with potentially novel biological consequences.

E-50: Octenidine Analogs as Promising Bolaamphiphilic QAC Disinfectants
Authors: Talbot, Daniella; Casey, Caroline; Membrino, Kelsi; Muldagaliyeva, Alina; Bezold, Elise; Wuest, William; Minbiole, Kevin
Advisor: Dr. Kevin Minbiole

Quaternary ammonium compounds (QACs) have been used in commercial disinfectants since the mid-1900s due to their strong antimicrobial activity and relatively low toxicity to eukaryotic cells. However, the problem of antimicrobial resistance to our common disinfectant compounds has compromised their effectiveness over the past decades. The growing threat of resistant microbial pathogens has resulted in a need for novel QACs to continue the fight against pathogenic bacteria. In light of this, our group has synthesized ~1000 novel cationic biocides over the past decade, and in conjunction with the Wuest group at Emory University, has tested QACs for bioactivity against gram positive, gram negative, and resistant bacterial strains. We have recently turned our focus to octenidine, a potent QAC that is often used in the medical field as an antiseptic and to disinfect medical instruments. Octenidine is a bolaamphiphile, bearing two cationic residues separated by an alkyl linker; this architecture seems to provide strong activity against resistant bacteria. Its structural analog, isooctenidine, has been suggested to possess similar antimicrobial activity to the parent structure, but with increased solubility. To pursue this promising observation, 24 isooctenidine analogs were synthesized, varying the carbon linker length and the length of the terminal alkyl chains. These 24 compounds along with three synthesized octenidine analogs were tested for bacterial inhibition, as well as solubility and surface tension reduction, leading to the identification of multiple highly potent analogs.

F-51: Optimization of the Multistep Synthesis of Deoxyprehelminthosporal
Author: Ryan, Nicholas
Advisor: Dr. Eduard Casillas

This project focuses on optimizing the multistep synthesis of deoxyprehelminthosporal, as originally hypothesized by Dr. Eduard Casillas and a graduate student. Each step of the synthesis was re-examined to improve yield, efficiency, and reproducibility. Utilizing commercially purchased triphenylphosphorane increased the yield of Reaction A from 47% to 55.2%. Challenges encountered included Wurtz-type coupling during Grignard formation and unexpected oxidation of an intermediate alcohol. Ongoing work aims to minimize side reactions, investigate the mechanism of oxidation, and refine later steps such as the Nazarov cyclization, ultimately advancing toward a higher-yielding total synthesis of deoxyprehelminthosporal.

F-52: Progress on the Synthesis of Caespitate
Author: Homolka, Lindsay
Advisor: Dr. Eduard Casillas

Many phenolic acids exhibit antibacterial properties against Gram-positive bacteria. Caespitate, a compound extracted from *Helichrysum caespititium*, has been tested and is known for its antibacterial properties against Gram-positive bacteria. The focus of the summer semester's work was to explore a new efficient synthesis for this natural product. As past research has shown unsuccess in using a Stille coupling due to the high reactivity of the hydroxyl groups on the compound, the focus of the summer was to progress the synthesis via the "Kolbe-Schmidt" like addition route, after the spring semester and early summer showed poorer efficiency of addition using a Friedel-Crafts reaction and an allylic alcohol reagent. The "Kolbe-Schmidt" like reaction yielded more product and allowed for further progression in the synthesis. With this new addition strategy came a new reagent, an allylic bromide. There was successful synthesis of the bromide, with great isolation of the product to be used in the addition. The "Kolbe-Schmidt" yielded impure product but still was used for a reduction. After multiple procedures and reagents, the phenols did not survive. The remaining focus was to successfully add a protection group to the phenols. There was little success with multiple protection groups. Moving forward, focus will be on isolating pure "Kolbe-Schmidt" product and protecting the phenols, and reagent possibilities will be explored to discover the most efficient synthesis.

F-53: Standardized Microwave-Assisted Aerosol Acid Digestion Method Development with Nitric Acid, Hydrochloric Acid, and Hydrogen Peroxide
Authors: Youngren, Meghan; Shakya, Kabindra; Boschi, Vanessa
Advisor: Dr. Vanessa Boschi

Microwave-assisted acid digestion procedures were evaluated to identify the optimal reagent composition for metal recoveries of aerosol matrices using nitric acid (HNO3), hydrochloric acid (HCl), and hydrogen peroxide (H2O2) in place of hydrofluoric acid (HF). Microwave-assisted digestions offer advantages over traditional methods as they allow for safer and more complete digestions in shorter time frames due to the closed system of the digestion chambers and higher pressure and temperature of the digestions. Complete digestion is a priority for aerosol sample preparation, as often these techniques involve trace metal analysis, with some detections requiring parts per billion (ppb) or parts per trillion (ppt) sensitivity. While complete acid digestion often requires the addition of HF, the potentially lethal hazards associated with the chemical make it undesirable in the lab setting, especially in academic research. To address this, varying solutions with HNO3, HCl, and H2O2 were used in the digestion of Standard Reference Material 1648, an urban particulate matter standard, with two microwave methods. The methods differed in hold time and hold temperature to compare digestion completion. The digests were analyzed with inductively coupled plasma mass spectrometry (ICP-MS) to determine digestion efficiency.

F-54: Structure & Function: Exploring a Loop Insertion in Trypanosome Malate Dehydrogenase
Authors: Rhilinger, Zach; Palenchar, Jennifer
Advisor: Dr. Jennifer Palenchar

Trypanosoma parasites are found in several regions of the world and cause potentially fatal diseases, including Chagas disease, now endemic to the US. Therapeutics are lacking. To better understand proteins that may serve as targets for therapeutics, this project aims to characterize the function of an unusual proline-rich region in several malate dehydrogenases (MDH) in *Trypanosoma* parasites. MDH catalyzes the reversible NADH-dependent conversion of oxaloacetate to malate. Our lab is characterizing MDHs from both *Trypanosoma brucei* and *cruzi*. Several trypanosome MDH constructs were generated, their overexpression optimized in bacteria, and purified to approximate homogeneity. The recombinant enzyme has MDH activity and its activity is modulated by several effector molecules tested. Work is in progress to generate mutant MDH enzymes to examine the proline-rich regions.

F-55: Synthesis and Characterization of Substituted Diamine Ru(II) Polypyridyl Complexes for Photoassisted DNA Cleavage

Authors: Thomas, Moriah; Kassel, William Scott; Paul, Jared
Advisor: Dr. William Scott Kassel

The focus of this work is to synthesize and characterize a series of Ru(II) polypyridyl complexes derived from bis(2,2'-bipyridine)(1,10-phenanthroline-5,6-dione)ruthenium(II) and a set of substituted aromatic diamines (4,5-dimethyl-1,2-phenylenediamine, 2,3- and 3,4-diaminopyridine, and 3,4-diaminobenzoic acid). Two synthetic strategies were employed: the direct microwave-assisted reaction of Ru(bpy)2(phendione)(PF6)2 with each diamine to afford hexafluorphosphate salts and synthesis of the ligands followed by coordination to Ru(bpy)2Cl2 to obtain the chloride analogues. The resulting complexes were characterized by ^{1}H NMR and UV–Visible spectroscopies to confirm ligand coordination and investigate electronic properties of the complexes. Future work will focus on electrochemical analysis, pH-dependent spectroscopy, and evaluation of the complexes for light assisted DNA-cleavage.

F-56: Synthesis and computational analysis of phenoxy functionalized N-heterocyclic carbene ligands

Authors: Shattuck, Kathryn; Zubris, Deanna; Casillas, Eduard
Advisor: Dr. Deanna Zubris

N-Heterocyclic carbenes (NHCs) are versatile and highly tunable ligands that can be found in a broad range of transition metals complexes. These transition metal complexes have applications in polymerization and other areas of catalysis. To minimize undesired NHC ligand dissociation during catalysis, a ring-expanded NHC ligand with a phenoxy chelate arm was selected as a synthetic target. A multi-step synthesis was developed to prepare these NHC analogues. Characterization data for synthetic intermediates and the proposed cyclized product will be presented. Density functional theory was used to determine which ligand substitution patterns of these NHC pro-ligands are best suited for complexation with 3d metals, such as Ni(II). The calculated $\tau 4$ parameter was used to quantify the differences in geometry between structures. These computational insights will guide future metalation attempts for these novel NHC pro-ligands.

F-57: Synthesis, characterization, and electrochemical performance of Sr2FexMoyO6 Double Perovskites as Anode/Cathode

Author: Koehler, Owen
Advisor: Dr. Bryan Eigenbrodt

Double perovskite oxides like $Sr_2Fe_xMo_\gamma O_6$ are promising materials for solid oxide fuel cells (SOFC) due to their mixed ionic-electronic conductivity and structural stability. If there was a purer form of the double perovskite Sr2Fe1.5Mo0.5O6, then determining an alternate composition of perovskite could act as a self-cleaning anode or cathode material. A series of double perovskite oxides Sr2FexMoyO6 (x = 1.5, 1.6, 1.4, 1.55/ y = 0.5, 0.4, 0.6, 0.45) were prepared through a Sol-Gel synthesis. Gravimetric analysis provided a better estimate of concentration than atomic emission spectroscopy. Samples reduced by GSL-1500X-OTF furnace at 800C, structures of samples after reduction characterized through X-ray diffraction. A hydraulic press produced Ni-YSZ electrolyte pellets for further electrochemical evaluation. The structural purity and composition of the samples inferred from XRD suggests that slight variations Fe/Mo ratios influenced crystallinity and oxygen vacancy formation. Optimized $Sr_2Fe_xMo_\gamma O_6$ consisted of ratios close to 1.5/0.5 such as 1.6/0.4 and 1.4/0.6. Strong potential for efficient voltage output and "self-cleaning" applications as SOFCs.

F-58: Synthetic Development and Coupling Optimization in the Preparation of Isogemichalcone Analogs for Aromatase Inhibition
Author: Ryan, Maggie
Advisor: Dr. Eduard Casillas

Aromatase, the enzyme responsible for converting androgens into estrogens, plays a critical role in hormonal regulation and has been directly implicated in the development of estrogen-dependent cancers such as breast and ovarian cancer. Current therapeutics, including Anastrozole® and Exemestane®, effectively inhibit aromatase activity, motivating continued efforts to design novel synthetic and natural inhibitors with greater potency and selectivity. Isogemichalcones B and C, which are natural products isolated from *Broussonetia papyrifera*, demonstrate moderate aromatase inhibition, though their activity remains inadequate for therapeutic application. This study centers on the synthesis and optimization of isogemichalcone analogs through improved synthetic methodologies aimed at enhancing inhibitory potential. The original synthesis involved a Stille coupling, resulting in low yields of product. To overcome challenges encountered in previous Stille coupling reactions, a modified route employing Suzuki coupling was investigated through the preparation of vinyl boronate intermediates. Multiple variations of the Suzuki coupling were attempted, exploring different catalysts, solvents, and concentrations. While the Suzuki route proved difficult to optimize, successful coupling and increased product yield were achieved through a Stille reaction, enabling continued progress in the synthesis. Subsequent Claisen–Schmidt condensations with various benzaldehyde derivatives were performed to generate the chalcone backbone, including a product formed from the acetophenone intermediate and 2,4-difluorobenzaldehyde. Future work will focus on purification and reaction optimization to improve yields. The synthetic insights gained from this project advance the development of more efficient routes for natural product analog synthesis and contribute to the broader pursuit of novel aromatase inhibitors for cancer therapeutics.

