

25th ANNUAL

KALMAN
RESEARCH SYMPOSIUM

SATURDAY, APRIL 11, 2026



Bucknell
UNIVERSITY

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INTRODUCTION

Spring 2026

Welcome to the twenty-fifth annual Kalman Research Symposium.

An important central element of the Bucknell experience is to offer our students in all disciplines the opportunity to engage in substantive out-of-the-classroom research and creative projects with faculty. As stated in the mission statement for Bucknell's Program for Undergraduate Research, these opportunities *allow students and faculty to participate in collaborative learning processes designed to dissolve the distinction between teaching and research, and to create a community of learners in which scholarship serves as the basis for teaching and learning.*

The symposium showcases the breadth and variety of undergraduate research taking place at Bucknell, as is evidenced by the abstracts of the projects contained herein. Visitors are encouraged to attend both the oral presentations as well as the poster session to interact with the scholars and to learn more about their work. In addition, more information can be found on the Kalman Symposium website, containing students' posters, slides and recorded presentations.

This symposium is named in honor of Ernest Kalman, who graduated from Bucknell in 1956. In addition to his service as a University trustee, Ernie's generosity to his alma mater has taken many forms, one of which was a significant gift in support of undergraduate research.

The ***Kalman Research Symposium*** features projects sponsored or supported by the following:

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- National Institutes of Health
- National Science Foundation Grant (NSF)
- Neuroscience & Human Health
- Open Discourse Coalition (ODC)
- Pennsylvania Firefly Festival and the Pittsburgh Foundation
- PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)
- PPL Undergraduate Research Fund
- Presidential Fellowship
- Psychology Undergraduate Research
- Robert P. Vidinghoff Memorial Summer Internship
- Ruth Everett Sierzega Chair in Linguistics

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- Susquehanna River Heartland Coalition for Environmental Studies Program - Degenstein Foundation
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- Undergraduate Investigator Grant
- USDA Forest Service, Rocky Mountain Research Station
- Walthour Fellowship
- Waters Family Fund for Undergraduate Research in Animal Behavior
- Wayne E. & Margaret S. Manning Internship in the Botanical Sciences
- Wendell I. Smith Endowed Internships in Psychology
- William Corrington Renewable Energy Fund

Darlin Amaya '28; Maria K. Pisciotta '25; Morgan Benowitz-Fredericks

Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, BIOLOGY, ANIMAL BEHAVIOR

Funding Source: Department of Biology

Is Siblicidal Aggression Innate or Experience-Dependant? Development of Aggression in Black-Legged Kittiwakes

Siblicide, the killing of a sibling, occurs in many bird species and is commonly associated with resource competition. In seabirds called black-legged kittiwakes (*Rissa tridactyla*), it is common to see older chicks attack their younger siblings shortly after hatching, but it does not happen in all nests. We aim to better understand variation in the development of aggression by comparing behaviors in the A chick (born first) at two different ages. This research investigates the potential contributions of prenatal development (innate) and early postnatal experience to siblicide. We recorded behaviors at nests of free-living kittiwakes in Alaska during one-hour-long sessions at two different time points. One, the day after the B chick hatched, and again, when the A chick was five days old. Aggression is common at five days old, but has not been studied in earlier stages. We manipulated postnatal environment by providing supplemental food to some nests. If aggression is innate, we should see aggression from the A chick when the B chick is only one day old, suggesting aggressive behaviors occur very early when presented with competition. In contrast, if increased aggression is only observed when the A chick is five days old and is lower in nests that are food-supplemented, it would support the hypothesis that aggressive behavior develops and is shaped by post-natal experiences and sibling interactions. Comparing aggression between early developmental stages and feeding conditions allows a better understanding of whether siblicide by kittiwakes is innate or shaped by early experiences.

Amy Ammerman '28

Faculty Mentor(s): Professor Brandon Vogel, CHEMICAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Developing a New Method for Measuring Hydrogel Erosion

Hydrogels are polymers that are cross linked together to form a soft, rubbery gel that has the ability to retain large amounts of water. Hydrogels play an important role in many common biomedical applications, such as drug delivery, contact lenses, and wound dressings. When hydrogels are introduced to a pH or temperature change such as the human body, they begin to degrade. In order to maximize controlled and safe drug delivery, we must measure this erosion rate. Typically, hydrogel erosion studies can be conducted in a variety of ways. To name a few, measuring the pH, analyzing the structure, and monitoring the weight of hydrogels over time all provide information that can be related to degradation properties. However, utilizing any single one of these techniques can be disadvantageous depending on the composition of the

hydrogel. My research involved a method that simultaneously measured both color change and integrity fluctuations of hydrogels. With two variables, the erosion models are more accurate, and I can be more confident about the applications of my experiments.

