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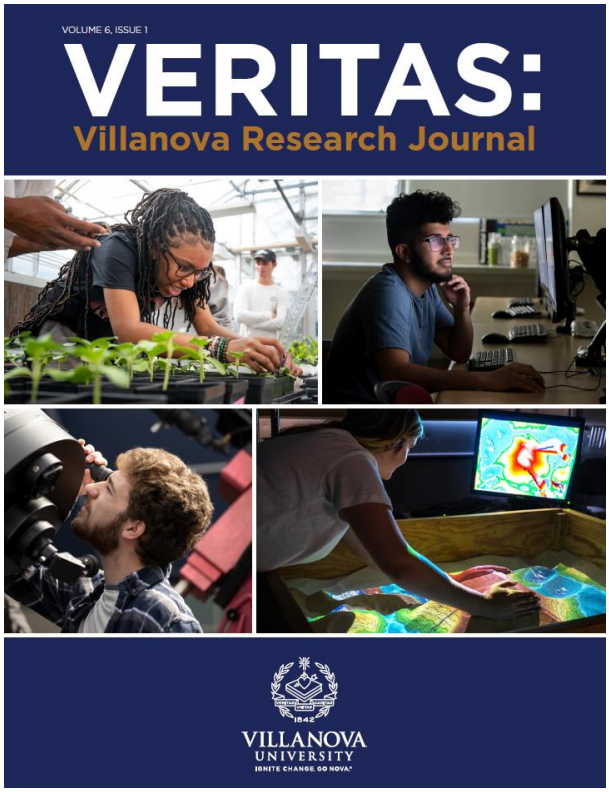

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Abstracts: Oral Presentations

All oral presentations will take place in the Devon Room

Astrophysics and Planetary Science

(1:30 p.m.)

A Web-Based Galilean Moon Simulation for Astronomy Education
Authors: Marici, Ed; Prsa, Andrej
Advisor: Dr. Andrej Prsa

In research, astronomers have always utilized (and often invented) cutting-edge equipment and tools. However, in education, we frequently rely on outdated, clunky, and frustrating software. With the rapid growth of student internet access and the advent of user-friendly web frameworks, developing web-based educational astronomy software is now easier and more impactful than ever. As part of a larger initiative to modernize all Villanova Astronomy Department labs for non-science students, we have developed a fully web-based simulation of the orbits of Jupiter's Galilean moons. Using the simple yet effective 'Nicegui' framework, we successfully created the program in Python and deployed it on servers managed by the Villanova Astronomy Department. The simulation offers a visual representation of Jupiter and its Galilean moons, akin to the view through a telescope. The simulation is paired with a lab assignment that guides students through the process of measuring Jupiter's mass. This involves time-stepping through the orbits of the moons, plotting position vs. time graphs, and fitting them to sine curves. From these graphs, students can determine both the period and semi-major axis for each moon. They then use Kepler's Harmonic Law to calculate Jupiter's mass, averaging the measurements from each moon's orbit. The program also serves as an interactive tool for students to explore orbital mechanics at their own pace. Being web-based, students can engage with the software on their own computers, both in and outside of class.

English

(1:45 p.m.)

"Boys don't tell their hearts out": Black Boyhood and Masculinity
Author: Akoma, Atamini
Advisor: Dr. Jean Lutes

Poet Alice Dunbar Nelson (1875-1935) not only wrote about the lives of Black people, but the lives and experiences of Black children growing up around the year 1900. One of her short stories, called "His Heart's Desire," is a captivating story about a five-year-old boy named Andy. Andy has a burning desire for a doll but cannot tell anyone about it because of the stigma that comes along with his desire. Andy knows it is frowned upon for him, and boys in general, to voice their emotions, and

he knows a consequence of doing that would be him being perceived as weak and an object of ridicule. Dunbar-Nelson's story is an example of how Black boys found spaces for themselves and created their own joy despite oppression. This presentation is based off an essay diving deeper into race, gender roles, and constructs of masculinity to understand how they intersect in the context of the United States post the abolition of slavery. Using the essay as a guide, an online exhibit has been curated to guide viewers through the material in both an informational and visual way. One of the missions of this exhibit is for it to be as accessible and easy to read as it can, so anyone can learn about difficult topics in a clear way.

(2:00 p.m.)

Resistance Through Representation: Redefining Representation in Black Literature
Author: Singh, Sonia
Advisor: Dr. Jean Lutes

How do we understand a piece as a form of Black literature when race is not clearly mentioned or marked in descriptions of the characters? This research focuses on answering this question through archival research, close textual comparisons of manuscripts and published stories, historical analysis, and critical race theory to analyze one of the stories of Alice Dunbar-Nelson's unfinished collection: "The Revenge of James Brown" with a focus on the former story as well as scholarship on this collection and the author's background and involvement with the White Rose Mission. Through this research and literary analysis, we are expanding our understanding of representation in literature. "The Revenge of James Brown" emphasizes the complexities of race and blackness as it is a story that does not include mentions of the race of any of the characters. The unconventionality of her writing as a form of representation teaches us that representation goes beyond stereotypical experiences and physical descriptions of race. It forces readers to pay closer attention to the nuances of race and blackness that cannot be limited to generalizations. Yet, we can understand "The Revenge of James Brown" by Alice Dunbar-Nelson as Black literature by expanding our understanding of Black literature beyond explicit descriptions of racial identity or markers, considering the author's identity and historical context, and studying where the story was published. This research will help to expand the way we as a society view representation and emphasizes its importance in literature.

(2:15 p.m.)

The Evolution of Black Barbies at Mattel
Author: Hazlewood, Jenine
Advisor: Dr. Jean Lutes

The Evolution of Black Barbies at Mattel began as a Black Barbie Timeline, that cataloged Black Barbie dolls presently and historically. With its completion, many underlying questions geared the project towards a thorough cultural analysis of Mattel, Black Barbie designers, and the existence of Black Barbie as a toy for children, though physically emblematic of womanhood. This project explores whether there is a clear difference in popularity between Black Barbies that are seen as an extension of Barbie and her world (family member, friend) versus Black Barbies that are independent of that world. It also asks whether Barbie and by extension Mattel, are righting their wrongs of exclusion. In any context, whether performatively political, economic, social, or authentically motivated (as much as a corporation can be), what does this mean for the future of Black Barbies and the consumerist

market? Within this question of sustainability, how can we understand the agency of Black guardians or parents and Black children? This line of query critiques and examines Black Barbies as a form of media and disbursement of social knowledge.

(2:30 p.m.)

Uniting Opposite Hemispheres: Parallel Traumatic Memories in South Korea's *Crash Landing on You* & Northern Ireland's *Derry Girls*
Author: Choi, Isabel
Advisor: Dr. Yumi Lee

The Korean War (1910-1945) and The Troubles in Northern Ireland (1968-1998) are seemingly dissimilar conflicts that have overlapping themes of war memory, trauma, and loss which are depicted in modern representations by Korean and Irish artists. This article explores the intertwined repercussions of war in both the Korean and Irish contexts through a cross-analysis of two popular TV series: Lisa McGee's Derry Girls (2018) and Ji-Eun Park's Crash Landing on You (2019). The interpretations of both series examine how instances of colonization and external influences have provoked and promoted violence within the Korean Peninsula and Northern Ireland. While scholars often segregate the east and west, this research will argue that it is significant to examine the parallel commentaries contemporary Korean and Irish media make about these historically disparate civil wars through popular culture. Both television series harbor commonalities including desensitization to violence, a starkness of division developing into respective and separate subcultures, memories of violence associated with place, and the continued threat of war capped only by a temporary ceasefire. Through a combination of postmemory and postcolonial studies, this article will argue for the significance of more globalized media analyses and comparisons through the example of Korea and Ireland which may unite cases of conflict in eastern and western hemispheres as not inherently different, but situations that can inform one another.

Physics

(2:45 p.m.)

The Feasibility of Using Machine Learning as a Veto in the Search for Burst Gravitational Waves
Author: Bevins, Nathaniel
Advisor: Dr. Amber Stuver

The Laser Interferometer Gravitational-Wave Observatory (LIGO) measures gravitational waves from astrophysical sources with amplitudes on the order of a ten thousand times smaller than a proton. Because of the high precision of the detector, it's very sensitive to disturbances from the environment which can cause glitches in the data. These glitches are often confused with candidate detections of unmodelled (burst) gravitational waves. Normally, glitches are manually removed (vetoed) from the data by performing data quality studies and compiling a list of times that are known to contain glitches to exclude from analysis. This research studies the feasibility of applying a machine learning algorithm

(iDQ), which measures the likelihood that a glitch is present, as a way to generate vetoes. We examine the feasibility of iDQ as both a binary and non-binary veto.

Sociology and Criminology

(3:00 p.m.)

The Impact of School Climate on Bullying Perpetration and Victimization
Author: Schornstein, Samantha
Advisor: Dr. Allison Payne

Bullying victimization and perpetration in the United States is a crucial topic to understand in order create effective prevention and intervention programs and policies in schools, so that students can thrive behaviorally and academically. My method during this research consisted of serval literature searches to identify gaps in recent bullying research. I also used surveys from a longitudinal study of highschoolers from the U.S. department of Education to identify common themes such as support, discipline, education, and achievement. The surveys were from the perspectives of principals, teachers, parents, counselors, and students. Some key information identified throughout the multiple stages of my research was that students who experienced bullying were more likely to take part in school avoidance behaviors, how classroom size can influence peer relationships, and the importance of a positive school climate. A main takeaway from my research was how important a positive school climate can be in affecting the types of behavior that occurred in schools. Future research should continue to address solutions to minimize risk factors, school support, and effective ways to prevent bullying.

Theology and Religious Studies

(3:15 p.m.)

Christian Environmentalism: Investigating The Connection Between Christian Social Thought and Environmental Health
Author: Whaley, Mike
Advisor: Dr. Brett Grainger

This research project is designed to investigate the relationship between Christian theology, environmental science, and public policy, by examining how Christian views of nature inform watershed management practices in Massachusetts and South Carolina. As society becomes increasingly more polarized, rather than creating harsh divisions between science, politics, and religion, it is important to explore their intersectionality and how they each can help us move together as a more informed community. Through existing research techniques and anthropologist practices, data suggests that Christian conceptions of nature, particularly with regard to watershed management, negatively impact how public policy is formed, and further harm the environment.

Abstracts: Posters

Astrophysics and Planetary Science

A-01: Betelgeuse After the Fall: Analysis of Photoelectric Photometry on Red Supergiant Progenitors
Authors: Guinan, Edward; Tyler, Jacob
Advisor: Dr. Edward Guinan

Visible as the shoulder of the Orion constellation, Betelgeuse is the brightest red supergiant star (RSG) seen from Earth, and one of the nearest. RSGs such as Betelgeuse are K or M-type stars that evolve from massive (~12-30MSun) O type main sequence stars. As they near the end of their lives, RSG's will run out of lighter elements to burn in their cores, such as H, He, C, O, etc., resulting in a core-collapse Type-II supernova. Betelgeuse is one of the nearest stars expected to result in a bright supernova, offering unique insight into the conditions of pre-supernova stars. In the previous two centuries of studying Betelgeuse's optical brightness, the star has followed brightness periods of ~6 years, ~420 days, and ~190 days. Following the star's notorious Jan-Feb 2020 "Great Dimming" event, however, the brightness dimmed to the lowest in recorded history. After this event, the characteristics of Betelgeuse's light variations changed drastically. Here we report on an analysis of Betelgeuse's photometry, presenting the disappearance of the ~420-day period following the Great Dimming. In its place we introduce the emergence of a dominant ~212-day period along with shorter periods of ~158 & ~106 days. Data was analyzed through the Peranso-3 Software, implementing the Weighted Wavelet Z-Transform program to model the evolution of the periods over time, and the CLEANest software to produce power spectra. We discuss the implications of these changes in Betelgeuse's pulsation.

A-02: Classical Cepheids as Probes of the Far Side of the Milky Way
Author: Shannon, Lara
Advisor: Dr. Scott Engle

Classical Cepheids, simply referred to as Cepheids, can be utilized to determine a multitude of properties. Cepheids have a pulsating pattern that causes their brightness to vary with periods of ~1 to 100 days. This has been crucial for determining and understanding important parameters for the Cepheids themselves, which then allows a better understanding of empirical relationships such as extinction laws. Furthermore, Cepheid pulsation periods change by tiny yet measurable amounts over time, and by monitoring their pulsations through photometry, we can calculate how quickly each Cepheid's period is changing and whether it is increasing or decreasing. This pins down the evolutionary state of the Cepheid. In this study, we have measured the period changes of Cepheids near the Milky Way central Galactic Bulge's line of sight, and on the far side of the galaxy, using a combination of publicly available and newly acquired data. We then model the stars using stellar evolutionary tracks to return accurate parameters that account for their specific evolutionary states. Our goal is to build a broad understanding of the environments and evolution of Cepheids across the galaxy.

A-03: Detection and Processing of Eclipsing Binary Stars in the TESS Full-Frame Images
Authors: Chawda, Aryan; Prsa, Andrej
Advisor: Dr. Andrej Prsa

In addition to the short cadence mission data, the Transiting Exoplanet Survey Satellite (TESS) provides Full Frame Images (FFIs), which contain hundreds of thousands of stars taken in sectors across the sky. Our particular interest lies in eclipsing binary (EB) stars. We present an automated pipeline to extract, analyze, and classify light curves from TESS FFIs using Python-based tools such as Eleanor. Our methodology begins with source detection in the FFIs, then using aperture photometry to plot the light curves and cross matching with the TESS Input Catalog (TIC) to identify target stars. To accurately determine stellar variability periods, we utilize Lomb-Scargle and Box Least Squares (BLS), complemented by harmonic testing to refine period estimates, particularly for EB systems. Preliminary results demonstrate pipeline's effectiveness in extracting light curves and accurately cross-matching the TIC target with the Mikulski Archive Space Telescope (MAST) Archive. We further improve the pipeline by precisely determining phase separations of primary and secondary eclipses and generating a fidelity score of probable EBs. The pipeline is used to vet and validate 150,000+ EB candidates in the TESS FFI dataset.

A-04: Expanding Stellar Age Estimation by Establishing Age-Rotation Relationships in GKM Dwarfs
Authors: Maldonado, Jennelle; Engle, Scott
Advisor: Dr. Scott Engle

Stellar gyrochronology is a method for estimating the ages of stars based on their rotational periods. Dwarf stars are ideal for this because their rotation slows predictably over time, which makes them great candidates for developing accurate age-rotation models. In this research, we use a set of over 400 benchmark stars with known ages to improve age-rotation relationships and expand their application to a broader range of stellar types. Using CPM (common proper motion) pairs, which are stars assumed to have formed together, we can evaluate the consistency of the current gyrochronology models for M, K, and G dwarfs. Testing stars of different types within CPM systems allows us to cross-check and validate these age-rotation relationships, thereby making them more reliable. Photometric data from TESS (Transiting Exoplanet Survey Satellite) were processed to extract light curves and analyzed using a Lomb-Scargle periodogram to detect periodic signals, leading us to determine stellar rotation periods. ASAS-SN (All-Sky Automated Survey for Supernovae) photometric data were also used to analyze brightness variations of stars over time and derive their rotational periods. The data were filtered by year, and separate datasets for V and g filters were combined. The light curves were cleaned to remove outliers, and a Lomb-Scargle periodogram was applied to identify the most significant periodic signals. Long-term trends were subtracted to focus on the rotational behavior of the stars, which then led to their stellar rotation periods. Establishing relationships between the rotational behaviors of M, K, and G dwarfs is important for creating a stronger age-rotation model that may be applied to a wider variety of stellar types. With these models, we can estimate the ages of any star, provided we can accurately measure its rotation period, which deepens our understanding of stellar evolution.

A-05: Extracting Tidally Excited Pulsations from Eclipsing Binaries
Authors: Hager, Phoebe; Hambleton, Kelly
Advisor: Dr. Kelly Hambleton

Two stars orbiting a common center of mass are referred to as binary systems. If one of these stars passes in front of the other we call the system an eclipsing binary (EB). Some EBs have extremely elliptical orbits which create variations in their gravitational pull, forming tial forces that can cause the stars to pulsate. The pulsations produced are called tidally excited pulsations (TEPs), and are visible in the observed light curves. Scientists have been studying TEPs for about 20 years as they offer a unique way to learn more about the internal structure of stars. The aim of this research is to extract TEP information from binary star light curves from the Kepler Eclipsing Binary Catalog, specifically the frequencies, amplitudes, and phases. The process begins with detrending the identified light curves by applying a Savitzky-Golay smoothing filter. Next, we implement a Lowess filter to remove any binary features, isolating the pulsation signal. We then apply wavelets and Fourier transforms to confirm the authenticity of the observed TEPs. Finally, we utilize additional diagnostics to determine if any pulsations are multiples of the orbital frequency. Here we present two eclipsing binaries, KIC 11923819 and KIC 07914906, with tidally excited pulsations. Through our analyses, we have identified these objects as being well-suited for the application of asteroseismology, the study of stellar pulsations, to analyze interiors. By combining asteroseismology with binary star models, we aim to improve our understanding of the internal structure of stars.