F-59: Synthesis of Ru(II) Polypyridyl Complexes with Extended Aromatic Ligands for Potential DNA Photocleavage
Authors: Sage, Evan; Kassel, Scott; Paul, Jared

Advisor: Dr. Scott Kassel

This project focuses on the synthesis and characterization of Ru(II) polypyridyl complexes incorporating substituted 2,2'-bipyridines (H and OMe), 1,10-phenanthroline, and extended aromatic ligands benzo[i]dipyrido[3,2-a:2',3'-c]phenazine (DPPN) and acenaphtho[1',2':5,6]pyrazino[2,3-f][1,10]phenanthroline (ABPQ). The DPPN and ABPQ ligands and their Ru(II) complexes were synthesized via microwave-assisted methods, affording analytically pure products. All complexes were characterized by ^{1}H NMR and UV–Visible spectroscopies to confirm ligand coordination and probe electronic structure, as well as by electrochemical methods to assess redox behavior. Future work will focus on introducing electron-withdrawing substituents to the bipyridine ligands to vary photophysical and redox properties, followed by evaluation of the complexes as light-activated DNA-cleaving agents.

F-60: Synthesis of the Putative Natural Product Cyclopentapeptide Aspergillipeptide D and Analogues Demonstrates Impact of Stereochemistry and N-Methylation on Cyclization Approach

Authors: Harth, Madison; Tiffany, Aidan; O'Reilly, Matthew
Advisor: Dr. Matthew O'Reilly

Aspergillipeptide D was reported as a cyclic pentapeptide natural product with antiviral activity against herpes simplex virus 1. Linear peptide cyclization to produce small cyclic peptides is often challenging due to oligomerization and/or C-terminal racemization. To address this, a high throughput experimentation (HTE) approach evaluating combinations of coupling reagents, bases, solvents, and temperatures was implemented for cyclization optimization. Ideal conditions were chosen via LC-MS analysis of the reagent array. With a strategic retrosynthetic disconnection of the natural product designed to promote conformational flexibility, various conditions successfully promoted cyclization. Scale-up led to a 48% cyclization yield of the putative natural product precursor. Preparation of analogues was pursued to evaluate structure activity relationships, focusing on derivatives with all-L stereochemistry and removal of the N-methylation. These seemingly minor changes had enormous implications on cyclization success, requiring extensive HTE and LC-MS analysis to identify a condition for reaction scale-up. The non-N-methylated analogue underwent 46 optimization reactions, leading to a 28% cyclization yield. After 106 optimization reactions of the all-L analogue, the most promising condition led to a 13.5% cyclization yield. While HTE allowed for production of desired analogues, the low yields demonstrate the challenges with macrolactamization of linear peptides. This led to exploration of secondary ligation approaches utilizing masked β-thiolactone amino acid analogues that can undergo a native chemical ligation to produce cyclic peptides.

G-61: Three's a Crowd? *Trypanosome HAD* Activities and the Impact of Molecular Crowding

Authors: Murphy, Audrey; Grzech, Eva; Palenchar, Jennifer
Advisor: Dr. Jennifer Palenchar

Human African Trypanosomiasis (HAT) and Chagas, now endemic in the US, are parasitic diseases caused by trypanosomes. There is a need for new therapeutics. These parasites are ancient single-celled eukaryotes that have acquired several genes from prokaryotes through horizontal gene transfer. Aiming to explore how some of these gene products have evolved in the eukaryotic parasites, which may also serve as future drug targets, this work has focused upon the characterization of three

Trypanosoma brucei haloacid dehalogenase *(HAD)*-like proteins. All three *T. brucei HADs* were acquired through horizontal gene transfer and are important in distinct parts of the parasite life cycle. TbHAD32, TbHAD35, and TbHAD42 are named for the molecular weight of each protein. We have identified substrates for His10-TbHAD32 and His10-TbHAD42. The metal dependence of each has been explored, as well as the native subunit association and the impact of crowding on enzyme activity. RNA interference is in process to determine HAD roles and potential redundancy of function. Antibody characterization will be presented.

G-62: Use of artificial intelligence in the development of novel QAC disinfectants
Authors: Westrate, Anastasia; Gazoo, Emily; Consylman, Amanda; Bezold, Elise; Forman, Mark; Wuest, William
Advisor: Dr. Kevin Minbiole

Quaternary ammonium compounds (QACs) have been used as disinfectants since the 1940s due to their broad spectrum of antimicrobial activity and low eukaryotic cytotoxicity. However, this extended period of use has led bacteria to develop resistance to these compounds through cellular mechanisms such as efflux pumps and cell membrane modification. The proliferation of resistance demonstrates a pressing need for the development of novel disinfectants, as resistant microbes present a threat to global public health. In pursuit of this goal, the Minbiole-Wuest collaboration has synthesized ~1000 QACs with variable structures and obtained accompanying bioactivity data (MIC vs gram positive and gram negative bacteria; hemolysis). Collaborating computer scientists at George Mason University and Emory University have created an artificial intelligence/machine learning model that leverages both synthetic and biological data to both generate and evaluate novel QAC structures. Select structures were then synthesized in the laboratory; the resultant data was fed back into the AI model, iteratively optimizing synthetic feasibility and bioactivity. Earlier rounds of generation by the AI model yielded improved structures, and in this current set, "clusters" of similar structures are used as inspiration for further chemist modification by varying the lengths of alkyl side chains and carbon linker. Herein we describe our approach to one of these structural clusters.

Civil and Environmental Engineering

G-63: Assessing Mobility Disruption From Hurricane Ida: A Comparative Analysis of Urban, Suburban, and Rural Counties Using Digital Footprint Data
Authors: Rodriguez, Alex; Gorgas, Jay; Cimaglia, Juliet
Advisor: Dr. Chenfeng Xiong

The large-scale flooding in the wake of Hurricane Ida in September 2021 severely disrupted movements and the delivery of essential services across the Northeast US. Understanding how communities are affected in terms of travel patterns over diverse geographic categorizations is essential for planning emergency actions and equitable recoveries. This study hence analyzes the mobility effects of Hurricane Ida by examining anonymized digital footprint data (SafeGraph) monitoring weekly and daily visits to Points of Interest (POIs) across select urban (New York County, NY; Philadelphia County, PA), suburban (Passaic County, NJ; Somerset County, NJ), and rural/suburban mix (Bucks County, PA; Chester County, PA) counties. We contrast flood-week (August 30th - September 6th, 2021) visits with visits recorded during a pre-flood baseline and

subsequent post-flood recovery periods within five weeks; POIs are categorized by NAICS codes. Our analysis reveals steep declines in POI visitation across all county types, with particularly acute disruptions in urban centers and uneven recovery patterns across suburban and rural areas.

G-64: Developing Coding-Based Tools for the Management and Analysis of Microplastic Datasets in Environmental Research
Author: Oliver, Mikaela Antonia
Advisors: Dr. Kelly Good; Dr. Erica Forgione

Microplastics (MPs), which are 1-um to 5-mm in length, have been found everywhere in the environment and even in the human body. Researching MPs is challenging because methods used to analyze them can vary greatly due to MP research being a developing field, so there are also no standardized methods for data management and analysis. For this research, the coding language, R, is the primary environment used to manage and analyze the MP datasets curated from Dr. Good and Dr. Forgione's 2025 VU MATCH Program Project. Because coding languages like R demand precise syntax, with a clean, consistent dataset structure (column name, allowed values, data class), these datasets required extensive data template preparation. Preparation and standardization of raw microplastics quantification and morphology datasets to an advanced template was completed to ensure accuracy and preparation for analysis. R scripts were outlined for data merging (Optical and Raman data), matching sample IDs to OpenSpecy library, and creating outputs for both analysis and data visualization. This code flowcharting work has laid the groundwork for MP data analysis. In addition, a visual microscopy Standard Operating Procedure (SOP), a thorough documentation of data organization through a Data Management Plan (DMP), and data storage structures were created in Lab Archives and OneDrive. The resources developed through this project will serve as valuable tools to improve the efficiency, consistency, and reproducibility of ongoing and future microplastic research at Villanova and for all researchers, ensuring that data can be more easily collected, archived, shared, and built upon.

Communication

G-65: Liminal and contested identities: Elaborating on communication and social consensus in social identity development and belonging
Authors: Cardwell, Megan; Soliz, Jordan; Kassler, Katie; Morley, Morgan
Advisor: Dr. Megan Cardwell

People with liminal or contested identities—such as multiracial individuals, bisexuals, those from interfaith families, or people with chronic conditions—often struggle to fit within fixed social categories. Their identities exist between established social borders, leading to feelings of exclusion and uncertainty. For instance, someone who is both Black and Asian may feel "not Black enough" or "not Asian enough" to be fully accepted by either group. Because society tends to define people through essentialized categories like race, gender, and sexuality, these individuals often face suspicion or rejection when seeking belonging. This mixed-method study investigates how liminal identity-holders experience belonging and exclusion, and how these dynamics affect their sense of self and well-being. Drawing on the social identity approach—which emphasizes that identity forms through communication and social interaction—the research examines *social consensus*, or the extent to

which others agree on who belongs to a group. Analyzing data from 455 adults with liminal identities, the study found that identity is not an inherent possession but a process continually shaped through social interaction. Experiences of acceptance and rejection reveal how people navigate the complexities of being "in-between." Ultimately, this research challenges traditional ideas of fixed group membership, advocating for more fluid and intersectional understandings of identity in today's diverse and interconnected world.

Computing Sciences

G-66: A Hierarchical Multi-Agent System for Predicting Equity Volatility Using a Mixture of Experts and LLMs
Author: Arora, Shivam
Advisor: Dr. Venkat Margapuri

Predicting stock market volatility is a significant challenge due to the non-stationary nature of financial time series, market efficiency, and noisy, unstructured data from news and social media. Furthermore, monolithic NLP models often fail to adapt to the distinct linguistic 'dialects' spoken across different market sectors. This research introduces a novel, hierarchical multi-agent system that combines a "Mixture of Experts" (MoE) baseline with a "Senior Analyst" Large Language Model (LLM) for synthesis. Our MoE architecture trains specialized "Junior Analyst" models (TF-IDF + Ridge Regression) on sector-specific news "dialects" (e.g., Technology, Finance), creating sharp, context-aware quantitative signals. These specialized scores, along with signals from four other agents representing social media sentiment, corporate fundamentals, market events, and technical indicators, are then fed to a "Senior Analyst" LLM (Gemini 2.5 Flash). The LLM performs a constrained validation task, using its deep reasoning to confirm or override the data-driven inputs, which increases consistency and reduces hallucination. Preliminary validation has been highly successful. In a rigorous out-of-sample stress test on NVIDIA (NVDA), our 5-factor model demonstrated genuine predictive power, explaining 21.9% of the variance in next-day volatility ($R^2 = 0.2192$) and an in-sample test demonstrated 37% of the variance in next-day volatility ($R^2 = 0.37$) thus significantly outperforming naive baseline models. We are currently scaling this validated methodology across a diverse portfolio of 50 equities to confirm its generalizability across different stocks. This research provides a robust new AI framework for volatility prediction with potential applications in quantitative risk management and algorithmic trading.

G-67: Developing an Interactive Augmented Reality Sandbox
Authors: Gallagher, Sean; Sweeney, Lily
Advisor: Dr. Frank Klassner

The Augmented Reality (AR) Sandbox is an interactive educational tool that allows users to model topographic landscapes by physically shaping real sand. The Sandbox's virtual elements teach geographic, geologic, and hydrologic concepts such as how to read a topography map, the meaning of contour lines, watershed dynamics, catchment areas, and more. In 2022, Villanova obtained a Sandbox along with a list of tasks for further development of the software. This research aimed to improve and expand the Sandbox's functionality through the analysis, testing, and modification of the Sandbox C++ source code. Specific development tasks included: creating/modifying Graphical User Interface

elements, tracing the source of texture data, isolating methods, and developing programs. The research methodology began by utilizing empirical analysis of code before transitioning to utilizing a GDB debugger. The Sandbox program's interconnecting parts and dependencies caused challenges through the research. By the end of research, all development tasks assigned were successfully implemented with the exception of the texture data tracking. While a concrete conclusion of the texture data location hasn't been reached, progress has been made towards identifying the process where texture data is implemented. This research resulted in the development of valuable skills concerning debugging programs, using C++, and the Linux interface. The project is a foundation for further development of the Sandbox.

G-68: Dissimilarity-Guided Multimodal Framework for Plant Species Classification: A Case Study on Solidago

Authors: Kazanjian, Garik; Loyson, Abigail; Kosaraju, Naren; Margapuri, Venkat
Advisor: Dr. Venkat Margapuri

Classification of the Solidago plant species, commonly known as goldenrod, presents challenges as field image quality lacks variability. Morphological similarities in Solidago species adds a further layer of complexity as standard image classification techniques fail to differentiate between different species. The computational cost behind classifying species is time-consuming and costly, as it requires specialized training on tens of thousands of data points. Different multi modal frameworks to address the high cost and differentiating between features have been suggested in overcoming these issues. Despite this, different objects in the images have interfered with the classification techniques. This approach includes image segmentation to isolate the plant structures, allowing the background interference to be minimized before classification. Additionally, inter species similarity was quantified using the mean feature vector, which increased the models' discriminative nature. Predictions from the species were included with textual descriptions of each species using a BERT-based classifier model. Between the image and text models, an ensemble approach weighs the outputs by confidence scores. The proposed methodology improves Solidago identification that pairs species for binary discrimination and combines multi modal predictions to improve classification outcomes.

G-69: NavAI: A Generalizable LLM Framework for Navigation Tasks in Virtual Reality Environments

Author: DiGiovanni, Matthew
Advisor: Dr. Xue Qin

Navigation is one of the fundamental tasks for automated exploration in Virtual Reality (VR). Existing technologies primarily focus on path optimization in 360-degree image datasets and 3D simulators, which cannot be directly applied to immersive VR environments. To address this gap, we present NavAI, a generalizable large language model (LLM)-based navigation framework that supports both basic actions and complex goal-directed tasks across diverse VR applications. We evaluate NavAI in three distinct VR environments through goal-oriented and exploratory tasks. Results show that it achieves high accuracy, with an 89% success rate in goal-oriented tasks. Our analysis also highlights current limitations of relying entirely on LLMs, particularly in scenarios that require dynamic goal assessment. Finally, we discuss the limitations observed during the experiments and offer insights for future research directions.

G-70: Predicting the Spread of *Lycorma Delicatula* Using Machine Learning and User Observations
Author: Grosh, Alexander
Advisor: Dr. Mauricio Gruppi

The invasive spotted lanternfly (*Lycorma delicatula*) is a planthopper insect native to eastern Asia - after first appearing in Pennsylvania in 2014, it has since rapidly spread across the northeastern United States. It spreads especially fast due to its tendency to lay eggs onto vehicles, which can travel vast distances before the eggs hatch. It feeds on a large variety of produce and it was estimated at the end of 2019 that the Spotted Lanternfly was costing the Pennsylvanian economy more than 500 million USD annually. This study explores a method of predicting their spread through machine learning methods - if the spread can be accurately predicted, farmers and local governments can put up quarantines and other protections ahead of time. Using data from iNaturalist (a program where users can submit pictures and locations of animal/plant sightings), a machine learning model was coded in Python using 30 feature-engineered variables. The model looked not only at the spread over time of the submissions but also traffic data, the spread of preferred food sources, and various environmental data maps. Preliminary analysis on the model already shows that presence of its preferred tree, the tree of heaven (*Ailanthus altissima*), seems to be very important in determining whether the spotted lanternfly will spread into a certain area. This program can be used to predict the extent of the spotted lanternfly ahead of time and give early warning signs to help prevent its spread.

H-71: Synthetic Perspectives: A New Metric Framework for LiDAR Odometry Evaluation
Authors: Bui, Hieu; Chodosh, Nathaniel
Advisor: Dr. Nathaniel Chodosh

Economics

H-72: Understanding Vote Switching in the UNGA
Authors: Heraty, Kathleen; Kilby, Christopher
Advisor: Dr. Christopher Kilby

This project examines why United Nations General Assembly (UNGA) member states occasionally amend their recorded votes after roll-call outcomes are finalized. Since 1954, delegations have been allowed to inform the Secretariat that they "intended" to vote differently, even though such corrections do not alter official results. Using over one million individual votes across 7,137 resolutions from 1960 through September 2024, this study investigates whether these post-vote amendments reflect procedural mistakes or strategic behavior. Our statistical analysis draws on a new database of UN General Assembly votes and incorporates country-level measures of capacity, democracy, and geopolitical alignment. The results show that vote switching is non-random and often shaped by great-power politics and institutional capacity. States are less likely to amend votes on issues designated "important" by the United States and less likely to change positions during major-power conflicts, suggesting heightened caution when geopolitical stakes are high. Conversely, vote changes are more frequent following strategic absences, contradicting the prevailing "strategic ambiguity" theory that countries avoid revealing preferences. High-capacity and more democratic states are most likely to correct missed votes, while poorer and low-capacity countries are more prone to absences in the first place. By linking amended votes to patterns of absenteeism, bloc alignment, and great-power rivalry, this research uncovers how even non-binding procedural choices in the UNGA can signal shifting alliances and reveal the subtle pressures shaping state behavior in global institutions.

Education and Counseling

H-73: Book bans and the Science of Reading: Analyzing literacy education coverage on cable news (2022-2023)
Authors: Skrlac Lo, Rachel; Ksiazek, Thomas; Garcia, Dusy; James, Majo; Girault, Gabrielle
Advisor: Dr. Rachel Skrlac Lo

This interdisciplinary study analyzes news coverage of literacy education given the heightened recent political emphasis on legislation aimed towards public schools. This paper expands on research which has already established the United States' long history of book bans and political interference in education. We analyzed the discourses and coverage of this topic by three major cable news networks - FOXNews, CNN, and MSNBC - from 2022 to 2023. Our quantitative analysis included the use of transcripts and video analysis to identify language patterns such as bias, tone, authenticity, and more. We implemented qualitative analysis through critical content analysis, through which we further analyzed the mannerisms of the actors and visual elements employed by the cable network such as footage and infographics. Investigating language patterns and conducting multimodal analysis provided us with a comprehensive cultural understanding of the news coverage of literary education in the United States. Indeed, this project provides insight into how cable news works to inform and reflect public sentiments about literary education and, in turn, how these attitudes shape political behavior and educational norms and outcomes.

H-74: Spiraling Student Understanding and Agency: Supporting Teacher Instructional Design for SSI
Author: Perez, Kristina
Advisor: Dr. Lisa Marco-Bujosa

Reframing how K-12 educators teach science and math to focus on local issues has engaged students, especially those from marginalized backgrounds. This poster discusses a 2-year Professional Development (PD) program for teachers designed to make science and math lessons more relevant and equitable. We employ two primary theories to provide a framework for creating lessons that address community issues: socioscientific issues (SSI) and sociotransformative constructivism (sTc). Specifically, we focus on how and why teachers change their use of instructional strategies utilized in the instructional unit they designed, implemented, and revised across the two years of the PD. Findings in our study indicate that by the second year of the program, teachers had reframed their STEM instruction to focus on engaging students in discourse practices and moral engagement as they facilitated students' understanding of, and work toward resolving, local community issues. They recognized that the most meaningful learning occurred when the purpose was to engage students in discourse and to address the social justice elements of the SSI-sTc framework, prompting them to modify their instructional approaches to support these areas better. Overall, teachers made changes in their use of instructional strategies that better met students' learning needs and encouraged them to take charge by spiraling the SSI, spiraling evidence integration, spiraling criticality, and spiraling taking a position. Implications include the importance of providing sustained PD experiences for SSI embedded within their authentic teaching context and utilizing strategies, such as Take a Stand and Question Walls, to engage students in meaningful discussion that attends to the complexity of SSI.

Geography and the Environment

H-75: Analyzing the Exotic Reptile and Amphibian Trade in the Mid-Atlantic United States
Authors: Nawn, Jeanette; Diaz-Santana Gaytan, Federico; Buettner, Kaja; Almeida, Ryan
Advisor: Dr. Ryan Almeida

The global trade in wildlife is a multi-billion-dollar industry that encompasses thousands of species and millions of individual organisms Among traded organisms, reptiles and amphibians, which are primarily traded live as exotic pets, are significantly threatened by the scale of the trade and lack of regulation in this trade network, which can result in overexploitation, the spread of invasive species, and the spread of disease. As the exotic reptile and amphibian trade has grown in scale, animals are increasingly being sold at trade shows, which are semi-annual gatherings of sellers, consumers, and enthusiasts. Despite their increase in prevalence, little work has been done to characterize the role these trade shows play in reptile and amphibian trade networks. To address this knowledge gap, in June through July 2025, we surveyed six reptile and amphibian trade shows and 21 pet stores across the mid-Atlantic region. At each site, we conducted visual surveys of species diversity, abundance, and selling price for all animals listed for sale. We then compared species diversity, selling prices, and conservation risks of listed species between trade shows and pet stores. We found that there was greater species diversity at trade shows as opposed to pet stores, with trade shows having 368 species compared to pet stores with 80 species. Overall, the average selling price per individual animal at trade shows was about 1.5 times higher than at pet stores, with trade shows having an average price of $275.48 and pet stores having an average price of $178.62; these high prices at trade shows were primarily driven by rare species and animals with unique morphological traits. These findings suggest that trade shows play a major role in the reptile and amphibian trade, contributing a high diversity of species to trade networks and providing consumers opportunities to buy premium species.

H-76: Climate Change, Water Insecurity, and Vulnerability in the Middle East: A Spatial Analysis of Environmental and Political Risk

Author: Booth, Alyson
Advisor: Dr. Frank Galgano

Climate change intensifies existing political, social, and economic vulnerabilities, with critical implications for environmental security in the Middle East. Rising temperatures and declining precipitation intersect with areas already marked by instability and violence, including Syria, Lebanon, the West Bank, and Gaza. This study employs a spatial and temporal analysis of long–term (i.e., 120 year) temperature and precipitation data from 29 stations in a GIS to quantify climate change. Climate and water resource data are combined with critical social, economic, and political variables in a composite indicator to evaluate compounding vulnerabilities from the adverse effects of climate change, water shortages, and socio-political factors. The results of the climate analysis reveal severe precipitation declines but most notably in Syria and Lebanon along with the region's largest temperature increases. These climatic shifts exacerbate pressures on already scarce renewable water resources, heightening risks to insecurity and violent conflict in what is already a highly unstable area of the Middle East. The index suggests elevated risk of insecurity across the region, but less so among the oil-rich states due to economic and robust health care systems. These findings underscore how climate-driven environmental change and particularly water insecurity magnifies preexisting fragility and threatens the security landscape of the Middle East.