A-06: Long Term Magnetic Activity Cycles of M Dwarfs and Atmospheric Habitability Potential of Their Planets
Author: Sunderland, Julia
Advisor: Dr. Scott Engle

GJ12 is a nearby M dwarf (M4) that has recently been discovered to host an Earth-size planet suitable for habitability studies based on stellar and planetary parameters. Due to their efficient magnetic dynamos, M dwarfs generate UV and X-ray activity that can be hazardous to potentially habitable planets, as these stars are much smaller than the Sun and therefore require closer orbits for planets to exist within the liquid water habitable zone. This smaller radius of orbit results in greater radiation exposure from the host star. The magnetic activity can also manifest as light variations due to the rotation of star spots, and long-term solar-like activity cycles. We analyzed the star and its planet, GJ12b, with a focus on modeling GJ12's activity cycle and how the star's activity could affect the evolution and retention of GJ12b's atmosphere. Light curves were computed through ASAS-SN all-sky photometry combined with data from Villanova's Robotically Controlled Telescope (RCT) at Kitt Peak National Observatory. Atmospheric modeling of GJ12b was done using VPLANET, and further analysis of stellar parameters was carried out using task-specific routines in python. The variability findings for GJ12 were also combined with this of other M dwarfs studied as part of the ongoing Living with a Red Dwarf Program. The findings provide insight into the effects of GJ12's activity on its planet and the conditions through which long-term habitability could either be supported or inhibited.

A-07: Reevaluating the Habitability of Gliese 581d: Insights into Atmosphere and Environmental Evolution around Inactive M-Dwarfs
Authors: Hallihan, Logan; Guinan, Edward
Advisor: Dr. Edward Guinan

Although Gliese 581d was previously dismissed as an exoplanet due to a possible coincidence between its orbital and rotational periods, Cuntz *et al.* (2023) present new evidence supporting its existence. Located 20.5 light-years away, the exoplanet has an estimated mass of ~5.6 Me, an orbital period of 66.64 days, and is 0.218 AU from its host star. With a bolometric irradiance of Sbol/S⊕ ~ 0.253, it occupies a lower-energy environment that could allow for habitability. Gliese 581 hosts three other confirmed planets (e, b, c) outside the star's HZ and has a debris disk at ~25 AU. Gliese 581 is a 10th mag inactive M3V star with a stellar rotation period of 148.7 ± 0.8 days, aligning with Gliese 581d's signal. Analysis using the 1.3-m Robotically Controlled Telescope and the Rotation-Age Relationship (Engle & Guinan, 2023) suggests the system is ~9.5 Gyr old. We investigated Gliese 581d's exposure to high-energy XUV radiation, estimating its XUV irradiance using X-ray and FUV Ly-α data. Despite Gliese 581's quiescence, long-term exposure to photoionizing radiation could influence the planet's atmosphere, affecting habitability. This research assesses Gliese 581d's habitability in the context of potential atmospheric retention around older, inactive M-dwarfs. Future infrared spectroscopic observations are essential to determine its atmospheric composition and habitability potential. This research is supported by a Villanova Undergraduate Research Fellowship (VURF) and NASA grants.

A-08: Super-Earth LHS 1140b: Age and XUV Irradiances of a Transiting Temperate-Zone Planet with Possible Secondary Atmosphere and Ice/Water Ocean
Authors: DiSanto, Aedan; Guinan, Edward; Engle, Scott
Advisor: Dr. Edward Guinan

LHS 1140b is a rare habitable zone (HZ) super-earth planet that has its radius (1.73 R/R⊕), mass (~5.6 M/M⊕) and density (5.9 g/cm^3) known from transit photometry and radial velocity spectroscopy (Dittman *et. al.*. 2017; Cadieux *et al.* 2024). LHS 1140b orbits near the cool edge of the HZ of its nearby (~49-ly), inactive M4.5V host star. Recent transit transmission spectroscopy with HST and JWST and planet models indicate LHS 1140b is a super-earth, possibly possessing a water/ice ocean. Moreover, there is tantalizing evidence that the planet possesses a possibly (N2-rich) secondary atmosphere (Cadieux *et al.* 2024). LHS 1140b is among the top exoplanet candidates for potentially hosting life. Here we determine a reliable age and provide estimates of photodissociation /photoionizing X-ray and FUV irradiances now and in its past for this important exoplanet.

A-09: Teegarden's Star-b and c: Exoplanets Nearly as Good as Earth?
Author: Micho, Matthew
Advisor: Dr. Edward Guinan

The potential of extraterrestrial life existing on other planets is one of the most exciting facets of astronomy today. Two of the most promising exoplanet candidates can be found orbiting Teegarden's Star (TGS), a red dwarf only 12.6 ly away. We have analyzed its properties to determine the habitability of TGS-b and TGS-c. The age of the star is one of the most important factors for this; using known rotation, metallicity, proper motion, and x-ray measurements, we determined that the star has an age

of 8±2 Gyr, providing ample time for life to arise. The X-ray irradiance on the planets is similarly important, as it affects whether or not they can retain the atmosphere. Using x-ray data from Swift and XMM-Newton, it was determined that TGS-b and TGS-c receive ~100 and ~33 times the x-ray flux of Earth respectively, notably lower than the TRAPPIST-1 system. Similarly, the Lyman-α fluxes for TGS-b and TGS-c were determined to be 4.7 and 1.5 times that of the Earth.

A-10: The Age and X-UV Irradiance of the Newly Discovered Transiting Potentially Habitable Earth-size TOI-700 d
Authors: Granda Argianas, Lili Mei; Guinan, Edward
Advisor: Dr. Edward Guinan

TOI-700 d is a nearby (101.5-ly) transiting Earth-size planet that orbits within the habitable zone (HZ) of its inactive 13th-mag M2V host star. TOI-700 d was discovered by TESS in 2020 as the first transiting super-earth exoplanet found by the mission orbiting within its host star's HZ, and the planet was confirmed by Spitzer observations. TOI-700 d is accompanied by three additional exoplanets interior to the HZ. While the planet has optimistic factors, such as Earth-like qualities, the age of the star/planet is not well constrained (age >1.5-Gyr). Age is a critical factor in evaluating a planet's potential for advanced life. For example, on Earth it took nearly four billion years for complex life to develop. Here, we determine the age of star/planet primarily using gyrochronology, as well as space motions, and metallicity-age relations. We also estimate the atmosphere-eroding photoionizing/photo-dissociating X-ray/ FUV irradiances of TOI-700 d using Activity-Age relations recently developed. An age of ~5.1 +/-1.7 Gyr was determined, adopting a Prot =54-d and employing previously known Rotation-Age relations. This age was adopted for determining the XUV irradiances. Like most HZ planets hosted by a M-dwarf, the XUV irradiances are higher than Earth's. The FUV irradiances of TOI-700 d are generally smaller than most HZ planets hosted by M-dwarf stars. As recently discovered, a planetary geomagnetic field like Earth's would be sufficient for TOI-700 d to retain an atmosphere and water inventories. Securing transmission spectra with JWST is needed to investigate if the planet possesses an atmosphere and water that could support potential life. We also estimate stellar winds and apply planetary models. The results of this project will be presented and discussed along with plans for follow-up studies

Biology

A-11: Analysis of ARID-1, a Transcriptional Regulator Multiprotein Complex, during Aging in *C. elegans*
Author: Puorro, Brianna
Advisor: Dr. Matthew Youngman

Transcriptional regulation by chromatin modifications alters gene expression resulting in cell identity loss, so chromatin maintenance is crucial for healthy aging. Using the roundworm *Caenorhabditis elegans*, our lab found that the evolutionarily conserved transcriptional regulator ARID-1 is expressed in neurons, required for longevity, and functions in innate immunity during adulthood. To investigate ARID-1's composition and function during aging in *C. elegans*, I took a two-pronged approach. First, I used a reverse-genetics strategy to ask whether candidate genes function in the same pathway as ARID-1 and thus encode ARID-1 complex subunits. I studied the SUDS-3 phenotype as it is a known

component in the human ortholog ARID4A. In adults, SUDS-3 knockdown phenocopies RNAi targeting ARID-1 with increased susceptibility to *Pseudomonas aeruginosa,* a bacterial pathogen, indicating contribution to innate immunity. Ultimately, more subunits could be analyzed. In parallel, I pursued a biochemical strategy to isolate the complex by immunoprecipitation. In ongoing experiments, I am optimizing steps to generate sufficient starting material by scaling up age-synchronized *C. elegans* cohorts on 15 cm plates with concentrated OP50 compared to normal conditions on 10 cm plates. So far, I have generated 80-fold more worms per 15 cm plate. Overall, studying ARID-1 is important for understanding its role in aging which could have potential implications for human gene regulation.

A-12: Balancing Act: Measuring Trade-offs between Carbon Niche Breadth and Growth
Authors: Krien, Cara; Opulente, Dana; Dardignac, Jessica; Sarfo, Afia
Advisor: Dr. Dana Opulente

The ecological niche of an organism is made up of both living and non-living components of an organism's environment. Organisms can display variation in their niche breadth. At the extremes individuals can have narrow niche breadth or very broad niche breadth—these extremes can be classified as specialists and generalists, respectively. Variation in niche breadth raises questions about how specialism and generalism evolve. One hypothesis suggests that there is a trade-off between breadth and growth, where a wide breadth comes at a cost. Testing for trade-offs between breadth and growth can be difficult. However, Saccharomycotina yeasts are a great model to investigating these trade-offs. Using yeasts from three different habitats, I measured variation in carbon niche breadth across 104 yeasts and classify them as specialists, standard, or generalists. To measure whether there is a trade-off between carbon breadth and growth, I quantified variation in carbon growth among a subset of classified yeasts (n = 24) across multiple carbon sources (n = 4). These data will then be used to quantify the extent that trade-offs between carbon breadth and carbon growth exist.

A-13: Dissecting Neural Circuits in *Drosophila* using Transcriptomics
Author: Shanker, Sasha Tejal
Advisor: Dr. Troy Shirangi

Drosophila melanogaster offers a model system to understand the neurobiological mechanisms behind the maturation of reproductive behaviors in a complex animal. In fruit flies, when maturation occurs during the pupal phase, new neural circuits arise; however, there are also many neurons that get reprogrammed and remodeled during metamorphosis. One example of this is a subset of neurons in the adult called DDAG neurons, which co-express the dsf and dsx genes and are responsible for the mating behaviors of adult females. The DDAG neurons are originally the A26g neurons in the larvae, but are then remodeled during metamorphosis. Previous research in the lab has identified these DDAG neurons as responsible for the female courting behavior of either vaginal plate opening (VPO) or ovipositor extrusion (OE), and has categorized them into the anatomical sub-groups A-E. This study investigates if these 5 anatomical subgroups are related transcriptionally, which can provide more information about the exact purpose of these DDAG neurons and why they remodel during metamorphosis. Gene expression patterns from single-cell RNA sequencing data showed that there are 4 gene clusters that also co-express dsf: tey, CARPA, retn, and ptx1. Based on this preliminary data, it is hypothesized that each gene cluster correlates to one of the A-E anatomical sub-groups. This was first tested with the gene tey, as a gene intersection between tey and dsf was performed with

adults, and it was found that the DDAG_C and DDAG_D neurons were labeled, along with a single DDAG_B. To confirm the identity of these neurons, multi-color flp out was performed to stochastically label single cells in the adults. The expression of tey and dsf was also observed in the larvae, and it was found that all of the A26g neurons in the larvae were labeled. These results present more questions about the role of tey and its part in A26g remodeling. By exploring the other three gene clusters and further studying tey, more information can be found about the DDAGs and their remodeling.

A-14: Exploring UPF1 LL-helix: a Hybrid Mutation of Two UPF1 RNA Helicase Isoforms and its Effect on RNA Decay Target Selection

Authors: Holzinger, Lillian; Fritz, Sarah
Advisor: Dr. Sarah Fritz

One of the major proteins in nonsense-mediated decay (NMD) is UPF1, an RNA helicase that directly binds to mRNA to select target transcripts for degradation. In mammals, there are two isoforms of this protein: UPF1 SL, with an 11 amino acid regulatory loop containing a partial alpha helical structure, and UPF1 LL, a 22 amino acid regulatory loop with no partial helical structure. The UPF1 regulatory loop was previously identified to modulate the binding of UPF1 to RNA in the presence of ATP, with UPF1 LL demonstrating a slower rate of dissociation compared to UPF1 SL, which correlates with different NMD target selection between the two UPF1 isoforms in human cells. An outstanding question is how sequence and/or structural features of the regulatory loop contribute to NMD target specificity. To determine the effect of the partial helical structure in UPF1 SL on regulating the binding of UPF1 to RNA in the presence of ATP, the amino acid sequence that makes up this structure was cloned into the regulatory loop of UPF1 LL, forming UPF1 LL-helix. After expression and purification of the helicase domain (HD), the UPF1 dissociation rate of UPF1 HD LL-helix from nucleic acid overtime was observed using fluorescence anisotropy dissociation (FAD) assays. UPF1 HD LL-helix was found to dissociate at a rate more similar to UPF1 HD SL than UPF1 HD LL, supporting a role for the partial alpha helical structure in regulating the binding of UPF1 to RNA in the presence of ATP.

A-15: Functional Implications of the Addition of Glycine to the UPF1 Regulatory Loop Structure

Authors: Blake, Michael; Fritz, Sarah
Advisor: Dr. Sarah Fritz

The mRNA surveillance pathway responsible for decaying mRNAs with premature stop codons is called nonsense mediated decay (NMD.) The NMD pathway has been well studied from yeast to humans, showing that the central coordinator UPF1 is highly conserved. Contained within the 1B subdomain of UPF1 is a highly conserved regulatory loop structure. Remarkably, there is an alternate isoform of UPF1 which has been identified in mammals. This alternative isoform, termed UPF1 – Long Loop (UPFLL) contains an extended amino acid sequence of the regulatory loop found in the major UPF1 isoform, UPF1 – Short Loop (UPF1SL). Previously, my research mentor, Dr. Sarah Fritz, concluded that UPF1LL showed a decrease in dissociation from RNA during ATP hydrolysis relative to UPF1SL. This distinct biochemical feature enables UPF1LL to promote the decay of mRNAs that are normally not substrates of the NMD pathway. To understand how changes to this structure's sequence affect the biochemical properties of UPF1, I cloned the novel UPF1 mutant, UPF1 –

Zebraloop (UPF1ZL). This mutant reflects the amino acid sequence found in the regulatory loop domain of UPF1 in the tropical freshwater fish *D. rerio*. The addition of a singular amino acid, glycine, into the standard 11 amino acid-long regulatory loop is predicted to reduce the rigidity of the regulatory loop, owing to glycine's role as a "helix-breaker." This structural flexibility is hypothesized to promote more rapid dissociation from RNA upon ATP hydrolysis. Using established in vitro assays, I characterized RNA binding ability, dissociation rates in the presence and absence of ATP, and unwinding rates. My results indicate that UPF1ZL is situated between the UPF1LL and UPF1SL isoforms with regards to biochemical activity. My current work is focused on determining the effects of the UPF1ZL sequence on NMD target specificity in human cells.

A-16: Impacts of the Hormone Vasotocin on Social Odors, Brains, and Chemosensory Behavior in *A. carolinensis*

Authors: Park, Janice; Campos, Stephanie
Advisor: Dr. Stephanie Campos

The hormone arginine vasotocin (AVT) and its homologues are important regulators of social dynamics in animals. In reptiles, AVT has been linked to chemically-mediated social behavior and may impact the detection and response to chemical signals—cues transmitted through smell and taste that convey social information (i.e., social odors)—by acting on olfactory and vomerolfactory systems. Here, we investigated the impacts of exogenous AVT on rates of chemical behavior (e.g., tongue flicks and lip smacks) in green anole lizards, *Anolis carolinensis,* to ask whether they can chemically discriminate between AVT-treated signalers and saline-treated signalers. We injected 15 males with either AVT (AVT-signalers) or a vehicle control solution (Saline-signalers), then introduced injected males to different untreated males (receivers; 15 per treatment) in 20-minute filmed interactions. Next, we sacrificed untreated receivers and extracted their brains to identify activated neurons using immunohistochemistry. We sliced and stained fixed brain tissue using an antibody that tagged activated neurons. I will count the number of active neurons in brain regions that process olfactory and vomerolfactory information and compare these counts between treatments. I hypothesize that receivers will perform higher rates of chemosensory displays in response to AVT-signalers than to Saline-treated signalers, and that receivers will have a greater number of active neurons in chemical-processing regions of the brain when interacting with AVT-treated signalers than with Saline-treated signalers. Determining the relationship between AVT and chemosensory processing and behavior in lizards will help to better understand hormonal regulation of social dynamics in animals.