H-77: Evaluation of Air Quality Monitors Measuring Particulate Matter

Authors: Hauenstein, Nathaniel; Sylvester, Charles; Shakya, Kabindra
Advisor: Dr. Kabindra Shakya

Particulate matter (PM) is a major air pollution concern, associated with adverse health effects. Monitoring of PM is essential for safeguarding public health and ensuring compliance with national air quality guidelines. Low-cost sensors (LCS) have improved the wide-scale capability to monitor PM. However, evaluating the accuracy of LCS is essential to ensuring data reliability. This study evaluates the accuracy of LCS by comparing them (and more expensive PM monitors) to the more accurate gravimetric reference method. Accuracy against the gravimetric method was assessed using the coefficient of determination (R^2), regression slope, root mean square error, and mean bias error. Sensor price often was an indicator of accuracy, with the most expensive sensor (the Grimm 1500) having the highest R^2 values for $PM_{2.5}$ and PM_{10} (0.89 and 0.95 respectively), but this was not true for all sensors. The DustTrak DRX 8533 was the second most expensive sensor in this study, yet had a lower R^2 value for both PM types than the PurpleAir PA-II Flex Monitor, which was the second least expensive sensor in this study. The other LCS in this study did not perform as well as the PurpleAir, compared to the more expensive sensor options. The results of this study demonstrate that while a more expensive PM air monitor will often perform better than a less expensive one, this is not always the case, highlighting the importance of thoroughly evaluating a PM monitor in order to determine if its data output is worth its price.

H-78: How Does Age and Geography Impact the Ingestion of Microplastics by Philadelphia's Grey Squirrels and Canada Geese?

Author: Rogers, Richard
Advisor: Dr. Lisa Rodrigues

Microplastics (MPs, < 5 mm) are ubiquitousness in the environment and bioaccumulate in organisms when unintentionally ingested or mistaken for food. To assess the pervasiveness of MPs in Philadelphia's wildlife, fecal samples were collected from grey squirrels (Sciurus carolinensis) and Canada geese (Branta canadensis) that were brought to the Wildlife Clinic at The Schuylkill Center for Environmental Education. The date and location where the individual was found and its approximate age were recorded with each sample. Fecal samples from sixteen squirrels and thirteen geese were collected by clinic staff. In the laboratory, samples were examined for MPs by sieving, density separation, and spectroscopy. We found an average of 27 MPs per squirrel and 117 MPs per goose, with average concentrations of 667 ± 648 and 603 ± 309 MPs per gram of feces, respectively. No correlations were found between MPs and age or location, suggesting an even distribution of MPs throughout Philadelphia. The overlap in concentrations of MPs between both species suggests they are being equally exposed to MPs, and that MPs are present in most places these animals inhabit. This is concerning because these species do not have similar diets and demonstrates that MPs are likely in several levels of the regional food web. As mammals, MPs in grey squirrels may indicate MPs found in humans, children, and/or pets that play outside. As a semi-aquatic migratory species, Canada geese may act as a vector of MPs among regions.

H-79: How does nutrient and trace metal availability in streams affect metal bioaccumulation in biofilms found on plastics?

Authors: Hesler, Allie; Goldsmith, Steven; Bean, Brianna
Advisor: Dr. Steven Goldsmith

Plastic pollution is a pronounced threat to aquatic ecosystems. Plastics physically degrade during transport and become microplastics (< 5mm in diameter), which can be easily ingested by marine life. These plastics can accumulate biofilms, communities of microorganisms, on their exterior that can bioaccumulate metals from the surrounding waters. These metals can then be released into the organisms that ingest these microplastics, with substantial impacts to aquatic food webs. Despite these environmental health risks, few studies have investigated the factors that control biofilm growth (nutrient availability) and their metal bioaccumulation potential (dissolved trace metals in streamwater). This research investigates the relationship between nutrient and trace metal availability in freshwater streams and the accumulation of metals in biofilms on plastics using incubation experiments conducted over 14 and 28 days. Water samples were collected from nine local streams in Pennsylvania exhibiting a range of nutrients and metal concentrations. Plastic incubations were performed by placing replicates of known plastic materials, polyethylene (PE) sheet and polyethylene terephthalate (PET) plastic water bottles, in stream water under artificial light for a total of 14 and 26 days. The plastic samples were then analyzed for their exchangeable trace metal concentrations using an acetic acid extraction. Study results highlight the risk of metal bioaccumulation in aquatic ecosystems resulting from improper waste disposal.

H-80: Long-Term Changes in Salinity and Nutrient Dynamics at the Plum Island Sound Estuary

Author: Bennett, Casey
Advisor: Dr. Nat Weston

Estuaries are dynamic zones where freshwater and seawater mix, forming strong gradients that regulate nutrient cycling, primary productivity, and ecosystem function. This study examines long-term changes in salinity, conductivity, and nutrient concentrations (NH_4^+, NO_3^-, and PO_4^{3-}) across the Parker River and Plum Island Sound Estuary (MA) using ~30 years of data from the Plum Island Ecosystems Long Term Ecological Research (PIE-LTER) program. Salinity and conductivity data collected during seasonal "nutrient ram" surveys were analyzed for temporal trends and adjusted for hydrologic drivers, such as river discharge and tide height. Linear regressions revealed significant positive trends in salinity and conductivity across nearly all stations, with the largest increases occurring upstream. These results indicate a gradual, system-wide intrusion of saltwater likely driven by sea level rise, while short-term shifts were largely explained by discharge. Nutrient analyses, based on colorimetric measurements, revealed spatially distinct patterns. Ammonium generally increased over time, nitrate mostly declined except for the mid-estuary, and phosphate rose through much of the system except at the most saline sites. Relationships among nutrients showed U-shaped spatial patterns for NH_4^+~NO_3^- and NO_3^-~PO_4^{3-}, with strongest correlations at the head of tide and ocean. Nutrient and salinity relationships were consistent across raw and adjusted data, indicating that nutrient distribution is more closely tied to spatial position than to instantaneous salinity.

I-81: Meeting Demand with Morphs: Investigating Biodiversity Implications of the Exotic Reptile Trade

Authors: Buettner, Kaja; Diaz-Santana Gaytan, Frederico
Advisor: Dr. Ryan Almeida

Consumer demand for rare and morphologically unique animals is pervasive in the wildlife trade, and can provide financial incentive to overexploit wild populations. In the exotic reptile and amphibian trade, the desire to own aesthetically distinct animals has resulted in the selective breeding of animals with unique morphological traits ("morphs"); as a result, a substantial amount of consumer demand for rarity in the exotic reptile trade is met by captive-bred, rather than wild-caught, individuals. Despite its potential importance as a model for sustainable wildlife trade, however, the relationship between morphological trait rarity and market value in the exotic reptile trade remains largely under-analyzed. To address this knowledge gap, in June 2025, we surveyed four exotic pet expos and recorded species diversity, listed morph, and selling price of all advertised animals from four of the most commonly traded exotic reptile species: ball pythons (Python regius), crested geckos (Correlophus ciliatus), corn snakes (Pantherophis guttatus), and leopard geckos (Eublepharis macularius). We compared selling price to the proportion of trait combinations, the number of traits per individual, and the frequency of individual traits. We observed that animals possessing rarer traits and a higher number of unique traits were associated with higher selling prices, while the prevalence of unique trait combinations was a comparatively weaker predictor of selling price. Our findings highlight the potential for meeting consumer demand for rarity in the exotic pet trade through captive morph breeding rather than wild extraction.

I-82: Public Perceptions of Air Pollution in Nepal

Authors: Hagan, Grace; Mejia Perez, Liseth
Advisor: Dr. Kabindra Shakya

Anthropogenic activity has profoundly altered global air quality, contributing to millions of premature deaths annually and exacerbating respiratory, cardiovascular, and other chronic diseases. Regulatory interventions in developed countries have led to significant local improvements in air quality; however, numerous low- and middle-income countries continue to face worsening air pollution. Nepal, and particularly the Kathmandu Valley, faces exceptionally high levels of ambient air pollution, with fine particulate matter (PM 2.5) concentrations far higher than the World Health Organization's guidelines. Although empirical evidence on air quality and its health impacts in Nepal is growing, comparatively little research examines public perception, awareness, and lived experiences of air pollution.

I-83: Residents' attitudes, perceptions, and knowledge of deicing salt use and its impacts on the environment: Guidance for future environmental education efforts

Authors: Horst, Taylor; Goldsmith, Steven; Weisberg, Deena; Magon, Rayan; Toscano, Joseph; Graham, Livia
Advisor: Dr. Steven Goldsmith

The cumulative use of deicing agents (e.g., road salts, deicing salts, etc.) has had a profound negative impact on the health of aquatic ecosystems and drinking water resources. While recent watershed-scale studies suggest that road salt from non-municipal stakeholders (i.e., private contractors, individual homeowners) can comprise over 50% of the cumulative salt loading, individual homeowner application rates are poorly understood. Additionally, little is known about the behavioral drivers behind individual homeowner application or about residents' knowledge and/or perceptions of the environmental impacts of road salt. To address these knowledge gaps, we created a public survey for non-municipal stakeholders to document road salt application practices and to better understand behavioral drivers, such as legal and peer pressures. The survey was distributed to residents in the greater Philadelphia region in winter 2024/2025 via an intensive social media campaign. The survey received a total of 300+ responses from residents in 10+ watersheds in southeastern Pennsylvania. A total of 81% of respondents either "strongly agree" or "agree" with the statement that they are aware of the environmental harm caused by road salts. However, several responses to questions highlighted issues of overuse and misuse. For example, only 7% of respondents are aware of the local municipal code regarding snow removal and the application of deicing salt for individual households. Additionally, 14% of residents reported applying de-icing salt either before or during storms, times when deicing salt application would be the least effective. From a remedial perspective, 78% of respondents indicated that they want to learn about guidance for household application rates and ways to reduce their road salt burden on the environment. However, only 40% of respondents indicated that they were willing to attend an in-person workshop, suggesting the need for user-friendly online resources. Collectively, the study results provide a starting point for future public-facing environmental education endeavors aimed at reducing road salt burden to the environment.

I-84: Sands of Plastic: Is Expanding Development for Tourism Polluting New York's Lakes?

Author: Herringshaw, Morgan
Advisor: Dr. Lisa Rodrigues

The rise of tourism and visitors seeking natural sites for vacations generates litter and harms historically undisturbed environments. Most litter is typically plastic waste that persists in the environment as it degrades into smaller pieces or microplastics. Despite these threats, the

concentration of plastics within freshwater environments, including in the Adirondacks, is not well known. To assess the impact of tourism on plastic pollution, I collected litter and sediment samples at eight beaches along four undeveloped and four developed lakes in the Adirondacks in May, June, and August. Macroplastics (> 5 mm) and microplastics (< 5 mm) were analyzed for their change in abundance and type during the summer. These data were compared over the summer and to population density in upstate New York to assess patterns associated with development. Macroplastic and microplastic abundance at all eight lakes increased by 56% and 96%, respectively, over the summer. Microplastics were primarily clear and black fibers, with an increase in clear fibers over the summer. Unfortunately, undeveloped lakes had high litter loads, sometimes higher than the developed lakes. Two undeveloped lakes, Lake Sacandaga and Lake Eaton, had higher plastic amounts compared to their neighboring developed lakes, making them ideal locations for additional waste management strategies. This shows that undeveloped lakes are also impacted by human activity in the surrounding area and that plastic litter spreads to remote locations. Therefore, undeveloped lakes need more waste management and regulations for litter that developed lakes have.

I-85: Strong long-term relationship between chloride and dissolved organic carbon export in road salt-affected exurban and suburban watersheds

Authors: Bean, Brianna; Hassebrock, Jenna; Goldsmith, Steven; Seng, Krista
Advisor: Dr. Steven Goldsmith

Road salts and salt-impacted runoff are often transported to the side of the road, where sodium (Na+) and chloride (Cl-) can infiltrate the soil, leach into groundwater, and slowly be released into streams over time, leading to a long-term increase in waterways. However, the deposition of Na+ in roadside soils can also alter the soil's composition, causing the displacement of calcium and magnesium, which leads to a decrease in soil aggregate stability and the release of organic matter. While lab and limited field studies suggest an influx of road salt to roadside soils can lead to pulses of dissolved organic carbon (DOC) delivery from soils and groundwater to streams, few to no studies have examined the long-term relationship of these parameters in road salt-affected watersheds. To address these knowledge gaps, we utilize a 20-year dataset (1998-2020) of monthly streamwater quality data, combined with daily streamflow data, for six exurban and suburban watersheds in southeastern Pennsylvania to assess the co-relationship between flow-normalized Cl- and DOC concentrations. The relationship between long-term land management practices (e.g., LULC change, road salt/brine inputs, etc.) and DOC concentrations and loads is also explored. Similar patterns were observed in the study watersheds, with flow-normalized Cl- and DOC initially increasing, reaching an inflection point in DOC, and then subsequently decreasing. Over the last 10 years of the study period, a strong, statistically significant negative relationship ($r^2 > 0.89$; $p < 0.01$) was observed between flow-normalized Cl- and DOC concentrations, suggesting a decrease in organic matter over time in upstream roadside soils. Furthermore, the subsequent decrease in flow-normalized DOC concentrations was not statistically associated with any LULC changes during the study period. These findings have important implications for watershed management. For example, road salt-driven increases in streamwater DOC concentrations can increase the potential for disinfection byproducts during the water treatment process. Conversely, a subsequent decrease in DOC concentrations can negatively impact microbial processes and freshwater food webs.

Mathematics and Statistics

I-86: Arithmetical Structures on Cycles with a Multi-Edge
Authors: Palma, Peter; Dogbatse, Nesty
Advisor: Dr. Alexander Diaz-Lopez

An arithmetical structure on a graph is an integer labeling on the vertices of the graph such that the label at each vertex divides the sum of the labels of its neighbors and the gcd of the labels is 1. Dino Lorenzini originally defined them in order to answer some questions in algebraic geometry, but more recently, they have been studied on their own, particularly through a combinatorial lens. In this talk, we discuss enumerative results related to arithmetical structures on cycles with a multiedge.

Mechanical Engineering

I-87: 3D printing with acoustic-assisted assembly of nanomaterials for tunable strain sensors
Authors: Yuan, Deana; Feddish, Kathryn; Li, Yun
Advisor: Dr. Bo Li

This study presents a novel approach for developing tunable strain sensors by combining techniques of 3D printing for structural designs and nanomaterial assembly to form functional layer coatings. Utilizing Direct Ink Writing (DIW) technology, we printed sensor substrates composed of a composite ink of polydimethylsiloxane (PDMS) and silica nanoparticles. The DIW process allowed us to design and fabricate a sensor with alternating wide and narrow strips, creating a non-uniform strain distribution of the sensor substrate that possessed different mechanical properties along the stretching direction. Nanometer-thick graphene flakes were then directly assembled onto the substrate surface through an acoustic-assisted dip-coating method. By tailoring the geometric and mechanical design, the resultant strain sensors were able to achieve different sensitivities: the graphene network on the narrow strips experienced large deformation, leading to significantly increased resistance. By fixing the width of the wide strips and varying the width ratio of the wide strips over the narrow strips (r), the gauge factor was tunable from 8.53 (r = 1:1) to 33.15 (r = 16:1). Furthermore, by printing the narrow strips with softer PDMS further enhanced the sensor's sensitivity. This research pioneers the integration of 3D printing and nanomaterial assembly in strain sensor fabrication. More importantly, however, it establishes the generic framework for designing flexible electronics and other polymer-nanomaterial hybrid systems.

I-88: Autonomous Explosive Ordnance Disposal Robots for Low-Income Countries
Authors: Bersalona, Marielle; Clayton, Garrett
Advisor: Dr. Garrett Clayton

In many low-income countries, the presence of unexploded ordnance (UXO) continues to pose a severe threat to civilian safety and economic development. This research focuses on the design and implementation of Autonomous Explosive Ordnance Disposal (EOD) Robots tailored for regions with limited resources and infrastructure. The project investigates cost-effective mechanical design, sensor integration, and autonomous navigation strategies that prioritize safety, affordability, and

accessibility. By leveraging open-source software and low-cost hardware components, the proposed system aims to reduce the dependency on human operators while maintaining precision in hazardous environments. The research also explores terrain adaptability, power efficiency, and modularity to ensure the robot's effectiveness in rural and post-conflict areas. Through simulation and prototype testing, the project seeks to demonstrate that advanced robotic technologies can be scaled and optimized for humanitarian applications. Ultimately, this work contributes to the broader goal of using engineering to create life-saving technologies that can be deployed globally.

I-89: Building a Computational Model of Biomechanical Knee Loading Using a System of Biometric Sensors

Authors: Wollan, Catherine; Al Qawasmi, Ahmad; Clayton, Garrett; Nataraj, C.
Advisors: Dr. Garrett Clayton, Dr. C. Nataraj

Anterior cruciate ligament (ACL) injuries are prevalent in athletes during high-acceleration movement. This particularly affects female athletes due to a combination of biomechanical, anatomical, and external factors including hormone fluctuations, quadricep dominance, and differences in neuromuscular activation patterns. This study aims to develop a computational model to better understand the biomechanics of knee loading. The focus is on analyzing biometric data and neuromuscular activation patterns during dynamic movements using a sensory system comprised of electromyography (EMG) sensors and pressure insoles.

I-90: Cellular Uptake and Nuclear Localization of Biomimetic Proteoglycans

Authors: Rukis, Efthimia; Bergstrom, Annika; Li, Anita; Marcolongo, Michele
Advisor: Dr. Michele Marcolongo

Osteoarthritis (OA) is a progressive joint disease marked by articular cartilage breakdown and proteoglycan loss. In early OA, mechanical, inflammatory, and oxidative stress disrupt chondroyte homeoastsis, leading to a cascade of organelle dysfunction and elevated levels of enzymes that weaken the pericellular matrix (PCM). Our laboratory molecularly engineers and modulates the biochemical properties of the PCM and territorial extracellular matrix (ECM) using our synthesized biomaterials, biomimetic proteoglycans (BPGs). BPGs are composed of natural chondroitin sulfate bristles (CS) and a poly(acrylic acid) (PAA) backbone that mimics the nano-architecture and water uptake of native proteoglycans. Our primary BPG, BPG10 (~250 kDa), contains ~7-8 CS bristles attached onto a 10 kDa PAA core, and has been shown to passively diffuse through cartilage zones in vivo and ex vivo, with preferential localization within the PCM and territorial-ECM. Previous non-viable tissue studies also suggest potential cellular uptake of BPGs. Thus, this study sought to determine if BPGs can be cellularly uptaken and what organelle BPGs localize within. Confocal microscopy and imaging flow cytometry were utilized to determine uptake and localization of BPG10 in chondrocytes. Confocal imaging confirmed cellular uptake and localization within the nucleus following 24 h. Imaging flow cytometry showed significant overlap between percent BPG10 and the nucleus at all dosages after 48 and 72 h compared to untreated controls. This study demonstrates BPGs' ability to enter and localize within the nuclei of chondrocytes for at least 72 h.

J-91: Challenges of Deep Brain Stimulation surgery for patients with Parkinson's disease

Authors: Anders, Ethan; Marchetta, Sophia

Advisors: Dr. Qianhong Wu; Siyu Chen

Parkinson's disease currently affects approximately one million people in the United States. Due to the widespread effect, it is estimated that the economic burden of Parkinson's disease is $52 billion annually (1). This disease causes patients to lose control over their movement and shake uncontrollably. However, there is currently a surgery in place to help return control to the people affected by this disease called deep-brain stimulation surgery (DBS). This surgery involves inserting a probe into the patient's brain to reach a specific target. Then, the probe is removed, leaving a channel in which an electrode wire can be inserted. This wire contains a metal rod that can be removed, allowing the wire to remain within the brain and deliver electric pulses that alleviate tremors. A complication with this surgery is that when the probe and wire are inserted into the brain, their path can deviate from the target location. The electrode wire needs to be directly on the target; deviation of more than 0.5 mm can impact the procedure's success. This inaccuracy can be detrimental to a patient's health and requires another round of operation. In our research, we discuss the causes of the deformation of the path for the probe and wire. One of the main causes of the deviation is the angle of the interface between the heterogeneous materials in the brain that the probe has to pierce to reach the target area. Through experimentation, we have been able to find what interface angles create the most deviation and put the most force on the probe, causing it to move in different directions. With this information, surgeons will hopefully be able to perfect their operations and help more and more patients.

J-92: Design and Development of a Bio-Inspired Starfish Robot for Integrated STEM Learning

Authors: Hernandez, Jose; Labella, Jake
Advisor: Dr. Deeksha Seth

Multiple national publications have emphasized the importance of integrated STEM learning in preparing young people for success in STEM fields. However, because individual subject areas like physics, biology, and mathematics are often taught separately, students struggle to see how these fields relate to one another. Educational robots have gained attention for their ability to make STEM learning more interactive and hands-on. Despite their popularity, there is still limited research on robots that effectively help students integrate principles from science, engineering, and mathematics, particularly in natural and applied sciences. To address this, we focused on developing a bio-inspired robot modeled after a starfish. Starfish are fascinating creatures whose tube feet demonstrate unique patterns of motion, coordination, and adhesion. Replicating these behaviors in a robot provides an opportunity to bridge biology and science with mechanical engineering in an interactive way. Our main goal was to design a robot that accurately mimics the kinematics of a starfish's tube feet while allowing users to tune parameters and observe how changes affect movement. We developed a robotic tube feet prototype designed to mimic the expansion and retraction of starfish tube feet. We also developed code to control motors that coordinate tube feet extension and retraction, mimicking starfish movement. Starfish walk through a four-step cycle: some feet anchor for stability, others extend forward, the anchored feet retract to pull the body, and then they release, allowing the cycle to repeat. This sequence produces coordinated, wave-like motion. This project demonstrates that a bio-inspired robotic starfish can be developed to support integrated STEM learning, making complex concepts in biology, engineering, and mathematics more accessible, interactive, and engaging for students.

J-93: Water-based Assembly of Nanomaterials on Target Substrates
Authors: Ding, Yuanlong; Williams, Trey
Advisor: Dr. Bo Li

This project focuses on observing the dip coating process in situ to examine how various factors, such as flow rate and sonication, influence particle assembly on a controlled substrate. The substrate used is a regular glass slide with a uniform layer of Polydimethylsiloxane (PDMS) on the surface. The nanomaterial involved is an aqueous Molybdenum Disulfide (MoS_2) solution. This MoS_2 solution is vacuum-pumped through a small chamber that is sealed with the PDMS-coated glass slide, allowing for the process to be viewed in real time using an Olympus microscope at 10× objective lens magnification. The recorded videos are then analyzed by an AI model to determine how different conditions influence the coating behavior. Specifically, the rate of particle deposition is observed to determine how fast coverage can be completed. Because of the variability in the data, the experiment is repeated numerous times to make sure the results are consistent and reliable.