A-17: Investigating the Role of DAF-18/PTEN in Regulating the Age-dependent Activity of the DAF-16/FOXO Transcription Factor to Preserve Healthspan

Author: Burnham, Emma
Advisor: Dr. Matthew Youngman

The insulin signaling pathway is an evolutionary conserved system in *C. elegans* that is used to regulate immunity and health span during aging. The genes encoding the Insulin signaling (IIS) pathway are necessary for various organisms, including humans, to reach their normal maximum lifespan. Daf-16, a component of this pathway, transcriptionally regulates the genes that promote cellular health in *C. elegans,* increasing in activity as they age. Daf-18 is a phosphatase and ortholog of the human tumor suppressor PTEN and is required to regulate daf-16. Our lab has found that daf-18 is expressed in a chemosensory-resembling neuron and its activity increases with age. I aim to determine the location

of daf-18 and characterize it as a lipid or protein phosphatase. To locate daf-18, a series of genetic crosses were performed between males of a strain daf-18::GFP, which has GFP fused to daf-18, and hermaphrodites with RFP fused to particular neurons, looking for the fluorescent overlap. Infection assays with daf-8(yh1) mutant worms with complete loss of lipid phosphatase activity in daf-18 and N2 wildtype worms were then conducted to characterize the phosphatase activity of daf-18. RNAi interference was also used on wild-type N2 worms to knock down tph-1, which codes for serotonin production, to test a model of daf-18's interaction with the IIS pathway from the neurons. Results currently suggest that daf-18 acts as a lipid phosphatase. Although the genetic crosses conducted were unsuccessful in determining the location of daf-18, our data narrowed down the list of possible daf-18-containing neurons.

A-18: Presence and Abundance of Arbuscular Mycorrhizal Fungi in Florida Mangroves
Author: Yost, Faith
Advisor: Dr. Samantha Champman

This project investigates the presence and role of arbuscular mycorrhizal fungi (AMF) in the migration of black mangroves (*Avicennia germinans*) in Florida. The black mangroves in this experiment inhabit Northeastern Florida in a marsh-mangrove ecotone. Using plots from the Chapman Lab's WETFEET project, soil core samples from interior and creekside zones will be analyzed for AMF colonization. The study aims to correlate AMF presence with mangrove growth metrics, hypothesizing that AMF abundance is greater in less waterlogged soils, which may aid mangroves in migration and resilience.

A-19: Substrate Adhesion by the Bumble-bee Parasite *Crithidia bombi* Depends on Growth Phase
Authors: Shaheen, Sarah; Bieber, Blyssalyn; Povelones, Megan
Advisor: Dr. Megan Povelones

Crithidia bombi is a single-celled, eukaryotic parasite of bumble bees such as *Bombus impatiens*. *B. impatiens* is an important pollinator species in North America, and there is evidence that *C. bombi* can spill over from *B. impatiens* to other bee species. *C. bombi* infections cause adverse effects on their bee hosts, including reduced stress tolerance and brood sizes. Each parasite has a single flagellum responsible for swimming. In the insect, however, the flagellum allows the parasites to attach to the wall of the ileum. There, they replicate as attached cells, forming clusters called rosettes that eventually cover the gut wall. The signals that control differentiation between swimming and attached states are not known. Since *C. bombi* will also adhere to artificial substrates in vitro, we have quantitated the frequency of *C. bombi* adhesion as a function of growth phase. Parasite cultures were staggered to represent different phases of growth (early log, mid log, late log, early stationary, late stationary). The same number of cells from each culture were harvested and subjected to a standard adhesion assay. After 24 hours, unattached cells were washed away, and the plates were imaged. The number of adhesive events, including attached singlets, doublets, and rosettes, were quantitated. Our data suggest that cells in late log phase undergo the most efficient transition from swimming to attached, as cells from these cultures produced the most rosettes. We now plan to adapt this assay to measure other parameters, including initial adhesion and detachment frequency. These studies will provide insights into the life cycle of *C. bombi* in its host, as well as how infection dynamics might affect transmission frequencies in natural settings.

Chemical and Biological Engineering

B-21: Enhanced Lithium Orthosilicate Composites for High Temperature CO_2 Capture
Authors: Coates, Trevor; Kopack, Lilianne; Steckley, Claire; Znachko, Molly
Advisors: Dr. Michael Smith and Dr. Charles Coe

Precombustion CO_2 capture, used in integrated gasification combined cycle (IGCC), sorption-enhanced steam-methane reforming (SE-SMR), and sorption-enhanced water-gas shift (SE-WGS), offers efficient hydrogen production by simplifying traditional processes. SE-SMR combines reforming and water-gas shift (WGS) into a single step, reducing both capital and operational costs. Operating at 550-650°C, SE-SMR produces nearly pure CO_2, ideal for sequestration or industrial use. The development of this single-step technology is key to transitioning from grey to blue hydrogen, accelerating decarbonization in the transportation industry. While most sorbent development has focused on CaO-based materials, lithium orthosilicate (LOS) shows greater potential for SE-SMR applications. LOS has a high theoretical CO_2 uptake (>35% by mass) and favorable thermodynamics in the target temperature range. The material undergoes the following reaction during CO_2 sorption: Li_4SiO_4 (s) + CO_2 (g) ↔ Li_2CO_3 (s) + Li_2SiO_3 (s). This research has developed a nanostructured LOS composite material synthesized with a surfactant that shows rapid uptake kinetics and cyclic stability up to 80 cycles. Our future research will focus on fully characterizing this material by varying synthesis methods to assess the impact of different conditions. This will deepen our understanding of its composition, behavior, and ideal reaction conditions for carbon capture. Additionally, we aim to develop scalable production methods, facilitating the industrial use of LOS for large-scale carbon capture.

B-22: Green Building Materials: Magnesium Oxide Based Cements as a Sustainable Alternative
Authors: Chelangat, Vicky; Soderman, Susanna; Fisher, Brooke; Davis, Felix
Advisor: Dr. Chris Kitchens

Magnesium oxide (MgO) based wallboards have emerged as a sustainable alternative to conventional building materials, including oriented strand board, Portland cement and gypsum, due to their favorable performance and decreased impact on human health and the environment. In recent years, concern has been raised regarding water resistance and susceptibility to moisture-induced damage. The synthesis of magnesium oxychloride cement (MOC) is achieved through the controlled mixing of magnesium chloride ($MgCl_2$), magnesium oxide (MgO), and water (H_2O) at precise ratios and controlled curing conditions. Existing literature has identified Phase 5 and Phase 3, as the stable oxychlorides. This study focuses on the effects of temperature on phase stability by investigating the microstructural changes of nine commercial formulations of MOC when exposed to water at temperatures from 30°C to 60°C for varying extents of time. We have measured the hydrolytic degradation of the MOC by measuring the free chlorides in the water phase and the composition of the solids using quantitative X-ray diffraction(Q-XRD). Our findings demonstrated that chloride levels directly correlate to the degradation extent of MOC, with conversion of phases 5 and 3 to brucite as the degradation pathway. Q-XRD results quantified the degradation kinetics measuring the disappearance of Phase 5 and formation of brucite as a function of time and temperature. The results also indicated that the presence of phosphoric acid led to an increase in activation energy and a

decrease in reaction rates, suggesting a potential pathway for enhancing the stability of MOC. Future research will build upon this work by assessing the mechanical properties and corrosion resistance of these modified MOC samples.

B-23: Investigating the Timing of Inflammatory Gene Knockdown in Endothelial Cells After Delivery of siRNA-PACE Nanoparticles

Authors: Hamel, Kate; Lallo, Valerie; Bracaglia, Laura
Advisor: Dr. Laura Bracaglia

There are currently over 92,000 people in the United States waiting for a kidney transplant ("Transplant"), and even after transplantation, many patients experience some form of organ rejection; renal ischemia reperfusion injury (IRI) can contribute to host rejection. IRIs are caused by reintroduction of blood flow after a period of ischemia, resulting in oxidation and cell damage. The damaged cells initiate an inflammatory response, in which the body attacks the transplanted organ (Zhao). The current method to treat this issue is immunosuppressant use, but total suppression can prevent the body from fighting other pathogens. This project aims to silence inflammatory genes in endothelial cells via nanoparticle drug delivery. Endothelial cells regulate interactions between the bloodstream and all other systems (Cui), making them key players in immune response. The polymer NPs release nucleic acids over time, silencing certain genes, thus inhibiting the endothelial inflammatory response. This project focuses on measuring nucleic acid release and tracking the endocytic pathway of various nanoparticles in human endothelial cells (ECs). Understanding the release and knockdown timing of the nucleic acids is an important aspect of this study; therefore, qPCR was used to detect genetic knockdown at different timepoints. Nanoparticles were introduced to ECs and incubated for 4, 24, 48, 72, 96, or 120 hours. The onset, magnitude, and duration of the protein silencing were quantified using qPCR. It was found that the endothelial cells experienced gene knockdown from various NP formulations, culminating in greatest knockdown around 48 hours. In some cases, this knockdown was sustained for several days. The data pointed towards the success of the treatment, though more experiments studying the release of the medicine need to be conducted.

B-24: Polycistronic Expression with Bacterial Intein-Like Linkers

Authors: Latham, Ashlyn; Mueller, Daniel
Advisor: Dr. Jacob Elmer

Eukaryotic polycistronic expression strategies exist, but genes are not expressed in equimolar amounts, and additional residues may remain on the protein termini. A bacterial intein-like linker (BILL) can be placed between target proteins to express multiple genes and spontaneously cleave the peptide backbone at each terminus, releasing equimolar amounts of each protein. This research focuses on providing proof of concept that a BILL can be used to co-express two proteins: GFP and mCherry. Site-directed mutagenesis was used to introduce mutations at the termini of the BILL. The six active site mutants each were controls for determining whether the wild-type BILL cleaved at both ends. Next-generation sequencing confirmed the mutations. The mutant was then transformed into BL21 cells, gene expression was induced, and cell lysis released the proteins. Chitin affinity and immobilized metal affinity chromatography were used to purify the target proteins and confirmed that the BILL cleaved at the junction of GFP and mCherry. Polyacrylamide gel electrophoresis (PAGE) was used to determine whether the BILL remained attached, but the results were inconclusive, as GFP was not fully denatured. Liquid chromatography-mass spectrometry (LC-MS) was also used to quantify the

protein's molecular weights. LC-MS confirmed that the BILL cleaved at the junction with GFP, but cleavage at the mCherry junction was inconclusive. The next steps include obtaining conclusive PAGE and LC-MS results. This research could provide proof of concept for BILLs as a novel technology for producing equimolar amounts of proteins without scars, offering opportunities for further study and graduate research applications.

B-25: Use of Shrimp Tail Waste and Eggshell Waste to Neutralize Low pH Water and Wastewater
Authors: Punzi, Vito; Skaf, Dorothy
Advisor: Dr. Vito Punzi

This research explores the feasibility and benefits of using eggshell waste (ESW) and shrimp tail waste (STW) as cost-effective and environmentally sustainable alternatives for neutralizing acidic waste streams. Beyond the immediate economic advantages, such an approach underscores a broader commitment to resource efficiency and environmental stewardship. By capitalizing on the inherent value of food waste and promoting circularity in resource utilization, this innovative solution holds promise for advancing sustainability objectives across diverse industries and geographic regions.

Chemical Engineering

B-26: Identifying Proteins that Inhibit Gene Therapy
Authors: Stozenski, Will; Mwangi, Leila
Advisor: Dr. Jacob Elmer

Gene therapy offers a promising pathway for treating severe illnesses such as genetic diseases and cancer. While some therapies have succeeded, questions remain regarding their efficacy and safety across different patient populations. This study focuses on understanding the interactions between therapeutic DNA and host cell proteins to identify factors influencing gene therapy effectiveness. To achieve this, a DpnI protein was utilized to specifically bind and isolate plasmid DNA (pDNA) from host cells, enabling the identification of proteins that interact with the DNA. This method aims to identify proteins that suppress gene activity, potentially leading to more effective therapies. The research involved optimizing the lysis process to minimize contamination from mitochondrial DNA (mtDNA), improving the purity of nuclear extracts. Preliminary data showed that mtDNA co-purified with pDNA, which lead to the modifications within the lysis procedure to separate nuclei and mitochondria prior to purification with DpnI. A BirA plasmid was also constructed to facilitate biotinylation, aiding in detecting and isolating DNA-binding proteins. Following the optimization, qPCR confirmed the removal of mtDNA, a critical step in ensuring the specificity of the subsequent analyses. The next steps include repeating Next Generation Sequencing (NGS), attempting Liquid Chromatography-Mass Spectrometry (LC-MS), and identifying the proteins bound to the plasmid DNA. Ultimately, this research could help refine gene therapy approaches by targeting proteins that inhibit therapeutic gene expression, with potential implications for both viral and non-viral gene therapies. This will offer avenues for further study and potential applications in graduate research.

B-27: Will Zincosilicates Provide Enhanced CO2 Capture Compared to Traditional Zeolites?
Authors: Kochman, Alex; Coe, Charles; Smith, Michael
Advisor: Dr. Charles Coe

This research project addresses the pressing need to reduce energy requirements and adsorbent usage for carbon dioxide (CO_2) removal from concentrated sources via the use of zeolites, a class of traditionally aluminosilicate, cage-like molecules. There is strong reason to believe that the replacement of aluminum (Al^{3+}) molecular framework atoms with zinc (Zn^{2+}) atoms in a zeolite with the Chabazite (CHA) structure will produce significantly improved CO_2 adsorption data in comparison to the traditional, aluminosilicate CHA. This is due to the Zinc framework atoms allowing dehydroxylated, divalent cations to reside on the walls of the zeolite framework (whereas Al in the framework only allows for monovalent cations), meaning a greater charge density on the zeolite and therefore improved uptake of CO_2, which has three times the quadrupole moment in comparison to N2. Adsorption studies using the new 3Flex adsorption instrument will begin soon to potentially confirm this hypothesis. It has been determined via X-ray diffractometry crystallization curve data that the ZnCHA structure is formed with the most purity when crystallized for five days rather than the previously believed seven days once the structure directing agent is removed from the freshly crystallized batch. Future work will include also testing the effect of Zinc as the extraframework cation itself, rather than the commonly used sodium, potassium, or lithium. The results aim to provide insights into the utility of Zinc zeotypes for enhanced gas adsorption, with the potential to revolutionize CO_2 capture technology and prevent the worsening of the greenhouse effect.

Chemistry

B-28: A Hammett-plot Inspired Structure-activity Relationship Analysis of QPC Disinfectants
Authors: Leatherbury, Moneya; Brouwers, Leoma; Rachii, Diana; Wuest, William; Minibole, Kevin
Advisor: Dr. Kevin Minbiole

Bacterial resistance has emerged as a critical global issue, largely due to the prolonged use of the same chemical agents in disinfectants; this has allowed bacteria to evolve, diminishing the effectiveness of chemical disinfectants. The development of innovative antibacterials, such as quaternary phosphonium compounds (QPCs), shows promise to combat resistance. Towards this end, a series of 12 mono- and bisQPCs were synthesized using commercially available triphenyl phosphine analogs, each substituted with electron-withdrawing electron-withdrawing or electron-donating groups to subtly alter charge distribution. These variations create a charge gradient, facilitating the investigation of specific charge effects of amphiphilic structure on resultant bioactivity. Taking inspiration from Hammett analyses, this study aims to correlate the calculated charge density of the phosphonium ion with minimum inhibitory concentration (MIC) and time-kill rates for both wild-type and resistant bacterial strains. Preliminary data indicates an unexpected trend in bioactivity, where less strongly cationic amphiphiles demonstrate potent bioactivities with the average MIC range of 1-4 mM across the entire bacterial panel.

B-29: Advanced Anode Catalyst of Fuel Cell Operators with Renewable Hydrocarbons
Authors: Moreland, Sebastian; Buckner, Jaylen; Eigenbrodt, Bryan
Advisor: Dr. Bryan Eigenbrodt

Sr_2Fe_2-xMoxO6-δ (SFMO) double perovskite has been studied for its use as an anode in solid oxide fuel cells (SOFCs), as it presents redox stability, high electric conductivity, and acts as a carbon formation deterrent. SFMOs perform well in SOFCs partially because of their crystal structure. SFMOs allow for charge to pass through them by oxygen vacancies in its crystal structure. The ratio of Fe to Mo in SFMO was varied to determine the best ratio for synthesis purity and redox stability. Ni was also added as a third cation to improve redox stability. These SFMOs were prepared using a sol-gel synthesis and subsequent purification through high-temperature purification, up to 1200 °C. The SFMO powder was also reduced in a high-temperature reduction furnace up to 800 °C. The perovskite compound was then tested for its redox stability in high-temperature environments using X-ray diffraction to analyze crystal structure before and after reduction at 800 °C. An SFMO that was stable under both high temperature conditions displayed similar X-ray diffraction patterns after both oxidation and reduction. SFMOs that were unstable under these conditions showed impurities in their X-ray diffraction patterns. Our findings provide various ratios of Fe, Mo, and Ni to be stable in either oxidized or reduced environments, with hopes to test these compounds in solid oxide fuel cells for their electrical performance.