J-94: Fabrication and Characterization of 2D Material–Polymer Hybrid Structures for Soft Electronic Applications
Authors: Marinko, Christopher; Sun, Mingyuan; Xiang, Yi
Advisor: Dr. Bo Li

The integration of two-dimensional (2D) materials with soft polymers provides a versatile platform for next-generation applications in robotics and artificial intelligence that require advanced electronic and tactile responses. This research explores the fabrication and characterization of 2D material–polymer hybrid structures designed to enable mechanical and electrical responses. Samples of monolayer graphene and molybdenum diselenide were synthesized using chemical vapor deposition and employed as templates for controlled polymer growth. This method provides precise control over the formation of the polymer layer, enabling the development of hybrid structures with tunable physical properties. One application of this type of system was evaluated through the fabrication of capacitance-based pressure sensors composed of graphene electrodes and a polyethylene dielectric layer. The resulting devices exhibited sensitivity to applied pressure and demonstrated scalability through the construction of sensor arrays capable of mapping distributed stimuli. These findings establish 2D material-polymer hybrids as a promising and versatile building block for next-generation soft electronics, particularly for applications in robotic tactile sensing and wearable devices.

J-95: Low-Cost Replication of a Bio-Inspired Goldfish Robot for Educational Use
Authors: Doodnath, Isabel; Seth, Deeksha
Advisor: Dr. Deeksha Seth

Educational robots are an excellent method for promoting interactive learning among K-12 students. However, most existing robots focus on individual subjects such as engineering, programming or design. As a result, there is a lack of robots designed for core natural science classes, such as Biology. To bridge this gap in STEM education, IDeAL Lab, led by Dr. Deeksha Seth, develops bio-inspired educational robots to teach integrated natural and applied science topics. One example is the Goldfish robot, which teaches respiration (biology) and functions (mathematics) in an integrated manner. The original Goldfish robot was expensive and complex to replicate, which limited the number of models

produced. With fewer robots available, not all students were able to engage in close, hands-on interaction, reducing the depth of participation in larger groups. To make the Goldfish robot more accessible for educational use, my research focused on creating a version that was easy and affordable to replicate, allowing more students to engage directly with the robots. To enable replication, I first developed detailed CAD models of each component and the full assembly. I then explored alternative materials and manufacturing methods to reduce cost and simplify the fabrication process. Finally, I built and tested the replicated robot to evaluate its performance and identify further improvements for large-scale classroom or museum use. The Goldfish's internal skeletal system, originally made from machined aluminum, was replaced by Delrin. The aluminum components had internal threading for assembly, which was modified to use precise screw inserts in the Delrin. Mechanical components, such as springs and DC motors were used to simulate moving gills and mouth. Other components, such as the 3D-printed exterior body, were adjusted to accommodate electronic components and improve usability amongst students. While the original Goldfish cost approximately $2,800 to build, the new version can be produced at around $600 each and at a much faster rate. With more affordable replicas, STEM-integrated education can now be more accessible for K-12 students through the combination of engineering and natural sciences into singular models.

J-96: Prototyping an Automatic Extremum Seeking Antenna for Optical Emission Sources
Authors: DiSanto, Aedan; Schoenwetter, Neil; McGill, Stephen; Wang, Bo; Nersesov, Sergey
Advisor: Dr. Sergey Nersesov

Satellites and communications systems rely on accurately oriented antennas to maintain strong connections between a source and receiver. Many traditional antenna alignment systems rely on knowing the position of the source relative to the antenna, which is unrealistic in dynamic situations where the source location or the antenna's relative orientation is not known. To address this challenge, this project implements an extremum seeking feedback control strategy to automatically orient an antenna toward the direction of maximum signal strength using only real-time feedback data. Building on an algorithm developed by Dr. Bo Wang and Dr. Sergey Nersesov, this research applies this framework to a physical torque-controlled antenna prototype with two rotational degrees of freedom. This system uses an optical light sensor to measure signal intensity and automatically adjusts orientation via feedback control to maximize the detected signal. Motor control and data processing are handled in Python, while MATLAB is used for torque computations within a continuous feedback loop. This study focuses on establishing a foundational proof of concept system for applying extremum seeking control to antenna orientation. While the current implementation does not account for factors such as local extrema or dynamic motion, it serves to validate the feasibility of this approach in a simplified real-world setting. These results will help inform future work on refining the control strategy and extending it to more complex, dynamically varying systems.

J-97: Structural Health Monitoring in Aircraft Structures Through Ultrasonic Guided Wave Analysis
Authors: Colocho, Amos; Warpinksi, Luke
Advisor: Dr. Sridhar Santhanam

Aircraft structures experience significant fatigue during service, which is why frequent inspection and maintenance are essential to ensure safety. However, many defects, such as small cracks around bonded joints, are difficult to detect through routine visual inspection. To address this challenge,

Structural Health Monitoring (SHM) is used for more consistent and reliable defect detection. This research focuses on using ultrasonic guided waves to detect and characterize defects within aluminum lap joints. Guided waves are transmitted and received across the bonded interface, and their reflections and transmissions are analyzed to understand how damage can influence wave behavior. Signal processing techniques are used to interpret data received from the guided wave and applied to identify features associated with defects within the lap joint. Experimental data is compared with Abaqus/FEA simulations to observe patterns linked to edge reflections and interfacial damage. These comparisons can provide insight into how guided waves interact with adhesive layers, supporting their use for defect detection. Future work will include the use of machine learning models to classify defect types based on signal features. Additionally, exploring alternative bonding configurations to study how joint composition can affect detectability. Overall, this research advances non-destructive testing and develops a data-driven SHM system to aim for long-term structural reliability for aircraft structures.

J-98: Using Data Center Waste Heat for Hydrogen Production
Authors: Kane, Sam; Norman, Maria
Advisor: Dr. Aaron Wemhoff

Data centers are anticipated to consume up to 9% of global electricity by 2030 and have a corresponding large carbon and water footprint. One area of exploration is the reuse of waste heat generated by data center equipment for the generation of hydrogen. The produced hydrogen can then be stored for later use in fuel cells as backup power in case of grid power failure. This scheme replaces diesel combustion in generators for backup power, potentially significantly reducing carbon emissions since no combustion of diesel is required for electricity production. Three approaches are explored for hydrogen production using waste heat: first, through electricity production using an organic Rankine cycle, which in turn generates green hydrogen using electrolysis; second, through steam methane reforming from biogas generation using anaerobic digestion; and third, through methane pyrolysis of biogas generation using anaerobic digestion. Preliminary calculations suggest that the three approaches theoretically provide backup power for 68 hours, 1,870 hours, and 2,430 hours, respectively, which greatly surpasses anticipated outage times. Other factors, however, need to be addressed in the practical implementation of these systems.

Nursing

J-99: Artificial Intelligence Applications in Reducing Falls Among Older Adults: A Review of the Literature
Author: Wong, Lillian
Advisor: Dr. Michelle McKay

One in four older adults (≥65 years of age) fall every year which can lead to negative outcomes such as permanent disability, decreased independence, and even death. Artificial Intelligence (AI) can process large volumes of data, identify subtle changes in movement patterns, and flag fall risks earlier than conventional methods which may assist in fall prevention approaches. Despite numerous studies exploring AI applications for fall detection and prevention, no comprehensive synthesis exists to categorize and evaluate these efforts. We conducted a literature review across PubMed, CINAHL, PsycINFO, and the Cochrane Library using the following search terms: artificial intelligence,

accidental falls, fall prevention, falls or falling, and aged. A total of 65 articles were identified. The research utilizing AI focused on fall prevention, fall detection, fall risk prediction, and fall risk assessment. The types of AI found in the literature included machine learning, deep learning, natural language processing, and neural network. Understanding how AI is currently being used to reduce falls among older adults can provide valuable insights into existing strategies, highlight gaps in current research, and identify what approaches are most effective or require further development.

J-100: Comparing Neonaticide and Infanticide Across the Globe: A Scoping Review of Literature

Author: Orszulak, Callie
Advisor: Dr. Elizabeth Burgess Dowdell

Infanticide refers to the homicide committed by a mother against her infant child. In the United States there are an estimated 500 infanticide cases per year. Purpose: To examine literature that discusses maternal neonaticide (less than 1month of age) and infanticide (2months – 3years) in the United States compared to Africa, Asia, Europe, and the Middle East. A scoping review was undertaken to identify existing literature using Cumulative Index of Nursing and Allied Health Literature (CINAHL) and PubMed. These databases were searched for relevant peer reviewed English language studies, and published between 2010 to 2025. Search terms used: "maternal infanticide" AND "infanticide" AND "maternal neonaticide" AND "neonaticide" AND "cultural" AND "risk factors". Results: Of the 104 articles only 21 met inclusion criteria. Major findings: 1) Neonaticide and infanticide are rare events; 2) Neonaticide is often associated with pregnancy denial; 3) Women in foreign countries are more likely to be are young, married, socially isolated, have low socioeconomic status; and 4) High rates of mental illness (mainly depression or psychosis), suicidal ideation, and receive psychiatric treatment instead of prison. Maternal infanticide involves complex psychological, social and personal circumstances. The majority of women across the globe who committed infanticide regret the act and not seeking help from family and healthcare professionals. Nurses and providers who work with and come in contact with women during pregnancy, post partum, and beyond need to be aware of the profiles of vulnerable women and undertake screening with assessments to identify at-risk women and infants.

K-101: Exploring a Social Justice and Health Equity Course: Preparation through difficult conversations

Author: Barber, Emily
Advisor: Dr. Meredith MacKenzie-Greenle

In healthcare, it is vital to foster an inclusive environment among employees and patients. One factor that goes into nondiscriminatory foundations is one's ability, as a nurse, to recognize and respond appropriately to microaggressions. This study is a descriptive, qualitative research study focusing on rising sophomores and juniors in Villanova University's M. Louis Fitzpatrick College of Nursing who have completed Nursing 1105. The purpose was to explore, via interviews, how taking a course on social justice has impacted students' comfort levels with recognizing and responding to microaggressions, how students' attitudes regarding social justice changed over the course, and whether student nurses who completed the course on social justice feel more prepared to engage in

discussions about social justice in healthcare. Method: Fourteen interviews were conducted using voluntary response sampling, and results were examined for major themes and sub-themes. Results: three key themes arose, with identity as a primary contributor. 1) How sharing experiences looks different; 2) the quality of seminar-based learning regarding confidence level; 3) how microaggressions are perceived differently and sometimes harder to identify depending on one's identity. Conclusion: Students found significant benefits from the course's curriculum, and further research should be conducted to encourage its implementation as a core course in the curricula of other colleges of nursing.