B-30: Altering N,N-bidentate Ligand Substituents of Iron(II) Catalysts as a Strategy to Tune Isomer Distribution in Polyisoprene
Authors: Malik, Sophie; Farry, Kimora; Zubris, Deanna
Advisor: Dr. Deanna Zubris

Amino- and imino-pyridine iron(II) complexes are well known as olefin polymerization catalysts. When these iron(II) catalysts are used to polymerize diene monomers, ligand substitution impacts the isomer distribution of the polymer repeat units, and ultimately affects polymer properties. This project focuses on the design of new amino- and imino-pyridine iron(II) catalysts to form polyisoprene with controlled isomer distribution. We hypothesized that the installation of a bulky substituent on the ligand's N-donor atom and/or the adjacent C-atom would impact the isomer distribution of polyisoprene, and this has been the focus of our work. Attempts at multi-step synthesis of novel amino- and imino-pyridine ligands with benzyl, benzhydryl, and ethyl substituents will be described; characterization data will also be presented. A reaction pathway was investigated and optimized that uses Ellman's chiral auxiliary for ligand synthesis. A second approach using zinc(II) chloride intermediates was explored. Work is ongoing to optimize product purity and yield for our multi-step ligand synthesis. In future work, iron(II) complexes with more bulky substituents on the ligand's N-donor atom and/or the adjacent C-atom will be investigated as catalysts for polymerization of isoprene and other diene monomers.

B-31: Copper CNC Pincer Complexes: Synthesis, Characterization, and Opportunities for Polymerization Catalysis
Authors: Acosta, Enzo; Rongo, Austin; Zubris, Deanna
Advisor: Dr. Deanna Zubris

The use of earth abundant metals for catalysis is an active area of investigation. While chelating CNC pincer ligands have been used for a variety of metal-ligand complexes, examples with copper are limited. We have synthesized and characterized CNC pincer ligands bearing identical substituents on opposing imidazolium nitrogen atoms; examples with different substituents on opposing imidazolium nitrogen atoms have also been realized. Further, the corresponding bimetallic copper (I) complexes have been synthesized by two methods: a transmetalation route with a silver(I) intermediate and a direct metalation route under aqueous basic conditions. Characterization data for these copper (I) complexes will be presented. Studies are underway to optimize reaction conditions for controlled radical polymerization, and progress towards this aim will be described.

B-32: Desorption Electrospray Ionization (DESI) for the Analysis of Surface Contaminants in Consumer Products
Authors: Barrera, Alan; Lagalante, Anthony
Advisor: Dr. Anthony Lagalante

This research will use desorption electrospray mass spectrometry (DESI-MS) to measure other environmental contaminants on the surface of materials. There is a published concern that certain brands of adhesive bandages, such as Johnson & Johnson and CareScience, may contain the forever chemicals PFOA and GenX. According to a study by MAMAVATION, they claim to have found 328 parts per million of organic fluorine in the Band-Aids, although the method of extraction is unknown and the specific type of PFOS found is not specified. DESI-MS was used to measure PFOA and GenX from the surface of bandages. In addition to bandages, other consumer medical items such as dental floss are reported to contain these forever chemicals. In a second study, 6PPD and 6PPD-quinone were measured on the surface of automobile tires by DESI-MS. Although 6PPD is not harmful to human health, 6PPD-Q can be fatal to coho salmon and other aquatic life. In a third study, bisphenols including BPA and BPS were measured on the surface of receipts by DESI-MS.

B-33: Effects of pH on Algae *Nannochloris eucaryotum* for Biofuel-Compatible Lipid Production
Authors: Tobin, Catherine; Clement, Emme; Fedele, Sophia
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 outlines the cultivation of the algae *Nannochloris eucaryotum* and the measurement of four intracellular lipids. During the summer, algae from a 25% nitrate-based colony were split into three groups: two colonies were grown at each pH level of 7, 8

and 9. 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.

B-34: How Extensions on the N and C-terminal of Proteins Impact Conservation, Function, and Stability

Authors: Lucenko, Sarah; Palenchar, Peter
Advisor: Dr. Peter Palenchar

Large-scale and proteome-wide studies of evolution compare orthologs between two different organisms and normally focus on the amino acid percent identity in proteins or the Ka (nonsynonymous substitution rate) or Ka/Ks (nonsynonymous substitution rate/synonymous substitution rate) of genes. However, these metrics don't consider mutations that result in differences in the number of amino acids in a polypeptide chain (e.g. indels). Protein structure and stability greatly impact protein evolution. To understand how evolution, protein stability, and differences in the number of amino acids in a polypeptide chain interact, we've identified *E. coli* proteins with at least 15 extra amino acids on their N or C-terminus compared to the orthologous protein in other organisms. Analysis of these proteins allows us to understand how adding amino acids to the N and C-terminus relates to the evolutionary conservation of the gene, protein sequence, protein function, and stability.

B-35: Phase Separation of Polyubiquitinated Proteins in UBQLN2 Condensates Controls Substrate Fate

Authors: Mulvey, Erin; Llivicota-Guaman, Jeniffer
Advisor: Dr. Daniel Kraut

Ubiquitination is one of the most common post-translational modifications in eukaryotic cells. Depending on the architecture of polyubiquitin chains, substrate proteins can meet different cellular fates, but our understanding of how chain linkage controls protein fate remains limited. UBL-UBA shuttle proteins, such as UBQLN2, bind to ubiquitinated proteins and to the proteasome or other protein quality control machinery elements and play a role in substrate fate determination. Under physiological conditions, UBQLN2 forms biomolecular condensates through phase separation, a physicochemical phenomenon in which multivalent interactions drive the formation of a macromolecule-rich dense phase. Ubiquitin and polyubiquitin chains modulate UBQLN2's phase separation in a linkage-dependent manner, suggesting a possible link to substrate fate determination, but polyubiquitinated substrates have not been examined directly. Using sedimentation assays and microscopy we show that polyubiquitinated substrates induce UBQLN2 phase separation and incorporate into the resulting condensates. This substrate effect is strongest with K63-linked substrates, intermediate with mixed-linkage substrates, and weakest with K48-linked substrates. Proteasomes can be recruited to these condensates, but proteasome activity towards K63-linked and mixed linkage substrates is inhibited in condensates. Substrates are also protected from deubiquitinases by UBQLN2-induced phase separation. Our results suggest that phase separation could regulate the fate of ubiquitinated substrates in a chain-linkage dependent manner, thus serving as an interpreter of the ubiquitin code.

B-36: Sugar Analysis by HILIC Separation with In-Source APCI-MS/MS Derivatization using Phenylboronic Acid

Authors: Pan, Vincent; Lagalante, Anthony; Reichman, Melvin
Advisor: Dr. Anthony Lagalante

The analysis of carbohydrates and oligosaccharides suffers both from poor separation on liquid chromatographic (LC) columns and poor ionization for detection by mass spectrometry (MS). A separation method using hydrophobic interaction liquid chromatography (HILIC) and post-column derivatization with phenylboronic acid (PBA) was developed to better separate and detect this class of compounds. PBA was used to derivatize mono-, di-, and polysaccharides directly in the heated atmospheric pressure chemical ionization (APCI) MS source. Conditions were optimized for multiple reaction monitoring (MRM) using tandem mass spectrometry and applied to the detection of saccharides and advanced glycation endproducts (AGEs) in mouse urine and kidney samples provided by Lankenau Medical Research.

B-37: Synthesis and Characterization of Ruthenium (II) Terpyridine Complexes

Authors: DeAngelo, Anthony; Paul, Jared; Kassel, Scott
Advisor: Dr. Scott Kassel

A series of homoleptic ruthenium (II) terpyridine (2,2';6',2"-terpyridine) complexes with a general formula of [Ru(R-phenyl-terpyridine)2]2+ were prepared using a microwave reactor. Varying substituted terpyridines with electron donating (methoxy) or electron withdrawing (trifluoromethyl) R groups allowed for the systematic study of the electronic effects on the ruthenium metal center. The complexes were characterized via 1H NMR, cyclic voltammetry, and UV-Visible spectroscopy.

B-38: Synthesis of a Series of Phenyl Substituted Diamines (4) for Preparation of NHC Ligands

Author: Brouwers, Leona
Advisor: Dr. Eduard Casillas

The goal of this study was to produce diamine (4) substituted with N-2,6-dimethylaniline. The purified diamine (4) will be used in the formation of an organometallic compound used as a polymerization catalyst. The formation of this amine target material was developed in three consecutive reactions. After preparing N-(4-bromobutyl)phthalimide (2) from phthalimide (1) and electrophilic 1,4-dibromobutane, the purified product would be the starting material for the addition of an aniline in Step 2. The N-(4-(2,6-dimethylaniline)butyl)phthalimide (3) product was formed by a substitution of the terminal bromine with dimethylaniline. The purified product would be used to generate the final target amine (4) in Step 3, by cleaving the remaining phthalimide (1) remnant. The possible formation of undesired minor products did not prove to affect the efficacy of the experiment (?)** Product yields from these consecutive reactions, specifically the substitution of bromine in Step 2, leaves much for further improvement. The purified amine (4) will be used in the formation of an organometallic compound used as a polymerization catalyst.

B-39: The Development of Disinfectant bisQACs Based on a Bolaamphiphilic Architecture
Authors: Asanta, Johanna; Casey, Caroline; Rachii, Diana; Wuest, William; Minibole, Kevin
Advisor: Dr. Kevin Minbiole

Quaternary ammonium compounds (QACs) play crucial roles in healthcare, industry, and domestic settings. Most commercially utilized QACs like benzalkonium chloride have a common architectural theme, with a single ammonium center and hydrophobic tail; this amphiphilic structure can effect bacterial cell lysis. However, there has been a rise in bacterial resistance over the years toward these commercially available QACs, which necessitates the development of novel compounds for effective bacterial control. Some QACs such as chlorhexidine feature a bolaamphiphilic architecture, comprised of two cationic centers at the molecular periphery and a non-polar region connecting them. Inspired by such structures, a series of 40 biscationic amphiphilic compounds based on an aromatic core, featuring flexibility of linker lengths, alkyl tails, and relative substituent positioning, have been synthesized to study their structure activity relationship (SARs). Antibacterial activity evaluation against a panel of bacterial strains, including ESKAPE pathogens (A. baumannii and P. aeruginosa), were encouraging, with micromolar inhibitory concentration (MIC) of 0.5 - 4μM against all tested strains for select compounds.

Chemistry and Biochemistry

B-40: Aerosol Jet Printing of Solid Oxide Fuel Cells
Authors: Buckner, Jaylen; Moreland, Sebastian
Advisor: Dr. Bryan Eigenbrodt

SOFCs (solid oxide fuel cells) can be fabricated through ink suspensions made of nickel oxide per yttria-stabilized zirconium and lanthanum strontium manganite per yttria-stabilized zirconium by way of aerosol jet printing. Aerosol JetÒ Printing permits SOFCs to undergo functional gradation of layer composition to enhance cell design, flexibility, and innovation. More specifically, the Aerosol JetÒ Printing of an electrolyte and composite layers both get incorporated within anode-supported button SOFCs to display electrochemical performance, in which LSM (cathode) and NiO (anode) are functionally graded and explored. As a result, deposition rate studies, linear sweep voltammetry, and scanning electron microscopy were incorporated with the aerosol jet printing of solid oxide fuel cells to determine how efficient solid oxide fuel cells are based on their production of heat and electricity. Additionally, sample NiO/YSZ and LSM/YSZ fuel cells were run through Raman Operando spectroscopy, as well as electron impedance spectroscopy, to determine what temperature or temperatures each fuel cell operates best at from a range of 600 to 800 degrees Celsius. The parameters around the aerosol jet printing of NiO/YSZ and LSM/YSZ (ink deposition head height, atmospheric air pressure of ink deposition, ink deposition head speed, flow rate of ink deposition, and the spacing of lines for ink deposition) were studied to determine the best approach to fuel cell preparation. In turn, many inks of LSM/YSZ and NiO/YSZ were tested with varying levels of Disperbyk-III, polyethylene glycol (PEG), benzyl butyl phthalate (BBP), ethyl cellulose (EC), Butvar (PVB), and 2-propanol. All fuel cells created from both LSM/YSZ and NiO/YSZ inks were heated in furnaces at varying temperatures to infuse the anode and cathode layers (NiO and LSM) into the fuel cells of YSZ. Thus, our findings us closer to determining what type of fuel cells work best for aerosol jet printing and many real-world applications.

C-41: Characterization and Electrochemistry of BIAN Derivative Ruthenium Complexes
Authors: Coyne, Max; Paul, Jared; Kassel, Scott
Advisor: Dr. Scott Kassel

A series of ruthenium 2,2¢-bipyridine complexes with derivatives of 1,2-bis(arylimino)acenaphthene ligands (Ph-BIAN, Mes-BIAN, 2,6 MePh-BIAN, and 3,5-MePh-BIAN) were prepared using microwave irradiation. The complexes were characterized by 1H, COSY (1H- 1H correlation) NMR, IR spectroscopy, and mass spectrometry. The electronic properties of varying the substituents on the pyridyl component of the BIAN ligand were studied by luminescence and UV-Visible spectroscopies, as well as electrochemistry. Initial studies on a related series of complexes with β-diketiminate ligands (Ph-BDI, Mes-BDI, and 3,5-MePh-BDI) were also reported.

C-42: Comparison of Photoirradiated Arctic Marine Dissolved Organic Matter to Standard Lignin Solutions Using Fourier Transform Ion Cyclotron Resonance Mass Spectrometry
Authors: Hutchison, Sydney; Mitchell, Katie; Youngren, Meghan; Boschi, Vanessa; Grannas, Amanda
Advisor: Dr. Vanessa Boschi

Global warming has pervasive effects around the world including temperature increase, flooding, and increased storm patterns. The Arctic faces the most immediate and harshest consequences of global warming due to ice melt. Studying the geochemical effects of reduced ice volume in the Arctic and its impact on water chemistry is necessary to better understand global warming. To model changes in Arctic water chemistry due to reduced ice coverage, the photochemical reactivity of lignin, an abundant component of marine dissolved organic matter (DOM) and biopolymer integral to cell wall structure in plants, was investigated. To do this, a standard lignin solution was photoirradiated and extracted at different time points. Samples of Arctic water DOM collected from different regions along an ice extent and at different depths were also photoirradiated for comparison. All samples were analyzed using Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FTICR-MS) and all compounds were categorized by their elemental ratios, molecular formula types, aromaticity types, and compound class. In the Arctic water samples, there were changes in the abundance of lignin-like compounds which were not observed in the lignin standard solution. This may indicate a methodological error in the classification of lignin or that the chemistry of lignin is biota driven instead of photochemically driven.

C-43: Crowd Control: Are Trypanosomal HAD Activities Impacted by a Crowded Environment?
Authors: Murphy, Audrey; Grzech, Eva; Palenchar, Jennifer
Advisor: Dr. Jennifer Palenchar

Human African Trypanosomiasis (HAT) and Chagas Disease are parasitic diseases caused by trypanosomes, ancient single-celled eukaryotes. Therapeutics for these parasitic infections are often lacking or problematic. There is a need for new therapeutics. Further, these parasites have surprised again and again with unusual biochemical features. In this vein, we present the partial characterization of three *Trypanosoma brucei* haloacid dehalogenase (HAD)-like proteins. All three *T. brucei* HADs were acquired by the parasite from prokaryotic bacteria through horizontal gene transfer. HAD32, HAD35, and HAD42, named for the molecular weight of each protein, are important to the life cycle of the

parasite. We sought to ask the enzyme activity of the HAD enzymes and if they are redundant. Further, we explored the possibility that the HAD proteins are regulated by each other or crowding molecules. Finally, we've begun to construct the tools to evaluate the HAD proteins in vivo.

C-44: Does Binding to Iron, Copper, and Zinc Affect the Evolutionary Rate of Proteins?
Author: Gutierrez-Pagan, Marianna
Advisor: Dr. Peter Palenchar

More abundant proteins evolve more slowly, presumably to avoid mutations that can cause toxic misfolding intermediates. Iron and copper can generate reactive oxygen species (ROS) that damage cells or tissues. To function, some proteins must bind to these redox-active metals. Misfolding of iron and copper-binding proteins might contribute to these metals being involved in unregulated and toxic reactions, which might impact the evolution of the proteins. To test this hypothesis, copper, iron, and zinc-binding proteins were identified. We compared three measures of evolution: percent identity of the amino acids in the proteins and the Ka (nonsynonymous substitution rates), and Ka/Ks (nonsynonymous substitution rates/synonymous substitution rates) values for the genes. Analyses based on comparisons of *S. typhimurium* proteins and genes to the orthologous proteins and genes in *P. putida* indicate that iron- binding proteins have lower Ka and Ka/Ks, and higher percent identity than expected. Interestingly, no differences were identified when comparing iron-binding proteins and genes from *E. coli* to *S. typhimurium* and *P. putida*. More work is needed to understand the organismal factors that cause these variations in the results.

C-45: Investigating Proteasomal Degradation and Glycine-Linked Modifications in Ubiquitinated pDAK581 Constructs
Author: Palta, Arushi
Advisor: Dr. Daniel Kraut

In eukaryotic cells, the ubiquitin-proteasome system plays a crucial role in degrading intracellular proteins. For degradation to occur, the proteasome must unfold and translocate folded protein domains, but "slippery" sequences, like glycine-rich regions, can impair this process by hindering the proteasome's grip during translocation. Our lab has shown that substrates degraded from the N-terminus can be affected by slippery sequences ranging from positions close to far away from the folded domain, with closer sequences having a greater impact on unfolding. We aimed to investigate how this compares with degradation from the C-terminus. To explore this, we investigated degradation of DHFR-ACTR-Neh2Dual substrates, where DHFR (dihydrofolate reductase) is a stably folded domain that resists degradation, ACTR is a natively unstructured protein, and the Neh2Dual degron allows ubiquitination. I created constructs with different regions of the ACTR domain replaced by glycine-rich sequences (e.g., ACTRΔ(1-10Gly), ACTRΔ(11-20Gly), up to ACTRΔ(51-60Gly)) to systematically examine the impact of these modifications on proteasomal degradation. Degradation experiments with the glycine-free control construct have been completed, allowing us to measure unfolding ability, and further experiments with ubiquitinated constructs are planned to compare their degradation profiles.

C-46: PII and Its Interacting Partners
Authors: Gennerman, Lexie; Palenchar, Pater
Advisor: Dr. Peter Palenchar

Nitrogen signaling protein PII plays a vital role in prokaryotic organisms, particularly in bacteria and cyanobacteria, by regulating responses to nitrogen availability. It functions as a sensor and transducer, influencing key metabolic processes like nitrogen fixation and amino acid synthesis. PII interacts with various proteins and metabolites, regulating gene expression and enzymatic activities to optimize nitrogen utilization. To explore the evolutionary interactions of PII with proteins like NAGK, AmtB, and PipX, we analyzed conserved amino acid residues using R for comparative analysis. Interestingly, no significant conservation was noted in the interaction between PII and AmtB. Laboratory studies involved cloning PII from *E. coli* and *A. Thaliana* to facilitate further investigation of these interactions, providing insights into the functional dynamics of PII in nitrogen signaling. This research underscores PII's essential role in maintaining cellular homeostasis amid fluctuating nitrogen levels, emphasizing its ecological significance.

C-47: Re-engineering the Cofactor Specificity of a Bacterial β-hydroxybutyrate Dehydrogenase: Can We Tune Cofactor Usage via One Amino Acid?
Authors: Newman, Ethan; Goldschmidt, Avi; Palenchar, Jennifer
Advisor: Dr. Jennifer Palenchar

Our laboratory studies the cofactor specificity of β-hydroxybutyrate dehydrogenases (HBDH). HBDH catalyzes the reversible conversion of hydroxybutyrate to acetoacetate, utilizing NAD in nearly all characterized enzymes except trypanosomal HBDHs. Our lab has successfully altered the cofactor specificity of several HBDHs. The crystal structure of an NADP-dependent eukaryotic trypanosome HBDH revealed an additional residue that may play a role in cofactor specificity. To better understand the cofactor specificity of NAD-dependent β-hydroxybutyrate dehydrogenases (HBDHs), mutagenesis was used to generate mutations in *Pseudomonas putida* HBDH: a single mutant (H56Y or H56C) and a double mutant (T14R/H56Y or C). The mutations mimic those found in the NADP-dependent trypanosome enzyme. H56 is not in direct contact with cofactor, but T14 is. Each enzyme contains an N-terminal His-tag used in nickel affinity chromatography purification and was purified to approximate homogeneity. Enzyme activity was monitored at 340nm. The results show that a single tyrosine residue at position 56 is sufficient to alter the cofactor specificity of *P. putida* HBDH. Further, the interaction between residues 56 and 19 will be presented.

C-48: Synthesis of Aspergillipeptide D and Analogues, an Antiviral Cyclic Pentapeptide Natural Product
Authors: Harth, Madison; Tiffany, Aidan; O'Reilly, Matthew
Advisor: Dr. Matthew O'Reilly

Herpes simplex virus (HSV-1) is an infection that causes painful ulcers and damage to the central nervous system. The pathogen has begun to develop mutations and resistance current therapeutics used to treat the virus, which creates a need for novel therapeutics that target the virus through unique mechanisms. Aspergillipeptide D is a cyclic pentapeptide natural product, and it has been reported to have antiviral activity against HSV-1, including resistant strains. The natural product has never been synthesized, and linear peptide cyclization to produce small cyclic peptides is often challenging due to

oligomerization and/or C-terminal racemization. To address this, a solution phase synthesis of Aspergillipeptide D's linear peptide precursor was performed, and cyclization conditions were screened using high throughput experimentation to evaluate different combinations of coupling reagents, bases, and solvents. Ideal conditions were chosen via LC-MS analysis of the reagent array, and reaction scale-up was performed, producing benzyl protected Aspergillipeptide D in 48.5% yield through 3 steps (saponification, Boc-deprotection, and cyclization). Preparation of analogues was pursued to evaluate the structure activity relationships, including an alanine scan and synthesis of derivatives with variable stereochemistry and N-methylation, which demonstrated that these seemingly minor changes to the linear peptide can have enormous implications on cyclization success. Finally, a pseudodilution cyclization approach was investigated to improve yield and reduce solvent waste. Our approach will allow for the production of an aspergillipeptide D analogue focused library to investigate their activity against HSV-1.

Civil and Environmental Engineering

C-49: Behavior of Castellated and Cellular Steel Beams
Authors: Solomons, Madeline; Bensche, Avery; Colocotronis, Ari; Dinehart, David
Advisor: Dr. David Dinehart

While most buildings utilize long-spanned standard steel beams, the need for a newer, cost-effective material has increased within the past one hundred years. Cellular and castellated steel beams (C-Beams) are beams with cutouts within them, typically hexagonal or circular, that have then been welded back together. These steel beams have been extensively researched during this period with regards to their design, buckling and bending patterns, reactions to fire and elevated temperature, earthquake performance, and general stability, failure, and strength. Cellular and castellated beams are cost-effective due to their low labor-to-material cost ratios and have excellent strength-to-weight ratios. However, when cutting out a part of the beam and increasing the depth, the beam can undergo multiple modes of failure when being loaded. The objective of this project is to summarize the findings of those who have previously conducted research on this topic while also presenting my own data analysis of two different steel beam tests. Two sets of tests were conducted in which a conventional steel beam and a cellular counterpart were tested to the same load of 3000 pounds to compare their performance. These were bending tests designated to be within the linear elastic range of a standard wide-flange steel beam. Displacement, strain, load, and time were recorded during the tests. Once the beams reached a load of 3000 pounds, they were unloaded.

C-50: Evaluating the Effectiveness of Foamed Glass Aggregate for Lightweight Concrete Mixes
Authors: Radford, Gabriella; Dinehart, David; Musselman, Eric
Advisors: Dr. David Dinehart and Dr. Eric Musselman

Concrete, a prevalent material used in construction, is easy to form and has strong compressive strength. However, the development of lightweight concrete can further reduce production costs and lessen the impact of concrete on the environment (Adhikary *et al.*, 2021). For example, both the harvesting of raw materials and the carbon dioxide emissions caused by concrete production negatively impact the environment (Mohamad *et al.*, 2021). Therefore, a more sustainable approach to concrete

production is practiced through using recycled, lightweight materials in concrete. Utilizing these materials has shown environmental benefits such as lessening energy usage, ozone depletion, and green-house gas emissions compared to conventional concrete (Tahir *et al.*, 2022). Expanded glass as a lightweight aggregate is both environmentally friendly and cost-effective. In the United States, the recycling rate of glass containers was 31.3% with approximately 3.1 million tons of glass containers recycled. Additionally, 7.6 million tons of MSW glass was placed in landfills (EPA, 2023). Therefore, the concrete industry could reduce the amount of unrecyclable glass waste in landfills while simultaneously reducing the weight of the concrete (Adhikary *et al.*, 2021). Previous studies have shown the strength of concrete is orrelated to the strengths of the lightweight aggregates. Moreover, studies show lightweight concrete can increase the porosity of the concrete adding more variably to the strength (Mohamad *et al.*, 2021) (Adhikary *et al.*, 2021). The correlation between lightweight concrete and decreased strength creates a foundation for inquiry on lightweight concretes compressive strength. This study aims to test the compressive strength of lightweight concrete produced using Aerolite Graded Foamed Glass Aggregate (FGA). In this experimental study, data was collected from concrete mixes with different ratios of FGA as both fine and large aggregates.

C-51: Feasibility Study for PA Bluestone Byproduct in the Production of Sustainable Concrete

Authors: Rauschenberger, Ryan; Musselman, Eric; Dinehart, David
Advisor: Dr. Eric Musselman

In this ecological crisis, today's civil engineers must discover more sustainable alternatives that can lessen the environmental impact of construction. One of the most commonly used materials in construction is concrete, and a major consequence of concrete is the degradation of river biomes to provide the river sand acting as fine aggregate. To this end, a feasibility study was conducted on utilizing stone dust byproducts from local bluestone to partially replace the river sand. This would not only reduce the amount of river sand being used but would also recycle a waste product and make the concrete cheaper. To evaluate the concrete, compressive cylinder tests and a slump test were performed at replacement levels of 10%, 20%, 30%, and 40%. After testing, it was determined that at lower levels of replacement, a large majority of the strength could be retained but at the cost of workability. From this, it was concluded that a partial replacement could work to produce concrete that is more sustainable with a strength suitable for construction purposes. Workability issues are shown to be able to be solved with the addition of more water and can retain its strength with the help of a water reducer. The stone dust concrete then is proven to be a viable alternative to traditional concrete at lower replacement levels.

C-52: Investigating the Impacts of Land Use Change on Urban Heat and Vulnerability in Cali, Columbia

Author: Bruffey, Breana
Advisor: Lauren Webster (NASA)

The urban heat island effect (UHI) is an environmental phenomenon where cities experience higher temperatures than rural areas due to increased pavement and decreased cooling from vegetation. Approximately 76% of people in Colombia live in urban areas, and the city of Santiago de Cali is facing UHI challenges exacerbated by land use change. Wetlands and forests formerly surrounded the city but were replaced by development and agriculture. The Colombian municipal government agency

Departamento Administrativo de Gestión del Medio Ambiente and the community organization Fundacion Dinamizadores Ambientales partnered with NASA DEVELOP to evaluate communities in Cali most vulnerable to urban heat. This project illustrated the utility of using NASA Earth observations to evaluate the relationship between land use, temperature, and social factors in Cali, Colombia between 2013 and 2023. The team used Landsat 7 Enhanced Thematic Mapper Plus (ETM+), Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS), and Landsat 9 OLI-2/TIRS-2 to generate land surface temperature (LST), normalized difference vegetation index (NDVI), and albedo maps in Google Earth Engine. Heavy cloud cover limited the accuracy of the LST but incorporating up to three satellites for a median image reduced potential errors. Through further analysis in ArcGIS Pro, the team classified land use change using a deep learning model and found that LST was significantly higher in urban areas than in wetlands or forests. Using R studio, the team ran a principal component analysis to determine which social factors had the strongest correlation with LST. The team found that health care and green space access were negatively correlated, and Afro-Colombian ethnicity was positively correlated with LST. With awareness of the most impacted and vulnerable regions, the partner organizations can work to prioritize green space establishment in those areas to reduce the impacts of urban heat. Addressing the urban heat island effect will reduce environmental justice concerns within the city and improve overall health, air, and water quality for those who live there.

Communication

C-53: Liminal and Contested Identities: Elaborating on Communication and Social Consensus in Social Identity Development and Belonging
Authors: Cardwell, Megan; Mondesir, Mehyssa
Advisor: Dr. Megan Cardwell

Belonging to a social identity group is not as clear-cut for some as it is for others. Adjusting in one's identity may not be that simple of a process for everyone, especially when social interaction is added. People with liminal or contested identities, the ones who exist between established identity categories and challenge rigid or fixed boundaries, often encounter difficulties that prevent them from feeling accepted by others who share those traits, or even from fully accepting themselves. This is all made possible through the intertwining of communication and social consensus. Communication allows for individuals to assert their social group membership and for others to either accept or reject their assertions, which in turn co-constructs the nature of their relationship to the group. Quite often, the rejection and acceptance carry such significance to the affected party that it alters the way that they are viewed altogether. This is something which highlights not only the power, but also the effects of communication, as they are so significant in relation to the definition of ones' identity. This research focuses on the role of communicative and interactional factors in an individual's sense of self and well-being. More specifically, it aims to understand the experiences of those who do not fit neatly into sedimented identity categories, and to determine how their experiences of inclusion and exclusion within their (non)overlapping social ingroups implicates their social and psychological wellbeing.

Computing Sciences

C-54: Improving LLMs for Linguistic Diversity: Igbo Translation
Authors: Nguyen, Minh; Nwafor, Ebelechukwu
Advisor: Dr. Ebelechukwu Nwafor

This research focuses on fine-tuning state-of-the-art large language models (LLMs) to enhance translation performance for low-resource languages, particularly emphasis on Igbo. Using a combination of open-source benchmark datasets and self-created dataset, we aim to improve the accuracy of translations for languages that are underrepresented in mainstream machine translation systems. In addition to optimizing performance, we compare the results of our fine-tuned models with those of GPT-4, evaluating differences in translation accuracy. Through multiple benchmark datasets, we identify both strengths and limitations of existing models in the context of low-resource language translation. Our findings contribute to closing the gap in machine translation for underrepresented languages and offer valuable insights for enhancing LLMs' multilingual capabilities. This research promotes linguistic diversity in AI, providing a pathway for more inclusive machine translation solutions.

C-55: Automatic Quality Estimation for Data Selection and Curriculum Learning
Author: Nguyen, Hiep
Advisor: Dr. Justin DeBenedetto

The accelerating increase in the size of language models (LMs) in recent years has led to an increase in the amount of training data required for training. While these larger models have shown strong performance, their use comes with added training and data costs, can be resource-prohibitive, leading to a shift of large LM research from academic to industry. This research focuses on exploring quality estimation as a method of data selection or filtering. This approach was applied to machine translation models with varying data sizes as well as to the BabyLM Challenge. Given the 100M word dataset provided in the BabyLM Challenge, we test out various strategies for selecting 10M words for pretraining and use a curriculum learning approach based on the quality estimation scoring. We have found small improvements in certain data settings.

C-56: Decoding YouTube's #AntiHaul Phenomenon: Analyzing Conscious Consumption Content on Social Media
Authors: Jackson, Rebecca; Perdoncin, Sophia
Advisor: Dr. Sarah Cooney

YouTube's #haul trend has inspired many videos that regularly amass millions of views. These #haul videos showcase newly bought items and can significantly impact viewer's consumption habits. Amid this trend, some creators have begun posting #antihaul videos, discouraging the over-consumption present in #haul videos. In this project, we used the YouTube Data API to compile a list of #antihaul videos, utilizing qualitative analysis to explore the ways creators present their content. Based on previous research and confirmed by our findings, these videos can be categorized into several motivations; in particular, we found motivations related to representation, environmental concerns, 'not for me,' 'too much,' and smart shopping. We considered that viewer engagement may be related

to each video's motivation; however, statistical testing and graphical methods proved this hypothesis false. Further, we found the themes with the least focus on anti-consumption–including 'not for me' and smart shopping--were the most commonly cited motivations. Ultimately, our findings suggest that the #antihaul trend may have begun with a desire to promote conscious consumerism, but #antihaul content has become increasingly focused on motivations outside of sustainability. This project contributes to the exploration of how social media platforms can promote sustainable behavior and is part of ongoing research quantifying the concepts of consumerism and anti-consumerism on algorithmic platforms.

C-57: Diagnosing Attention Deficit Hyperactivity Disorder using Artificial Intelligence
Author: Huang, Xin
Advisor: Dr. Venkat Margapuri

Artificial intelligence and machine learning are changing the medical field, with recent research exploring deep learning models to diagnose cancer and Alzheimer's using X-rays and MRI scans. My research focused on using 2D, 3D, and 4D deep learning models with functional MRIs (fMRIs) to identify correlations and potential diagnoses of ADHD based on brain structure. We began with 2D models, such as ResNet and InceptionNet, to analyze MRI slices frame-by-frame. However, this approach was limited by the high amount of black space in the images, resulting in models that produced near-random (50/50) predictions. Moving to 3D models was similarly ineffective, as fMRIs are inherently 4D, making the 3D analysis insufficient to capture the data's complexity. Finally, we applied a 4D approach, using a UNet model from MONAI combined with a Recurrent Neural Network (RNN) to incorporate the temporal dimension of fMRIs. I initially used Google Colab to run my code, but due to its computational limitations, the 4D model approach didn't succeed. After switching to Augie, Villanova's cloud service, I gained the necessary processing power; however, an error emerged during the process, and unfortunately, my research period concluded before I could resolve it. This research underscores the complexities of applying deep learning to fMRIs and the need for further exploration of computational solutions to enable effective 4D analysis.