K-102: Investigating the Role of the School Nurse in Providing Mental Health Screenings and Interventions Related to Grades and Academic Performance in Adolescents
Author: Cikota, Benjamin
Advisor: Dr. Elizabeth Burgess Dowdell

Background: Adolescent rates of depression, anxiety, and behavioral concerns continue to rise. School nurses are uniquely positioned to identify, screen, and intervene; however, their role, specific tools used, and interventions remain a literature gap. Purpose: To examine the role of school nurses in screening for mental health conditions related to academic performance and evidence-based screening tools. Methods: Referenced literature between 2000 to 2025 in CINAHL, ERIC, PubMed, and PsycInfo databases were searched using: "grades OR academic grades OR academic performance OR performance scores," and "anxiety OR mental health OR depression OR mental wellbeing OR behavioral health," alongside the previous mental health category and "school nurse OR school health nurse OR school nursing OR school health nursing." PRISMA guidelines were followed; eligible articles were assessed for quality under narrative analysis. Results: Of 1,179 articles screened, 11 met inclusion criteria. Findings indicate: (1) school-based health centers (SBHCs) improve student outcomes; (2) school nurses bridge at-risk populations with mental healthcare gap(s); (3) academic performance can inform an identification of necessary mental health screening; (4) validated screening tools and nurse-led interventions can be used with at-risk students; and (5) nurses report limited confidence and education in mental health assessment. Conclusion: School nurses are pivotal in mediating mental health treatment and academic achievement. Evidence supports the integration of standardized screening tools and nurse-led interventions to improve student mental health and educational outcomes. Acknowledgement: This study was made possible through the Davis Family Undergraduate Research Fund at the M. Louise Fitzpatrick College of Nursing, Villanova University.

K-103: The Lived Experience of Black Birthing People in Philadelphia
Authors: Idusuyi, Alyssa; Trout, Kimberly
Advisor: Dr. Kimberly Trout

Background: Maternal Mortality refers to the death of a person while they are pregnant or within 42 days of the end of their pregnancy. Black birthing people are up to three times more likely to die during childbirth or have maternal complications compared to their White and non-Black counterparts. Concerning the Philadelphia area, as of the 2024 Severe Maternal Morbidity Report, Non-Hispanic Black birthing people, who accounted for 42% of all births during this time, had the highest rate of Severe Maternal Morbidity (118 cases per 10,000 deliveries) compared to other racial and ethnic groups. Purpose: This research project aims to investigate these disparities and explore ways in which health care professionals can better support Black birthing people throughout their

pregnancy, childbirth, and postpartum care. Methods: This study analyzed articles regarding Maternal Mortality and Severe Maternal Morbidity in Philadelphia within the context of the United States. National statistics were referenced and compared in relation to the Philadelphia area. Conclusions/Implications: This research suggests that social determinants of health (i.e., neighborhood environment, access to stable housing, nutritious food, and quality health care), along with accessible perinatal care, resources during pregnancy, and maternal education, are essential to the overall well-being of those giving birth. It is imperative that health care professionals consider these factors when caring for Black birthing people. Further Research: The next phase of the research will involve a phenomenological study of qualitative interviews with Black birthing people in the Philadelphia area. This qualitative portion will help address the lived experiences of these individuals and where improvements should be made regarding maternal health for Black people.

Physics

K-104: Analysis and Sonification of Black Hole Binary GRS 1915+105 Heart Beat State
Authors: Slichta, Nathaniel; Phillipson, Rebecca
Advisor: Dr. Rebecca Phillipson

The goal of this project has been to sonify the X-ray data from the black hole binary system GRS 1915+105 in a unique and innovative way. GRS 1915+105 is a black hole X-ray binary system consisting of a black hole and a main sequence donor star. Using data taken from the Rossi X-ray Timing Explorer (RXTE), we created time series visualizations and recurrence plots (RPs) to examine the behaviour of GRS 1915+105 in the canonical heartbeat state. A RP is a visual representation of a square matrix that highlights when a dynamical system returns to a previous state. Sonification is the process of converting data into sound. The RP features clusters of dots that loosely form diagonal lines parallel to the RP's main diagonal. These parallel diagonal lines are cornerstone features of the RPs of periodic and quasi-periodic systems, like those evident in the accretion states of GRS 1915+105 and other XRBs. We utilized the Strauss python package for sonification, which is a flexible tool focused on converting various forms of data into sound. The process for sonifying RP provides us with a meaningful and unique way to probe the dynamics of the HB state of GRS 1915+105. Our method could be applied to other binary systems or alternate states in GRS 1915+105 to compare dynamical states through sound.

K-105: Further Investigations of Crystal Structure in Nb and Mo-based Double Perovskites
Authors: Dillon, Taylor; Carlo, Jeremy
Advisor: Dr. Jeremy Carlo

Materials crystallizing in the double perovskite structure have numerous applications in magnetism, fuel cells and solar panels, since they can incorporate a wide range of chemical elements. They can do so in a number of different ways, including octahedral rotations and distortions, cation and vacancy ordering, and ferroelectric displacements. Materials in this structure exhibit a wide range of properties including superconductivity, magnetoresistance and geometric magnetic frustration, owing to close relationships between their structural, electrical and magnetic properties. The samples, of the chemical formula A2BB'X6, where A = Ba and B' = Mo and Nb, were synthesized using solid state methods with B elements including samarium, lanthanum and praseodymium, and compared to previously

synthesized samples. The niobium samples were synthesized in air but the molybdenum samples required hydrogen reduction to achieve the desired 5+ oxidation state. The crystal structures were determined using x-ray diffraction followed by Rietveld refinement. The addition of Sm explored the transition between cubic and tetragonal crystal symmetries as progressively larger cations required octahedral distortion to incorporate them. The combinations of La and Pr investigated the tetragonal-monoclinic transition as further distortion occurred to incorporate even larger cations. Together, these samples paint a fuller picture of the nature of crystal structure, and its interplay with electronic and magnetic properties, in double perovskites.

K-106: Modeling the Changing Dynamics of a Black Hole Accretion Environment
Author: Spivack, Samantha
Advisor: Dr. Rebecca Phillipson

This project explores various machine learning models for predicting the accretion states of the black hole X-ray Binary (XRB) GRS 1915+105 based only on the features in the recurrence plots of its flux over time. GRS 1915+105 is a binary star system that includes a black hole accretor and a regular star donor in close orbit to each other. The accretion states of XRBs are traditionally identified using energy spectra measurements. The most common states include the low-hard state and high-soft state. After generating Recurrence Plots (RPs; 2D images representing the variability of a light curve) of all observations, we generate a logistic regression model using eight summary statistics of the RP to make a binary classification model that predicts the different accretion states and find a strong indication that the RP features are distinct in the different accretion states. We test out several regression models to predict the continuous values of four spectral parameters. We found that a random forest (RF) regression model is most accurate for predicting all spectral features. We conclude ML models can be successfully paired with RPs to predict the energy spectrum using only the light curves of GRS 1915+105.

K-107: Nanoscopic Characterization of Engineered Human Ferritin Heteropolymers Using Magnetic Force Microscopy
Author: Warren, Kourtney
Advisors: Dr. Scott Dietrich; Dr. Georgia Papaefthymiou-Davis; Yeonni Zoo

Ferritin, a naturally occurring iron storage protein, forms a nanocage structure with a superparamagnetic iron core. There are two types of subunits, H and L, that work cooperatively in iron oxidation, nucleation, and growth of the ferrihydrite core. H-rich ferritins are associated with heart and brain tissue, where fast iron trafficking occurs, while L-rich ferritins are associated with liver and lung tissue, for long-term iron storage. This study aims to explore the magnetic properties of genetically engineered human ferritin heteropolymers using Magnetic Force Microscopy (MFM) on a Park Systems Atomic Force Microscope (AFM). The L-rich ferritin is expected to have stronger and more uniform phase contrasts, while H-rich ferritin should have weaker, more fluctuating patterns. These differences in MFM phase should aid in understanding the difference in storage of iron for the L-rich and H-rich proteins. Optimized magnetite dilutions (8.6 nM) were prepared to yield well-isolated nanoparticles (~20 nm), allowing for clear surface visualization and
calibration of imaging parameters. After validating sample preparation through NCM, MFM
was employed to decouple topographic and magnetic signals, enabling nanoscale mapping of local magnetic fields. Magnetite served as a model system due to its stronger magnetic signal, providing a

reference framework for subsequent ferritin imaging. This research is supported by a Villanova Undergraduate Research Fellowship (VURF) and NASA grants.

K-108: Unveiling Disk Winds in GRS 1915+105
Authors: Granda Argianas, Lili Mei; Neilsen Joey
Advisor: Dr. Joey Neilsen

GRS 1915+105 is a stellar-mass black hole X-ray binary that underwent an unprecedented 26-year-long outburst before its luminosity abruptly declined in 2019. The system entered a faint "obscured state," with its brightness reduced to ~1% of its previous level, likely due to Compton-thick obscuration. We present a time-dependent X-ray spectral analysis of 1,350 NICER observations spanning ~4.1 years of the obscured state. Our baseline model includes absorbed thermal Comptonization with Gaussian Fe Kα emission lines and a partially covering obscurer. We identified two spectral categories: one dominated by emission lines from multi-temperature iron and the other by prominent absorption lines. These strong wind signatures appear to be associated with a four-month period of increased brightness and reduced obscuration, which suggests that GRS 1915+105 continues to evolve throughout its obscured state. Our ongoing work focuses on quantifying the physical parameters of the wind during the rebrightening episode, with implications for the coupling between obscuration, disk winds, and long-term accretion state transitions in black hole X-ray binaries.

Psychological and Brain Sciences

K-109: Activating Nrf2 with Dimethyl Fumarate to Modulate Stress-Induced Affective Behaviors in Mice
Author: Yankah, Kojo
Advisor: Dr. Benjamin Sachs

Nuclear factor erythroid 2-related factor 2 (Nrf2) is a central regulator of cellular antioxidant defenses, and its activation presents a promising therapeutic approach for mitigating stress-induced neuropsychiatric disorders. In this study, male mice were treated with dimethyl fumarate (DMF) or vehicle prior to and during a five-day psychological stress paradigm. Behavioral assays revealed that DMF-treated stressed mice exhibited significantly reduced anxiety- and depression-like behaviors compared to vehicle controls, as shown by improved performance in the open field, light-dark emergence, elevated plus maze, and forced swim tests. Molecular analyses of brain tissue demonstrated upregulation of Nrf2 and its target antioxidant genes, alongside reduced expression of inflammatory cytokines, in DMF-treated groups exposed to stress. These results indicate that pharmacological activation of Nrf2 via DMF enhances antioxidant and anti-inflammatory responses, conferring resilience to psychological stress at both behavioral and genetic levels.

K-110: Discovering How Alcohol Consumption alters Depression- and Anxiety-like Behaviors in Mice
Authors: McCall, Corey; Sachs, Benjamin
Advisor: Dr. Benjamin Sachs

Alcohol Use Disorder (AUD) is a condition that is characterized by periods of binge drinking and associated with an increased risk of depression and anxiety disorders. However, whether repeated binge drinking itself casually contributes to developing anxiety or depression symptoms is not clear. This study examined the effects of repeated binge-like alcohol intake on anhedonia, the inability to experience pleasure (a cardinal symptom of depression) and anxiety levels in mice. Mice were given free access to 20% alcohol in the Drinking in the Dark paradigm for five days a week for 7 weeks. Mice in the alcohol group consumed significantly more liquid (i.e., alcohol) than mice in the water control group, suggesting that they were drinking excessively. Two behavioral tests of anhedonia (Sucrose Preference Test and Food Devaluation Paradigm) and two measures of anxiety (elevated plus maze and light-dark emergence test) were used to determine the behavioral impact of alcohol exposure. The study consisted of 19 C57BL6 mice, which are bred and raised in the Sachs Lab at Villanova University. The mice were divided into experimental and control conditions. The first cohort showed no significant effect for the Sucrose Preference Test or Light Dark Emergence. However, there was an effect in distance in the Elevated Plus Maze, where mice exposed to alcohol exhibited less exploratory behavior than control mice. Overall, the alcohol group ate less of the regular food in comparison to the control group. Both groups exhibited devaluation, but there was no significant difference between the groups. These findings suggest that repeated binge-like alcohol intake has inconclusive effects on anhedonia and may contribute to anxiety-like behavior.