C-58: Exploration into the Efficiency of Parallelized Regular Expressions.
Author: Wang, Tom
Advisor: Dr. Mauricio Gruppi

For many modern technologies that deal with texts, regular expressions are a critical component in processing and parsing raw data into more useful forms. However, the usage of match patterns for string searching, like other algorithms in that general problem field, could be faster. We started by exploring a non-deterministic finite automaton (NFA) approach using managed C#, looking for ways to parallelize Thompson's construction. Initial approaches didn't bear fruit as we soon found the sequential nature of automata meant that parallelization in the construction stage and direct comparison stages was ill-feasible. The focus then shifted to realizing faster string searches, whereby an input corpus could be partitioned into n sub-corpora and parallelized thereon. Our results were then benchmarked against grep and the .NET regular expression engine. After remediation of matches appearing at divisional borders, we found this approach generally outcompetes DFA implementations when dealing with smaller corpora owing to significantly less overhead in the initial construction. However, we realized that scalability to larger corpora was less efficient, necessitating the adaptation of our work to unmanaged code and further research into NFA alternatives. As the current

implementation does not make use of skips, one route could further explore improvements by leveraging concepts behind the bad character and good suffix rules that Boyer-Moore utilizes, albeit to a token or token grouping level.

C-59: Machine Learning and Neural Networks to Predict Colorectal Cancer Treatment
Authors: Kazanjian, Garik; Margapuri, Venkat
Advisor: Dr. Venkat Margapuri

Colorectal cancer, also known as colon cancer, is a type of cancer that originates from the colon that can be either be non-cancerous (benign) or cancerous (malignant). Malignant tissues can grow to other parts of the body, causing a disruption in a person's digestive movements. Despite recent advancements in treatment options, there is a need to predict the correct personalized treatment for patients while understanding how to navigate between different treatment plans. A machine learning based approach can leverage patient specific characteristics including medical history, genomic data such as mutated genes and structured gene variants, and clinical symptoms. The study will utilize a publicly available dataset from the Cancer Genome Atlas (TCGA), that contains clinical and genomic data from 594 patients, 594 samples and 33 treatment options collected from patients with colon cancer. The aim of this study is to address predicting these medicinal treatment plans for patients through a machine learning (ML) based approached application. The ML algorithm will navigate across features such as genetic mutations, structural variant genes, and cancer scores to predict which treatment would be most well-tailored according to a patient's situation. The approach comprises testing different algorithms including Support Vector Machine (SVM), Random Forest, k-Nearest Neighbors, and XGBoost. The study will determine the most effective approach based on an evaluation of the performance of these ML models based on performance methods such as percent accuracy, f1 and mean error scores.

C-60: NoteNinja: A CNN-Based Solution for Multi-Currency Classification and Accessibility
Author: Panday, Swopnil
Advisor: Dr. Venkat Margapuri

Currency classification is a critical challenge in today's connected world, especially for international travellers and individuals with visual impairments. While many classification techniques are based on Optical Character Recognition(OCR), the study presents the development of an innovative Convolutional Neural Network (CNN)--based solution for accurate and efficient currency note classification designed for accessibility and financial independence. Our research began by focusing on distinguishing between the front and back of US one-dollar bills, later expanding to multiple currencies. We implemented transfer learning techniques using pre-trained models, primarily ResNet50 and compared their performance with other architectures such as VGG16. The methodology involved creating a diverse dataset, initially comprising 1,000 high-quality images of one-dollar bills, captured under varied conditions. This dataset was later expanded to include multiple currencies from different countries like the USA, Nepal, India etc. ultimately encompassing 20 different types of bills, providing a robust foundation for a solid classification system. A key outcome of this research was the development of a user-friendly mobile application using Swift. This app enables real-time currency identification, providing immediate audio feedback - a feature designed for visually impaired users. For travellers, the app offers quick and accurate currency

recognition, facilitating smoother financial transactions in foreign countries. Our future work will be focused on expanding the currency database, exploring advanced architectures like EfficientNet, and conducting extensive real-world testing with target user groups to better the application's usability and accuracy.

Education and Counseling

D-61: Shaping Young Minds: The Impact of News Media on Elementary School Education
Author: Garcia, Dusy
Advisor: Dr. Rachel Skrlac Lo

This research explores how news media influences elementary school education, examining its impact on both curriculum development and student learning. News media, encompassing television, print, and online platforms, has become a pervasive force shaping public perception and knowledge. In the context of elementary education, this research investigates how news stories, particularly those related to politics, social issues, and science, are integrated into classrooms. Using content analysis, this research aims to identify trends and patterns in the use of news media in elementary education. The findings will contribute to the ongoing conversation about media literacy in early education, providing insights into how teachers and parents can balance the educational value of current, past, and future curriculums around the United States.

D-62: USTRIVE & GEOPATHS Project: Incorporating SocioScientific Issues and Social Justice into Environmental Science
Authors: Marco-Bujosa, Lisa; Hughes, Sarah; Jett, Sanaa
Advisor: Dr. Lisa Marco-Bujosa

The topic Geoscience has been what most consider underrated. Its roots in science and objectivity have become the subject's primary goal in education. Many teachers have forgotten or not become aware of its importance regarding societal structures and environments. One way we attempt to solve this is adjusting pedagogies to incorporate social domains relative to the student. We aim to challenge traditional science class curriculums that tend to lack relational themes, and make them more inclusive for students. Our project showcases the importance of educators incorporating procedures and pedagogical strategies to cultivate cultural appropriations, and liberal ideals to produce inclusion in a topic (math/science) that, when utilized incorrectly, fails students in urban communities. Educators role and beliefs systems are crucial when conducting and leading a class. How they present material, what material, and usage of different perspectives have the power to create good students, but even greater adults. Curriculum can feel bland and discouraging. To maintain structure, the SSI Framework allows room to not only know your student, but making their learning more profitable. This strategy can look like more class discussions, group work, hands on activities, etc that encircle community scientific topics and factors.

Electrical and Computer Engineering

D-63: High Efficiency Power Amplifier For 50 MHz using GaN-FET
Authors: Kapranov, Dimitri; Berde, Andrew
Advisor: Dr. Tommaso Cappello

The research included the design, fabrication, and testing of the high efficiency class-E power amplifier using GaN FET at 50 MHz. A three-stage design was implemented to meet the specifications of the IEEE IMS student design competition that sets the objective to generate 10-11 W CW output power from the input signal of unmodulated constant amplitude sine wave with a power level of 10 dBm and a dc-voltage supply of 12 V. Additionally, the rules asked to suppress the power output at the harmonic frequencies by at least 40 dBc. The final design relies on the design equations of the class-E PA theory in the amplifying stage obtained in research ahead of time, generates an inverted/regulated square wave to drive the GaN transistor, and uses an LC-LC matching network to satisfy the harmonic specification. After manufacturing and tuning the device, it yielded a respectable efficiency of 85.8% at 10.35 W output power.

Geography and the Environment

D-64: An Assessment of Community Gardens in the City of Philadelphia
Authors: Lemmons, Sophia; Fryberger, Rylie; Douyon, Kenny; Kremer, Peleg
Advisor: Dr. Peleg Kremer

Urban community gardens offer many environmental and communal benefits, from reducing CO2 levels and the urban heat island effect to promoting public health, connectivity, and food security. The Philadelphia Garden Data Collaborative (PGDC), formed in 2016, partners with local organizations to collect and maintain data on community gardens in Philadelphia. PGDC aims to preserve land and empower growers, particularly in low-income areas facing food insecurity and gentrification. PGDC has created a comprehensive inventory of gardens and land parcels, crucial for evaluating urban agriculture's value and preventing adverse sales of garden land. Data collection was last completed in 2019. To maintain this database, a data collection campaign was conducted in the summer of 2024. A group of researchers from Haverford and Villanova universities visited 719 sites previously known to be gardens to survey each site. Utilizing 123 Survey and ArcGIS technology, the study offers a full census of garden activity, including identifying the garden spatial footprint, garden type, public access, and water access. In addition, each garden was associated with all of the city parcels on which it is located to allow for analysis of garden tax status and enable analysis of garden tax delinquency. The results illustrate the abundance and spread of urban community gardens, offering critical insights for tracking land parcel ownership and tax records to prevent foreclosures and preserve these spaces.

D-65: Assessing Ultrafine Particle (UFP) Levels in Philadelphia Subways
Authors: Gjertsen, Ava; Alejandra Molina, Maria; Coppes, Johnernest; Staley, Justin; Eggler, Aimee; Shakya, Kabindra
Advisor: Dr. Kabindra Shakya

High levels of air pollution in subways have become a critical issue for public health in urban areas. The underground platforms can exhibit high levels of UFP caused by passenger movement, subway operations, and the friction that is generated between the wheels of the subway car and the tracks. This research aims to assess the UFP levels in Philadelphia subway stations and analyze their impacts on human health looking at the UFP number concentration and lung-deposited surface area (LDSA) and compare it to that of suburban and roadside UFP levels. Sampling was conducted at three subway locations (15th Street Station, 5th Street Station, and Cecil B. Moore Station) and at a suburban location. UFP was measured using the Naneos Partector 2. Mean LDSA in below ground subway locations at 15th Street Station was almost two times the LDSA in the roadside locations. Mean LDSA in below ground sample locations at 5th Street Station and Cecil B. Moore Station were only slightly higher than the roadside locations. However, the mean LDSA for all the below ground locations was three times higher than the mean LDSA for the suburban location, and the mean LDSA for above ground locations was over twice as high as that of the suburban location. High concentrations of LDSA indicate an increased deposition of particulate matter within the alveolar regions of the lungs, which is one of the most vulnerable areas of the lungs for health effects when it comes to pollution.

D-66: Climate Change & Water Vulnerability in the Middle East
Author: Booth, Alyson
Advisor: Dr. Frank Galgano

Climate change is a multifaceted issue that is exacerbating vulnerabilities in regions already facing political, social, and economic challenges with implications on environmental security. Among the consequences of climate change are increasing temperatures and decreasing precipitation, which are of particular importance in the Middle East. The Middle East is already vulnerable due to aspects including government instability, inequality, economic dependency, food insecurity, communication, and lack of access to health care. With environmental shifts, the physical and regional security risks are heightened as resilience to climate impacts is undermined. Through the spatial and temporal analysis of climate data, specifically temperature and precipitation, which impact these vulnerabilities and environmental security, this research will consider the growing environmental risks in the region that is already experiencing endemic instability.

D-67: Local Scale Spatiotemporal Modeling of Air Temperature Using Remotely Sensed Surface Temperature in a Peri-Urban Environment
Author: Jenkins, Brent
Advisor: Dr. Peleg Kremer

Land surface temperature (LST) is commonly used in studies of urban heat island (UHI), human health, and heat vulnerability because of its wide spatial availability. Air temperature (AT) is a more accurate representation of human heat experience but is limited in spatial representation. AT measures the warmth of the air at a specific height, while LST is measured by capturing the heat emitted from the Earth's surface. The thermodynamic properties of LST and AT differ, a relationship that becomes

complicated in urban and peri-urban environments where materials with low albedo, such as asphalt, are prevalent. In this study, we created a stationary monitoring network to measure AT data and collected Landsat LST data during summer 2024 to explore the dynamic relationship between AT and LST in the peri-urban environment of Villanova, PA. We aim to construct a spatiotemporal model capable of predicting AT using LST across the Villanova University campus. It is critical to account for spatial and temporal dependence in the model as it is well known that temperature is not independent across space and time. Comprehending the relationship between LST and AT is critical for a nuanced understanding of the impact of local climate on human health and well-being.

D-68: Particulate Matter Variability within Philadelphia Subway Stations, and their Respective Aboveground PM Levels

Authors: Coppes, Johnernest; Gjertsen, Ava; Molina, Maria; Staley, Justin
Advisor: Dr. Kabrindra Shakya

Air pollution, specifically particulate matter (PM), can pose risks to human health, once suspended into the atmosphere at high levels. PM can be formed from combustion of fossil fuels, industrial, and natural processes. PM can vary regionally, and oftentimes is found to be higher in enclosed spaces, such as subway stations. This study assesses the difference between aboveground and belowground atmospheric PM levels within three subway stations in Philadelphia, Pennsylvania, and how PM levels vary across the different stations. Particulate matter of different sizes (PM2.5 and PM10) were measured using the DustTrak DRX (model 8533) from approximately 9:00 AM - 3:00 PM each day. These measurements were collected at the platform within the subway stations, and above ground at the street level. The three locations that were selected for this study were the 15th St. Station, 5th St. Station, and the Cecil B. Moore Station. The belowground PM 2.5 mean levels that were measured were all significantly higher at all three subway stations compared to aboveground levels. Belowground PM 2.5 levels were also found to be higher at 15th St. Station, compared to belowground levels at the other two stations. High levels of exposure to particulate matter within Philadelphia SEPTA stations show the importance of proper cleaning, and maintenance within these stations, as well as future infrastructure changes to ensure PM inhalation rates lower in the future.

D-69: Philadelphia Roadside and Subway Black Carbon Assessment

Authors: Shakya, Kabindra; Coppes, Johnernest; Gjertsen, Ava; Staley, Justin
Advisor: Dr. Kabindra Shakya

High level of particulate matter (PM) in subway systems can pose health risks to commuters and workers. Subway systems, particularly those in urban areas, are especially vulnerable to elevated PM levels. This is due to inadequate ventilation and the friction created by the train's metal wheels breaking on the tracks, generating additional PM. This study focuses on measuring BC concentrations in an underground subway station during the Summer of 2024 and comparing them to levels aboveground in Philadelphia and in a suburban location. Black carbon, essentially a form of soot, comes from the incomplete combustion of fossil fuels from vehicles, posing serious threats to human health and the environment through warming and contamination. The findings revealed that the highest BC concentrations were recorded in the subway environment, followed by the roadside location in Philadelphia, with the lowest concentrations observed at the suburban site. This study helps indicate that while trains do not emit BC inside the subway systems, external factors, such as outdoor traffic can also influence the underground BC levels. The findings underscore the need for improved

ventilation and pollution control measures in subway systems to protect public health, given the high BC level observed in subway systems.

D-70: Sowing the Seeds of Pollution: How Plastics are Shaping Soil Chemistry
Author: Hansen, Grace
Advisor: Dr. Steven Goldsmith

Recently, plastic mulching has become commonplace in both large- and small-scale agriculture. Despite this widespread use, the practice is of concern to human health as lab-based research suggests plastic mulching materials, such as polyethylene, can leach heavy metals in solution. However, the metal leaching potential of plastic mulching materials in field settings is unknown. This study assesses four types of commercially available weed suppressant materials for metal leaching potential and physical degradation: PE sheeting, a blue all-purpose vinyl tarp, coconut husk roll, and burlap roll. Materials were placed in mason jar microcosms consisting of small rocks, overlain with planting soil with the weed suppressant placed on top to imitate agricultural conditions. All microcosms were deployed in Villanova University's greenhouse with 5 samples of each material collected at the 30- and 90-day time intervals. Each microcosm was watered weekly with 40 mL of deionized water to replicate a 1-inch rainfall, further emulating field conditions. Total metal concentrations in the materials and underlying soils were determined using an x-ray fluorescence spectrometer, while exchangeable metal concentrations were determined using an acetic acid extraction and inductively coupled plasma mass spectrometry. Physical degradation of samples was also evaluated through weight change. The hypothesized results are that plastic mulching materials will exhibit higher metal leaching and lower physical degradation under field conditions than nature-based alternatives. The study results provide insights into potential alternatives to the use of agricultural plastics, reducing the impact of such plastics on environmental and human health.

D-71: The Value of Peer Mentorship in Diversifying the Geosciences: Lessons Learned from the Villanova Environmental Geochemistry Summer Institute
Authors: MacKinnon, Kayla; Santana, Sade; Turner, Heith; Feldman, Hannah; Goldsmith, Steven; Shakya, Kabindra; Boschi, Vanessa; Marco-Bujosa, Lisa
Advisor: Dr. Steven Goldsmith

The geosciences are one of the least racially and ethnically diverse STEM fields. However, the geosciences are uniquely positioned to address issues of environmental injustice, such as disproportionately high levels of soil, water, and air contaminations in disadvantaged urban communities. Additionally, increased diversity in the geosciences would lead to more inclusive decisions. The Villanova Environmental Geochemistry Summer Institute (VEGSI) is a partnership between Villanova Department of Geography and the Environment and the Walter B. Saul High School in Philadelphia, P.A; a school with ~80% of children below the poverty line and about 85% from underrepresented minority groups (URM). In Sumer 2024, the VEGSI program hosted 10 high school students from Saul High School to carry out experiments documenting the disparities in pollution exposure along the Cobbs Creek watershed, from the wealthy and predominantly white suburbs to the predominately black communities in West Philadelphia. As undergraduate peer mentors, we assisted three student cohorts (soil, water and air teams) with their investigations, which consisted of soil core collection, air pollution monitoring, and plastic waste collection. We also assisted the three cohorts with mapping and graphing their data using ArcGIS Pro and Excel, respectively,

and presentation of their results to the City of Philadelphia Environmental Justice Commission. As part of this presentation, we share our reflections on serving as peer mentors and the effectiveness of the program.

Mathematics and Statistics

D-72: Extremal Spectral Radii of Arithmetical Structures on Bident and Star Graphs
Authors: Noonan, Katie; Shattuck, Katie
Advisor: Dr. Alexander Diaz-Lopez

An arithmetical structure is a labeling of integers on a finite, connected graph such that each vertex divides the sum of its neighbors, and the greatest common divisor among all labels is 1. There is a matrix associated to each structure that encodes these divisibility conditions. The goal of this project was to find the structures that maximize and minimize the spectral radii of arithmetical structures on bident and star graphs. We present the structure that minimizes the spectral radius on bident graphs and a conjecture about which structures maximize the spectral radius on bident graphs. For star graphs, we show which structures minimize the spectral radius when the number of vertices is a perfect square or a pronic number, and we present a conjecture for which structures minimize all others.

D-73: Infectious Disease Modeling: Human Papillomavirus in Haiti
Author: Mullen, Clare
Advisor: Dr. Peter Muller

Vaccines and routine testing of Human Papillomavirus (HPV), among other preventative measures, are widely available in high income countries. However, in low- or middle-income countries (LMICs) with poor public health infrastructure and a lack of education, medical breakthroughs, such as vaccines, are a luxury that few can access. In LMICs, preventable diseases are claiming an alarmingly high number of lives each year. For example, cervical cancer is a leading cancer cause of death among women in Haiti, despite the willingness of many individuals to vaccinate themselves and their children against HPV. We use an ODE model to explore the impact of introducing a national HPV vaccine program in LMICs, specifically Haiti.

Mechanical Engineering

D-74: A Fluid Mechanical Study of Rotation-induced Traumatic Brain Injury
Authors: Wang, Qifu; Zhang, Jiaqi; Bates, David; Feng, James; Yue, Pengtao; Wu, Qianhong
Advisor: Dr. Qianhong Wu

Traumatic brain injury (TBI) is a serious health issue. Studies have highlighted the severity of rotation induced TBI. However, the role of cerebrospinal fluid (CSF) in transmitting the impact from the skull to the soft brain matter remains unclear. Herein, we use experiments and computations to define and probe this role in a simplified setup. A spherical hydrogel ball, serving as a soft brain model, was subjected to controlled rotation within a water bath, emulating the CSF, filling a transparent cylinder.

The cylinder and ball velocities, as well as the ball's deformation over time, were measured. We found that the soft hydrogel ball is very sensitive to decelerating rotational impacts, experiencing significant deformation during the process. A finite-element code is written to simulate the process. The hydrogel ball is modelled as a poroelastic material infused with fluid and its coupling with the suspending fluid is handled by an arbitrary Lagrangian-Eulerian method. The results indicate that the density contrast, as well as the rotational velocity difference, between the hydrogel ball and the suspending fluid play a central role in the ball's deformation due to centrifugal forces. This approach contributes a deeper understanding of brain injuries and may portend the development of preventive measures and improved treatment strategies.

D-75: ACL Injury Prediction and Prevention in Athletes: Analysis and Experimental Design
Author: Wollan, Catherine
Advisors: Dr. Chandrasekhar Nataraj and Dr. Garrett Clayton

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. 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, pressure insoles, and a motion capture system. Trials will include kinematic and soccer-specific agility drills, with male and female collegiate athletes. Using comparisons of knee loading patterns, joint angles, and acceleration data, this study aims to identify differences in injury risk between the sexes. This will allow for the identification of safe loading patterns and high-risk movements. With these insights, increased risk for ACL injuries, particularly for female athletes, can be predicted and would potentially lead to injury prevention programs.

D-76: Event Based Camera Usage in Dynamic Systems
Author: Szeghy, John
Advisor: Dr. Stephen McGill

The primary purpose of this study was to understand the practical application of neuromorphic event-based cameras in various dynamic environments. Neuromorphic event-based cameras use a biology-inspired sensor to detect both movement and changes in light. The year-long project analyzed the abilities of the camera as well as the tracking methods used to recognize and trace events. Studying both egocentric and exocentric motion, the camera was put through a variety of tests to find its ideal use environment. The camera was tested in various light conditions, focuses, and temporal resolutions. Peak performance was seen when the camera was stationary, tightly focused, at a mid-to-high temporal resolution, and in an indirectly lit environment. Tests were run in a controlled environment using pendulum motion. The algorithms used to trace motion were based on a Kalman filter. Using the location and velocity of previous events, the algorithm predicted the location of future events. After new events occur, the algorithm uses the measured states from the camera to enhance its propagated state. The result is a frame-by-frame recap of actual events with an overlaid predicted state. The project concludes that neuromorphic event-based cameras are capable tools that work well in stationary, consistently lit environments. While they offer a dense data stream, use in dynamic applications is not practical. Dynamic systems drown out useful data with noise and egocentric events. Performance is at its peak when egocentric motion is minimized.

D-77: Hydrogen Generation for Backup Power in Data Centers
Authors: Kane, Sam; Norman, Maria
Advisor: Dr. Aaron Wemhoff

Data centers consume approximately 1-3% of global electricity and have a corresponding large carbon footprint. One contributor to carbon footprint is the burning of diesel fuel in backup electricity generators, which could be replaced with hydrogen-fueled fuel cells. Two promising areas of exploration for hydrogen production using waste heat generated by the cooling of data center information technology equipment (ITE) are electrolysis and methane pyrolysis via anaerobic digesters. This project both predicts the limits of waste heat-based hydrogen production based on different cooling schemes, compares the energy use efficiency and floor space requirements of hydrogen storage with fuel cells compared to batteries, calculates the energy tradeoffs when vapor recompression of waste heat is used and explores the efficacy of locating data centers near wastewater treatment plants for use of anaerobic digestion to reduce the carbon footprint of data centers, especially when compared to other mechanisms for waste heat recovery for carbon reduction.

D-78: Integration of 3D Printing with Acoustic-assisted Assembly of Nanomaterials for Tunable Strain Sensors
Authors: Yuan, Deana; Yun, Li; Sun, Mingyuan; Feddish, Kathryn; Zhao, Liang; Li, Bo
Advisor: Dr. Bo Li

This study reports a novel methodology for the development of tunable strain sensors by leveraging 3D printing for structural designs and nanomaterial assembly for functional layer coating. We utilized Direct Ink Writing (DIW) to print sensor substrates using composite ink of polydimethylsiloxane (PDMS) and silica nanoparticles. DIW allows us to create a non-uniform strain distribution of the sensor substrate by designing alternating wide and thin strips with different mechanical properties along the stretching direction. Then, we assembled nanometer-thick graphene flakes on the surface of the substrate using an acoustic-assisted dip-coating method to construct strain sensors. The graphene network on the narrow strips will experience large deformation leading to significantly increased resistance. By fixing the width of wide strips and tailoring the width ratio of the wide strip over narrow strips (r), the gauge factor can be controlled from 8.53 (r = 1:1) to 33.15 (r = 16:1). Also, by printing the narrow strips with softer PDMS, the sensitivity of the sensor can be further increased. The research pioneers the integration of 3D printing and nanomaterial assembly for strain sensors. More importantly, it paves the way for the generic design of flexible electronics and other hybrid systems of polymer and nanomaterials.

D-79: Molecule Probed Raman Spectroscopy for Femtogram per Liter Detection of Per- and Polyfluoroalkyl Substances
Authors: Dyke, Alexis; Zhao, Liang; Hu, Jiayue; Gong, Chenchi; Cao, Han; Wu, Jianlei; Bracaglia, Laura G.; Liu, Ling; Xu, Wenqing; Li, Bo
Advisor: Dr. Bo Li

Per- and poly-flourolkyl substances (PFASs), often referred to as "forever chemicals", have received significant attention due to their robust carbon-fluorine bonds. This persistent behavior causes wide concerns especially as PFAS exposure in humans has been linked to many health issues. In this project, we discovered a new PFAS sensing method to achieve a femtogram-per-liter (FPL) detection level in

aqueous solutions. This method utilizes molecule probes on the surface of a polymer substrates to detect the attached PFAS molecules. It also enables the successful detection of multiple PFAS species. PFAS were successfully detected against impurities such as ions, which enables the real-life PFAS detection in complex water systems including surface water. Our method paves the way for highly sensitive, low-cost, and fast detection of PFAS for daily use.

D-80: Optimization of Carbon Dioxide Hydrate Formation with Carbon Nanoparticle Additives: The Key to Reversing the Greenhouse Effect

Author: Patel, Aryan
Advisor: Dr. Calvin Li

The formation of carbon dioxide (CO_2) hydrate is of significant interest to climate change mitigation for carbon capture, storage, and utilization. CO_2 hydrates are crystalline compounds that are formed as CO_2 molecules become trapped within a lattice structure of water ice at low temperature and high pressure. CO_2 hydrates occur naturally within the arctic as a means of sequestering gas, hence, why we effectively aim to recreate its natural formation, although more efficiently. Hence, the maximization of CO_2 hydrate formation is the key to the efficient capture of CO_2. Methods for trapping CO_2 in a stable, solid form will help reduce and ultimately reverse the greenhouse effect. In general, the experimental investigation utilized a chilled, high-pressure system to enable a high solubility of CO_2 in water, leading to high quantities of CO_2 trapped within the water molecule lattice as the hydrate nucleates and forms. Additionally, these high-pressure conditions have streamlined the numerical processes for quantifying the amount of CO_2 stored within the hydrate, allowing us to utilize the Ideal Gas Law, treating the CO_2 as an incompressible fluid. In doing so, we achieved hydrate formation under conditions determined by the hydrate phase diagram, although, were limited by the quantity of CO_2 dissolved prior to hydrate nucleation. Hence, we now look to investigate higher pressure conditions alongside the use of nanoparticle additives to further optimize this process, making it more efficient.

E-81: PolliBot Project: A Low-Cost, Open-Source Mobile Robot for the Testing of Manual Pollination Approaches for Cucumber Plants in an Urban Garden Environment

Authors: Ford, Celia; Tagliaferri, Maria; McGill, Rebecca
Advisor: Dr. Rebecca McGill

With the decline in natural pollinator populations, mechanical pollinators are becoming more widely accepted in agricultural practices. The PolliBot project aims to develop and test an affordable, effective solution for mechanical pollination in field-like conditions. PolliBot mimics the process of hand pollination for pollinator-dependent plants, using multiple motors to control the end applicator and rear wheels, allowing for precise movements. Initial testing in mock garden aisles has shown promising results. These findings support further research into mechanical pollinators for plants that cannot rely on wind-based pollination, with the potential to significantly improve pollination in environments lacking natural pollinators.

E-82: Reach to Grasp: 3D Printed Dual Mode Contact Sensor
Authors: Feddish, Kathryn; Li, Yun; Li, Bo
Advisor: Dr. Bo Li

Flexible sensors are critically important for applications in environmental monitoring and wearable electronics. However, developing a multifunctional sensor with a simple structure remains challenging due to the need for high sensitivity across multiple sensing modes. Here, we fabricated an interdigitated silver-MXene sensor using direct ink writing 3D printing technology for proximity and pressure sensing, both based on capacitive responses. The sensor demonstrated proximity sensing within 5 mm with a sensitivity of 234.8 pF/m and pressure sensitivity of 0.5 pF/N at 38.2 kPa. Additionally, a silver-PVDF-MXene pattern was printed, where the combination of MXene and PVDF induces a dual-mode response, enabling capacitive and piezoelectric pressure sensing with sensitivities of 0.56 μA/N and 1.65 pF/N, respectively. Furthermore, a three-electrode silver-PVDF-MXene sensor was developed for H1N1 virus detection, successfully identifying the virus at four different concentrations. These multifunctional sensors demonstrate strong potential for practical applications in synchronous environmental and biological detection.

E-83: The Blind Robot
Author: Ghorbanian, Datamis
Advisor: Dr. Hashem Ashrafiuon

Individuals with visual impairments developed significant navigation skills by relying on their other senses. This project marked the beginning of the development of a reinforcement learning algorithm that could navigate through an unknown environment. The algorithm was created and tested using a robot vehicle and a motion capture system available in the Heterogeneous Autonomous Vehicles Laboratory (HAVLab). The potential applications of this self-learning algorithm spanned across domains such as autonomous vehicles, automatic control and image processing. The research is currently focused on further developing the algorithm into a comprehensive reinforcement learning system capable of operating in a fully blind scenario. This algorithm is anticipated to serve as a valuable assistive tool for individuals with vision disabilities. In the next stage, the algorithm will undergo training to navigate through environments with no visual information available. Additionally, we are working on implementing multi-agent systems where different autonomous vehicles can communicate with each other. These reinforcement learning agents will be capable of coordinating and controlling multiple vehicles to enhance navigation and overall system efficiency.

E-84: Ultrathin Capacitor-Based Pressure Sensors for Robotic Systems
Authors: Marinko, Christopher; Sun, Mingyuan
Advisor: Dr. Bo Li

Recent progress in robotics and artificial intelligence has called on the use of highly integrated yet miniaturized sensing systems. For instance, robotic hand systems could be greatly improved with the inclusion of ultrathin pressure sensors that can be directly planted onto the device's fingertips. In this project, an ultrathin pressure-sensing capacitor was developed with a target thickness ranging from 10 to 100 nanometers. Graphene, a two-dimensional material consisting of carbon atoms arranged in a single layer, is used as an electrode, and polyethylene is used as a dielectric layer. Deformability of the dielectric later is important to enable pressure sensing capabilities. Due to the atomic template that

graphene provides, the polyethylene dielectric layer is directly assembled on the material with a nanoporous structure of controlled thickness and porosity. The resultant data indicated a minimum pressure detection of 8.35 Pascals with a device thickness of 40 nanometers. This capacitor-based pressure sensor, potentially the thinnest in the world, could bring about important applications in future robotic systems.

E-85: Water-based Assembly of Nanomaterials on Target Substrates
Authors: Ahmed, Sheraz; Williams, Trey
Advisor: Dr. Bo Li

This presentation includes two projects, one centered around the in-situ observation of the dip coating process and one centered around the rate of scaffolding in inks extruded by a direct ink writing (DIW) printer. The first project examines the impact of different variables, such as flow rate and sonication, on particle assembly on a controlled substrate. The substrate involved is a standard glass slide with an even layer of Polydimethylsiloxane (PDMS) on the surface. The nanomaterial used is an aqueous Molybdenum disulfide (MoS2) solution. This MoS2 solution is moved through a simple chamber covered by the glass slide by a pump at a controlled flow rate. The setup of this experiment allows for the in-situ observation of the process by using an Olympus microscope at 10x magnification. The recordings of this process are examined by an AI to determine the rate at which different factors impact the coating process. Due to the nature of this data, it is necessary to carry out this experiment many times to ensure that the data is consistent. In addition to this experiment, another process is being examined in the scaffolding rate of ink used in DIW printers under sonication. For this project, it was first necessary to create a new DIW printer using an Ender 3 pro FDM printer as a base. With this printer, the scaffolding of newly created parts will be examined with and without sonication being a factor to determine whether or not it improves the rate of scaffolding in the ink.

E-86: Wheeled Robot for Human Performance Analysis on a Running Track
Authors: Colocho, Amos; Owusu, Riquel; Smurro, Sabrina; Soto, Diego
Advisor: Dr. Stephen McGill

This research project investigates runners' performance through innovative technology, aiming to foster a human-robot partnership. Our study involves the development of a wheeled, remote-controlled running track robot that will integrate these elements. The robot's capabilities were first modeled using simulations, with an emphasis on efficiency and high torque capabilities. The runner will wear a heart rate sensor during training on a 400m track, which will output biometric data to the running track robot. The robot is designed to analyze this data logged by the heart rate sensor. Future research will aim to develop the robot as a biomarker-driven pacing tool that can leverage the head-to-head psyche that runners experience throughout competition. This will allow the running track robot to act as a pacing robot that can analyze the biometric data in real time and provide personalized pacing support.

Nursing

E-87: Assessing the Effects of Discrimination on Health-Related Quality of Life and Hypertension Self-Care in LGBTQ+ Adults
Author: Dsouza, Aidan
Advisor: Dr. Meredith Mackenzie Greenle

Nearly half of the adult U.S. population live with hypertension (HTN). Hypertension is one of the primary risk factors for cardiovascular disease (CVD). The LGBTQ+ adult population has a higher incidence of chronic disease rates, CVD being one of the most prevalent. LGBTQ+ adults face more socioeconomic hardships which correlates to lower quality of life (QOL). This creates challenges for LGBTQ+ adults regarding their CVD management. The purpose of this study is to explore the relationships between self-perceived discrimination, health-related quality of life (HRQOL), and HTN self-care among LGBTQ+ adults. A convivence sample of self-identifying LGBTQ+ adults 18+ living with HTN was obtained from various LGBTQ+ centers in Philadelphia, PA. Participants filled out a 4-part survey with (a) demographic questions (age, gender identification, sexual orientation, race/ethnicity), b) the HRQOL-4 scale, a four-item measure developed by the CDC which is widely used to measure HRQOL3, c) the Sexual Orientation Microaggressions Scale (SOMS), a 14-item measure that captures self-perceived discrimination9, and d) the Self-Care of Hypertension Inventory (SC-HI), a 23-item measure of self-care maintenance, monitoring, and management appropriate for persons with chronic HTN. Results are still pending analysis. We hypothesize that self-discrimination will be negatively correlated with both HTN self-care and HRQOL and that HTN self-care will be positively correlated with HRQOL. We further hypothesize that HTN self-care will moderate the relationship between self-perceived discrimination and HRQOL, as individuals with better self-care are more likely to have improved HRQOL.