L-111: How Underrepresented Racial Minority College Students Perceive University Responses to Federal anti-DEI Policies
Authors: Martin, Arthur; Yantis, Arthur
Advisor: Dr. Caitlyn Yantis

In 2025, President Trump sought to eliminate DEI in education, with some universities dismantling their programs to avoid backlash and others maintaining DEI despite potential costs (e.g., federal funding cuts). Previous studies have found that DEI efforts can backfire if marginalized group members do not perceive them as genuine. For example, when an organization's stated commitments to diversity and inclusion are not supported by evidence of this commitment (e.g., racial diversity in workforce), marginalized individuals perceive diversity dishonesty: a sense that the organization's DEI efforts are inauthentic (Wilton et al, 2020). This pre-registered experiment examined how college students of color (SOC) perceive various university responses to federal DEI mandates. Participants (N = 354) imagined themselves as students at a fictitious university planning to build a center for SOC on campus. Next, participants were told that, given federal DEI rollbacks, the university either (a) removed DEI by changing both the name and mission of the center to include all students, (b) strategically maintained DEI by keeping the center's mission but changing its name, or (c) fully maintained the DEI initiative. As predicted, SOC perceived the university as a more authentic ally and anticipated more support and belonging there when they fully maintained DEI (vs. strategically maintained or removed). Unexpectedly, there were no condition differences in perceptions of allyship costs. These findings highlight SOC perspectives on DEI changes in higher ed.

L-112: Intergenerational Trauma in Families Experiencing Homelessness
Author: Tisdale-Floyd, Delia
Advisor: Dr. Janette Herbers

Adverse childhood experiences (ACEs) are widely recognized for their detrimental effects on physical and mental health (Portwood et al., 2021). However, less is known about how parents' own early experiences of adversity influence their parenting and contribute to the transmission of trauma across generations. Intergenerational trauma occurs when the traumatic experiences of a parent affect their child's well-being, either directly as shared experiences or indirectly through the parents' behavior and parent-child relationship (Narayan et al., 2021). This study examines intergenerational trauma among families experiencing homelessness in Philadelphia, a population facing multiple layers of disadvantage and systemic inequality. Participants include approximately 60 parents residing in emergency family shelters, each with at least one child between 4 months and 5 years old. Parent interviews assess ACEs, trauma symptoms (PCL-6), parent-child relationship quality (Parenting Stress Index), and children's social-emotional functioning and resilience (DECA). Additional measures capture children's exposure to stressors and adversity. Analyses include bivariate correlations and multiple regression models to examine associations among parental ACEs, trauma symptoms, parent-child relationship quality, child adversity, and resilience. I hypothesized that higher parental ACEs would be associated with increased trauma symptoms and weaker parent-child relationship quality, which in turn would relate to lower child resilience. This project seeks to illuminate the pathways through which trauma persists across generations within highly vulnerable families. Findings may inform trauma-informed interventions and policy initiatives that support both parents and children in breaking cycles of adversity and promoting resilience within homeless service systems.

L-113: Odor Discrimination and Reward Preference in Drosophila melanogaster: Developing a Y-Maze Paradigm

Authors: Aldridge, Kevin; Matell, Matthew
Advisor: Dr. Matthew Matell

Drosophila flies can choose rewarding pathways through odor discrimination. These flies are attracted to rotting fruit due to the fermentation process, which releases acetic acid. The smell of vinegar is similar, and it was used as the reward odor in our Y-maze paradigm. This paradigm was designed to test the flies' ability to distinguish between odorless air and air containing 5% vinegar solution. These odors were presented in opposite arms (right and left) at the choice point of the maze. Flies were introduced into the maze, and their arm choices were recorded to determine odor preference and discrimination ability. However, maze airflow and sealing issues produced inconsistent results in odor discrimination. Flies did not show a statistically significant preference for either odorant in any trial condition. Additionally, the future goal of running Drosophila that exhibit Alzheimer's-like traits and comparing them with flies without cognitive impairments was not explored due to time constraints. Future research must be conducted to observe successful odor discrimination in the Y-maze, with further interest in how gene knockouts and knock-ins that simulate Alzheimer's affect the flies' ability to choose rewarding pathways.

L-114: The Effects of Colitis on Stress Susceptibility and Hippocampal Neurogenesis in C57BL/6 Mice

Authors: Cwik, John; Keevins, Abby; Khoo, Emily; Doetzer, Elizabeth; Orel, Anastasia; Fong, Chloe; Virone, Anthony; Alvarez, Andrea; Borrelli, Hannah
Advisor: Dr. Benjamin Sachs

Inflammatory Bowel Disease (IBD), encompassing Ulcerative Colitis and Crohn's disease, is a chronic inflammatory condition of the digestive tract. Beyond gastrointestinal symptoms, IBD is linked to higher rates of anxiety and depression, but whether altered gut-brain communication drives these comorbidities remains unclear. This study tested our hypothesis that gut inflammation increases susceptibility to stress-induced changes in 'depression-like' and 'anxiety-like' behaviors using the dextran-sulfate sodium (DSS) model of colitis and a three-day sub-chronic stress paradigm. To evaluate potential neurobiological mechanisms, we examined hippocampal neurogenesis following behavioral testing. In the Forced Swim Test, stress reduced activity and latency to immobility. Males were more active than females, with no main DSS effect. However, a sex-by-DSS interaction showed DSS reduced immobility latency in males but increased it in DSS females, suggesting sex-dependent DSS effects. In the Open Field Test, stress reduced locomotion and center exploration across sexes. A DSS-by-stress interaction indicated that DSS-treated mice were particularly stress-sensitive, consistent with our initial hypothesis. A three-way interaction revealed that stress reduced locomotion only in DSS females, whereas males showed stress deficits regardless of gut condition. These results highlight that the combined effect of colitis and stress is more pronounced in females, suggesting sex-specific vulnerability within the gut-brain axis. Preliminary neurogenesis analyses in males suggest that neither DSS nor stress significantly impacted the number of BrdU-positive cells in the hippocampus, but quantification is ongoing in females.

L-115: Using Structural Equation Modeling to Understand the Relationship Between Bilingualism and Cognitive Control

Author: Donnelly, Claire
Advisor: Dr. Grant Berry

Becoming bilingual requires significant cognitive effort, but not all bilinguals learn their second language in the same way. Bilingualism is multifaceted, and this complexity results from the unique experiences a person has while learning the languages. Many studies have investigated how bilingual experience influence how attention is regulated and directed in an attempt to address the bilingual advantage hypothesis, which claims that bilingualism provides cognitive flexibility and thus more efficient use of cognitive strategies relative to monolinguals. However, these studies have found mixed results. This study uses structural equation modeling to identify how bilinguals' experiences shape their cognitive control strategies, measured by two cognitive control tasks. Participants (N=63) completed a language history questionnaire (LHQ-3) asking about language usage patterns, family language background, and self-ratings of proficiency. Participants performed two tasks measuring cognitive control: the AX-CPT and the n-back task with lures. Structural equation modeling was then done with four exogenous variables from the LHQ-3 (L2 age of acquisition, L2 to L1 dominance ratio, proficiency score, immersion score) contributing to a bilingualism index, and the AX-CPT reactive metric and n-back reactive metric contributing to a reactive control index. This was repeated with the AX-CPT and N-back proactive metrics. No significant relationship between the bilingualism index and proactive or reactive indices was found. The absence of a significant difference is not evidence of a significant absence; yet these results call for more systematic standards of practice for studying the cognitive consequences of bilingualism.

L-116: Young Children in Family Homeless Shelters: Before and After COVID-19

Authors: Dell'Olio, Wylie; Hearns, Kelsey; Herbers, Janette
Advisor: Dr. Janette Herbers

Our study compares families experiencing homelessness before and after the COVID-19 pandemic to examine whether conditions, demographics, and reasons for shelter residence have shifted over time. We analyzed data from 60 families residing in shelters prior to the pandemic and 62 families living in shelters post-pandemic. Because families experiencing homelessness often face extreme poverty and other adverse conditions, the shelter environment can play a critical role in their resilience. While all shelters in the two samples were not identical, two shelters were represented in both groups. Across both samples, the average length of stay was approximately five months. The mean age of children was 2.9 years, with an even gender ratio. Among parents, the mean age was 28.8 years; most were female caretakers and unemployed at the time of the survey. In terms of education, 23% had not completed high school, and few held college degrees. Several factors, such as children's socioemotional functioning, remained relatively stable between the pre- and post-pandemic groups. However, notable differences emerged in the reasons families entered shelters and in their perceptions of shelter community and support. Families in the post-pandemic sample were more likely to cite neighborhood violence and rising rent costs as primary reasons for entering shelters, whereas these reasons were less prevalent before the pandemic. Additionally, compared to pre-pandemic levels, families in the post-pandemic sample reported significantly lower perceptions of support and community within their shelters.

Radiology

L-117: Effects of Diet on Near-Infrared Autofluorescence in Preclinical Imaging
Authors: Williams, Justin; Isuri, Ritesh; Samuel, Christopher; Delikatny, Edward
Advisor: Dr. Edward Delikatny

Fluorescence imaging is an increasingly popular modality being used intraoperatively to assist surgeons in delineating tumors accurately. Most current systems operate in the first near-infrared (NIR-I) range, which is limited by shallow tissue penetration, reduced spatial resolution, and high autofluorescence. The second near-infrared (NIR-II) window provides enhanced performance yet is constrained in the clinical setting due to the lack of high-performance imaging systems and the absence of FDA-approved NIR-II imaging dyes. This study examines autofluorescence in the NIR-I and NIR-II windows and attempts to simulate NIR-II levels of contrast in NIR-I images by removing fluorophores present in the standard mice chow diet. NIR-I and NIR-II images were obtained using the IR VIVO—a near-infrared small animal imaging system. One group of mice on the standard diet and another group on a chlorophyll-free diet were then imaged over a period of fourteen days to examine how autofluorescent metabolites were affected by the change. Lastly, dyes were injected to assess how autofluorescence impacts the contrast to noise ratio of near-infrared dyes. The autofluorescence in the NIR-I window followed an exponential decay trend, with most of the observable changes being present within the first day where the intensity decreased from 2700 to 2200. The contrast to noise ratio increased with the introduction of diet chow from 1.53 to 2.73 in NIR-I and from 5.08 to 6.02 in NIR-II. The chlorophyll-free diet decreased autofluorescence in the abdomen for NIR-I images but still fell short of the quality achieved using the NIR-II range. The best contrast to noise ratio was achieved while imaging mice on the diet in the NIR-II range.

Sociology and Criminology

L-118: The Impact of Student Sense of Belonging on Academic Self-Efficacy in STEM Fields

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Previous research has demonstrated a strong positive relationship between student sense of belonging and academic achievement. Similarly, additional studies demonstrated that academic achievement is directly correlated with student academic self-efficacy. However, an examination of the relationship between student sense of belonging and academic self-efficacy has not been established. Using national data from 27,552 fourth and eighth-grade students, this study investigates the impact that student sense of belonging has on science and math confidence and disesteem. Results from bivariate correlations and OLS regressions confirm that students who enjoy attending school and feel a sense of belonging in their school report higher confidence and esteem levels in science and math subjects. Other significant variables that were found to impact academic self-efficacy include the student's sex and perceived teacher effectiveness. By recognizing such relationships, policymakers and educators can institute purposeful interventions that heighten student involvement and pride.