E-88: Exploring Human Trafficking's Impact on Maternal Healthcare Access and Associated Risks: A Scoping Literature Review
Author: Montemuro, Brandy
Advisor: Dr. Elizabeth Dowdell

Human trafficking, or modern-day slavery, is defined as recruiting, harboring, transporting, providing, or obtaining a person for service or commercial sex acts using force, fraud, or coercion. Women who are trafficked face barriers to healthcare that limit their ability to find and access care. Currently, there is a significant gap in the science on the experience of pregnancy among trafficked women. A scoping review was undertaken to identify existing literature on the issues and experiences of pregnancy and maternity care for women who have been trafficked. The Joanna Briggs Institute guidance for scoping review was used. Four electronic databases — CINAHL, PubMed, Scopus, and Embase — were searched for published articles. The search was completed in August 2024 and included the search words: "human trafficking OR sex trafficking OR labor trafficking OR modern-day slavery OR commercial sex sale," "maternity OR obstetrics," "pregnancy OR childbearing OR childbirth," "nursing," "maternity nursing OR maternity care". Frequency and thematic analyses were conducted using Braun (2013). A total of 15 articles were identified, with four themes derived from the literature: the impact of trafficking on health, access to maternity care, knowledge of staff, identification and referral of trafficked victims. Women who have been trafficked and become pregnant are at risk for physical and emotional health complications. Barriers to access of care exist for these vulnerable

women and further complicate maternal health outcomes. Findings support the development of evidenced-based strategies to improve nursing practice when working with victims of human trafficking. Nurses are uniquely positioned as providers of person-centered care to identify, assess, and connect victims with available resources. Additionally, this study acts as a call for future research by nurses and healthcare professionals to further examine maternal outcomes of women who have been trafficked and how the healthcare system can implement interventions to disrupt the associated risks of human trafficking.

E-89: Managing Hospital-Acquired Infections in Older Adults: A Case Study Highlighting Nursing Interventions and Best Practices

Authors: Gensley, Erika; Teeter, Brian; Dowdell, Elizabeth
Advisor: Dr. Elizabeth Dowdell

In the United States, Hospital Acquired Infections (HAI) are a major cause of morbidity and mortality, leading to serious emotional, financial, and health repercussions. HAI are preventable infections that affect 1 in 31 patients with adults aged 65 years or older being at higher risk when compared to the general population. This study employed a case study methodology to explore the dynamics and contextual conditions pertinent to HAI, nurse actions, and interventions. Using a case study involving an older adult who was discharged to home with three HAI and a narrative literature review, this paper describes and discusses the complexities associated with managing such infections in a vulnerable population. Literature from the past 14 years (2010 - 2024) from multidisciplinary databases were used and included studies focused on HAI and/or cross infections, older adults, and nurse(s) and/or nursing interventions. The use of a single case is not generalizable however, by employing this method, this study provides a detailed and nuanced understanding of HAI, nurse actions, and interventions specific to an older adult hospitalization. HAIs are viewed as preventable patient events that stem from a variety of healthcare procedures that expose patients to infectious agents. In the case study, the HAI directly impacted the patient's discharge and led to admission at a long-term care facility. Nurses are distinctively positioned as providers of person-centered care to identify, assess, intervene with clear procedures, and outcomes monitoring to ensure that patients are protected from HAI. Promoting communication between all care providers, re-education on important prevention strategies, and following detailed care regimens are ways nurses may help lower the prevalence of HAI. Working together, nurses and healthcare staff can lead the way in the design and implementation of policies with procedures that allow for reduction and potential elimination of risk for HAI.

E-90: Threads of Connection, Older Adults and Younger Generations' Experiences with ReachOut: A Qualitative Study

Author: Martinez, Daniel
Advisor: Dr. Christina Whitehouse

This research proposal aims to explore the lived experiences and perceptions of older adults (OAs) and younger generations engaged with the ReachOut program, focusing on their overall satisfaction, sense of connection, and feelings of social isolation. The COVID-19 pandemic has exacerbated social isolation among OAs, who often face additional challenges due to existing vulnerabilities. ReachOut facilitates meaningful interactions between students and OAs through conversations centered on common interests, thus addressing the heightened loneliness experienced during the pandemic. The study will employ qualitative, semi-structured interviews with OAs actively participating in the

program for over a month and focus groups with students engaged in ReachOut. The data will be analyzed and common themes will be identified. These themes will help assess the program's impact on both demographics. This research seeks to contribute to the understanding of intergenerational engagement and its role in alleviating social isolation among older adults.

Pharmacology and Toxicology

E-91: Impact of Nanoparticle Inhalation on Term Rat Placental Structure
Authors: McWilliams, Destiny; Seymore, Talia; Cary, Chelsea; Adams, Samantha; Moreno, Gina; Stapleton, Phoebe
Advisor: Dr. Phoebe Stapleton (Rutgers University)

The placenta is a temporary but vital organ that supports fetal growth and development during pregnancy. It is the site of nutrient exchange and fetal growth is dependent on access to these nutrients from the maternal circulation. Due to the high blood flow, placentas are susceptible to damage by xenobiotic particles. Previous studies have indicated an association between fetal growth restriction and exposure to particulates. Sources of exposure include air pollution containing ultrafine particulate matter (<100 nm in diameter). Epidemiological evidence has associated particulate exposure during pregnancy with adverse outcomes. The purpose of this study was to evaluate changes to placental morphology after exposure to particulate matter, which may ultimately affect placental function and fetal development. Sprague Dawley rats were exposed to titanium dioxide aerosols during pregnancy (gestational day 6-19) to mimic exposure to ultrafine particulate matter. Placentas from both male and female fetuses were collected on GD 20, fixed in formalin, and prepared for histological examination using hematoxylin and eosin staining. Zen Blue software was used to measure the area of placental zones and maternal and fetal blood spaces. We observed a significant increase in the size of maternal blood spaces and decrease in the size of the decidua zone in exposed placentas compared to control. This observation was more pronounced in female derived placentas. Understanding how particulate matter exposure affects the placenta will enhance our knowledge of the potential human health outcomes associated with air pollution exposure during pregnancy.

Physics

E-92: Constraining the Inner Radius of the Black Hole Binary GRO J1655-40
Authors: Bohlsen, Hannah; Connors, Riley; Neilsen, Joey
Advisor: Dr. Riley Connors

The study of black holes is integral to the field of astrophysics, providing insight on the physical rules that govern the Universe. They are completely quantifiable by their mass and spin (rotational angular momentum), where the former is much more reliably measured than the latter. Stellar-mass black holes are often found in binary systems with a companion star, referred to as black hole X-ray binaries (BHBs). These systems are good candidates for reliable measurements of spin due to the X-rays emitted by gas accreted from the companion star. One of the most popular methods to perform this measurement utilizes relativistic reflection, occurring when X-ray radiation is reflected off of the accretion disk of the black hole. The reflection features in the X-ray spectrum—the iron Kα line at

~6-7 keV, the iron K edge at ~7 keV, and the Compton hump at > 10 keV—are distorted by the strong gravitational effects of the black hole, and thus can be used to constrain spin. Refection spectroscopy benefits from high sensitivity spectral observations in order to distinguish these reflection features and constrain key physics parameters, such as spin. We present reflection modeling of archival data from the Rossi X-ray Timing Explorer (RXTE), which monitored many BHB outbursts during its years of operation, providing an abundance of high signal-to-noise data. We use updated instrument calibration to reduce detector systematics, referred to as the RXTE-II archive. The BHB GRO J1655-40 was chosen for this study due its availability of RXTE-II data, making X-ray reflection spectroscopy possible for this source. Using these methods we found that the inner radius of its accretion disk (a key quantity needed to reliably constrain spin) remained close to the innermost stable circular orbit (ISCO) down to low X-ray luminosities.

Political Sciences; Sociology and Criminology

E-93: Family Still Matters: Exploring Media Coverage of Presidential Candidates' Families by Gender and Race

Authors: Persico, Mariel; Meenan, Siobhan
Advisors: Dr. Camille Burge-Hicks and Dr. Melissa Hodges

The media's portrayal of presidential candidates' family narratives plays a substantive role in how candidates' messages resonate with voters and can have a strong impact on who wins elections. However, researchers have only recently begun to examine the role of parenthood and family in politics. In this project, we build on the prior work of researchers who have examined these processes using content analysis of the 2004 and 2008 Democratic presidential primaries. Our goal was to further explore the concept of politicized family, which includes narratives of candidates' spouses, parents, grandparents, and children, to gain a broader understanding of the role this concept plays in the political discourse and how media coverage of presidential candidates differed along gendered or racialized lines (Burge, Hodges, and Rinaldi 2019). For the VSSA, we collected over 20,000 additional articles from the New York Times, Wall Street Journal, and Washington Post to extend the analysis to coverage on Republican and Democratic presidential primaries in 2008, 2012, 2016, 2020, and 2024. We completed data collection and began coding articles; however, data cleaning remains far from complete. During the research process, we learned the significance of precise data collection and analysis, reinforcing our understanding of research methodology. This proved to be meaningful research as we learned of the ways media articles can contribute to politicized family narratives ahead of the presidential election, while also gaining immersive research experience.

Psychological and Brain Sciences

E-94: Development and Impairment in Narrative Identity Following the COVID-19 Pandemic
Author: Aguilera, Antonia
Advisor: Dr. John Kurtz

The lockdown policies initiated during the COVID-19 pandemic had a significant negative impact for adolescents and young adults, as this is a critical period in human development. This study hypothesized that the lockdown event disrupted the identity formation process, contributing to negative psychological outcomes among young people. To explore this, 200 participants were asked to narrate two personal stories: a high point and a low point of their pandemic experience. They also completed several self-report measures, including the Self-Concept Clarity Scale, the Ryff Well-Being Scale, and the Basic Psychological Needs Scale. Two independent raters coded the narratives using two Social Cognition and Object Relations Scale -Global (SCORS-G) dimensions, specifically, Identity and Coherence of Self (ICS) and Emotional Investment in Relationships (EIR). Coders achieved high interrater reliability for both scales across both story prompts. The coded narratives showed significant correlations with scores on several self-report personality variables, supporting the hypothesis that the pandemic's impact on personal storytelling reflects broader disruptions in self-concept and psychological well-being. The findings also suggest that the COVID-19 lockdown may have disrupted essential identity development processes in youth, with potential long-term consequences for mental health and personality development.

E-95: Effects of Chronic Stress and Sex Differences on Fentanyl Consumption in c57BL6 Mice
Authors: Nemeth, Colin; Sachs, Ben
Advisor: Dr. Ben Sachs

This research proposal investigates the relationship between chronic stress and fentanyl consumption in C57BL/6 mice, aiming to address the critical issue of opioid misuse. Building on existing literature, this study examines the effects of a non-social stressor on fentanyl intake and associated behaviors in both male and female mice. Two cohorts of 16-20 mice were exposed to either 21 days of variable stressors or handling as controls. Following the stress period, fentanyl consumption was measured using a modified drinking-in-the-dark (DID) paradigm over four days. Data was analyzed using repeated measures two-way ANOVA to assess the effects of stress, sex, and time. The study's broader impacts include informing targeted interventions for opioid use disorder and addressing sex-specific differences in substance use disorders. Future directions involve exploring cellular and molecular alterations, assessing alternative stress timelines, and testing stress-relief interventions. This study aimed to deepen our understanding of the interplay between stress, neurobiology, and opioid use disorder, providing a foundation for more effective treatments.

E-96: Examining the Role of Parent-Child Synchrony in the Well-Being of Dyads Experiencing Homelessness

Author: Helstrom, Sarah
Advisor: Dr. Janette Herbers

Families experiencing homelessness are an understudied but large population that experience risk and also resilience. Specifically, children who experience homelessness are at an elevated risk of having delays in language and social development as well as behavioral and mental health problems. One possible protective factor against those risks seems to be a positive parent-child relationship. Parent-child interactions are fundamental to early cognitive, social, and emotional development in infants and toddlers. Synchrony during parent-child interactions is an effective way to assess the quality of a relationship. Overall, prior research has shown that higher behavioral synchrony of a dyad is associated with sensitive parenting, higher levels of child engagement, and more reciprocal behaviors. However, little is known about the behavioral synchrony of parent-child dyads experiencing homelessness. More knowledge about these relationships will help inform interventions that can increase resiliency in this population. For this project, I will utilize a sample of parent-infant dyads recruited from emergency housing to explore the association between parent-child synchrony and the well-being of the dyads experiencing homelessness. I will use observational coding of parent-child free play sessions in combination with parent-reported depression symptoms and infant developmental scores to evaluate the well-being of the dyad. I predict that there will be positive correlations between parent-child synchrony and dyadic well-being, suggesting that more synchrony is associated with better dyadic emotional and developmental well-being.

E-97: Expanding the Marley Hypothesis: Concrete and Historical Examples of White Privilege Boost White Americans' Systemic Racism Recognition

Author: Spencer, Jane
Advisor: Dr. Caitlyn Yantis

Although White Americans often fail to recognize systemic (vs. isolated) racism, their acknowledgment has been found to increase following exposure to an example of critical history: housing policies that intentionally created Black ghettos. However, this effect is weaker among those who are strongly White-identified (Bonam *et. al.*, 2019). We extend this finding by testing whether concrete historical examples of White privilege also increase White peoples' awareness and understanding of systemic racism. White-identified Prolific participants (N = 472) viewed either historical examples of White privilege (e.g., G.I. bill) or unrelated control examples (e.g., New Deal for Wildlife). As predicted, participants who engaged with White privilege (vs. control) examples reported more knowledge gained about the history of White privilege and systemic racism in the United States as well as greater belief in White privilege. These two factors acting in sequence partially explained participants' heightened recognition of systemic racism in the privilege (vs. control) condition. White identification was not found to moderate these effects. These results highlight the relationship between privilege and systemic racism beliefs and demonstrate that educating White people about their group's historic privileges can help them recognize the systemic nature of racism in the present.

E-98: The Impact of Parental Stress on the Social/Emotional Development of Children Experiencing Homelessness
Authors: Martin, Arthur; Floyd, Delia; Herbers, Janette
Advisor: Dr. Janette Herbers

In the context of homelessness, parents of young children experiencing homelessness tend to experience stress due to several factors surrounding fears regarding their child-wellbeing, lack of social and/or shelter support, difficulty obtaining sufficient educational opportunities, or feelings of isolation and loneliness. Parental distress and child development are often correlated, where external stressors tend to have a significant impact on parental attunement and nurturance. Many existing studies have identified the impact of parental distress on parental nurturance and child well-being as it relates to an increased frequency of physiological aggression toward children, increased child behavior management issues, and the onset of developmental disabilities and psychopathology. Existing research also suggests that affective development in parents and children experiencing homelessness is often transactional, where the mental state and mechanisms by which parents express and manage their emotions frequently have a direct impact on the emotional regulation of children. However, very few studies have sought to pinpoint the mechanisms by which parental distress impacts the psychosocial development of children before adolescence, as children begin to acquire positive (or negative) social-emotional competence. This study seeks to explore the relationship between parental distress and children's social/emotional development in the context of homelessness. Families with children ages 5 and under were recruited from homeless shelters in the Philadelphia area. Structured parent interviews included a range of measures about risk and resilience including parenting distress, trauma, as well as children's social-emotional development. We present preliminary data on 28, families considering the link between stress and children's social and emotional resilience.

Spanish

E-99: Bilingual Perceptual Flexibility in an Auditory Oddball Task
Author: Hanumali, Rina
Advisor: Dr. Grant Berry

This study analyzes how language experience influences perceptual flexibility. English monolinguals (n=21) and English-Spanish bilinguals (n=23) participated in an auditory oddball task while neurophysiological responses were recorded via electroencephalography (EEG). In this task, participants listened to stimuli consisting of the English vowels /ɛ/ (e.g., bet) and /ɪ/ (e.g., bit). Participants heard a series of identical sounds (standard) followed by a distinct (deviant) sound; the standard and deviant sounds were counterbalanced, and the order of stimuli was pseudorandomized. We measured the negative voltage deflection occurring approximately 100-250 ms after the onset of a deviant stimulus (mismatch negativity, or MMN), using each participant's mean amplitude difference between deviant and standard stimuli as a continuous measure of perceptual category sharpness. Data from electrodes Fz, F3, F4, and Cz were analyzed via principal component analysis to generate a single composite measure for perceptual category sharpness (PC1; 84.8% of total variance). These data were then analyzed through linear regression in R to determine whether monolinguals and bilinguals differed in their responses to stimuli that crossed a phonological category boundary. We found significantly lower mean amplitude differences for bilinguals compared to monolinguals ($t(42) = -2.42$, $p < 0.05$), indicating attenuated response to phonological category change. We take this finding as

evidence of perceptual flexibility in bilinguals relative to monolinguals, which may facilitate language processing and mental integration of language change.