Yahel Amsili '26

Faculty Mentor(s): Professor Rich Kozick, ELECTRICAL & COMPUTER ENGINEERING

Funding Source: PPL Undergraduate Research Fund

Simulating Low Probability of Detection: A MIMO Phased-Array Approach to Covert Communications

Conducted within the Department of Electrical Engineering at Bucknell University during the summer of 2025, I investigated the fundamental principles of MIMO-based covert communications. My primary objective was to simulate a covert wireless link that balanced robust, high-throughput connectivity with a low probability of detection by minimizing transmit power and unintended "side-spill." Utilizing the ns-3 network simulator, I implemented custom C++ phased-array antenna models in both 2x2 and 4x4 configurations. To systematically evaluate performance, I developed an automated Linux shell script that iteratively adjusted transmit power and logged throughput and signal strength at both intended and passive probe nodes. My results demonstrated exceptional beamforming capabilities, with signal strength dropping significantly beyond a narrow 15-degree cone, thereby rendering outside detection highly unlikely. Furthermore, my simulations revealed that the 4x4 array was significantly more efficient for covert operations, as the 2x2 array required double the transmit power to achieve equivalent throughput. Ultimately, I quantified the critical trade-off between connection strength and stealth, providing a foundational framework for the design of future secure wireless networks.

Finn Atkins '26

Faculty Mentor(s): Professor Ronald Ziemian, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: College of Engineering

Performance of Blind-Bolted Connections in Aluminum Hollow Structural Sections

Blind-bolted connections are a well-established alternative to welding in steel construction, but much less is known about how they perform in aluminum structures. This gap is especially relevant for aluminum given the notable strength losses that occur in the heat-affected zone created by welding. This study looks at blind-bolted connections in aluminum hollow square sections (HSS) and whether existing steel-based design guidance can be applied to aluminum with reasonable modifications.

Testing was conducted on both aluminum (6061-T6) and steel (ASTM A500) HSS specimens with matching geometry, allowing for a direct comparison between the two materials. Specimens were detailed so that failure would take place in the HSS wall

rather than through the bolt itself, and both single-bolt and multi-bolt arrangements were tested under tensile loading. For most configurations tested, punching shear through the HSS wall governed failure. However, bolt fracture was observed in some specimens at the outer bounds of the material thickness range, indicating that wall thickness plays a role in determining which failure mode controls. Wall distortion under tensile load is also being tracked as a possible additional limit state, since aluminum has an elastic modulus roughly one-third that of steel.

The results are being used to evaluate whether aluminum connections follow the same strength trends seen in steel and whether pull-out models developed for steel can be adjusted to predict aluminum connection capacity. The broader goal of this work is to give designers a reliable, weld-free connection option for aluminum structures supported by test data.

Caleb Ayau '27; Eric Kennedy; Anurag Roy

Faculty Mentor(s): Professor Anurag Roy, MECHANICAL ENGINEERING

Funding Source: College of Engineering

Understanding the Tribological Implications of Engine Oil Change Frequency Through Elemental Analysis of Used Engine Oils

A predominant factor influencing a vehicle's longevity is its engine health. Typical internal combustion engines experience frictional losses alongside wear owing to the articulation of varied mechanical components. This study develops an assessment to better grasp the implications of oil change frequency from the tribological and longevity vantages. This has broad applicability to customers as automobiles are omnipresent and gives them an assurance on why frequent oil changes and over-maintenance are beneficial. Analysis of the elemental composition of engine oils provides insights into engine wear. By taking note of the metals which exhibit the highest concentration drops after an oil change after a preset number of miles, wear rates in ppm/mile are ascertained. This study also goes on to demarcate the initial uptick in engine wear during the break-in period vis-à-vis the onset of steady-state wear. The trend points towards maximum wear transpiring in the first 1,000 miles, followed by a steady state. The authors believe that this initial oil change is consequential to the longevity of the mechanical components in an engine, which may undermine the general recommendation by OEMs of administering the initial oil change in the 6000-15000-mile range. Manufacturers' recommendations may not account for this initial break-in period, and to maximize overall engine health by minimizing this wear, it is recommended to undertake accelerated oil changes at frequent intervals. The authors are quantifying this benefit to determine the optimal oil change frequency for ideal engine performance based on data from oil changes in multiple automobiles.

Ben Barkofsky '26

Faculty Mentor(s): Professor Katherine Ward, PHILOSOPHY

Funding Source: None

Definitions of Death and Medical Marginalization

In this project, I examine how the medical establishment developed its definition of death in order to argue for a more pluralistic approach to end-of-life decision making. I analyze competing definitions of death—including higher brain death, whole-brain death, and cardiopulmonary death—and explore the considerations that led the medical community to adopt whole-brain death as the accepted definition. I focus on the controversy surrounding Jahi McMath, an African-American girl, and the difficulty her family faced when they rejected the whole-brain definition of death to show that, in the medical field, brain death is not currently understood through a pluralistic approach, and it is a view that reflects white secular values of the medical establishment. I provide a brief history on the racism, mistreatment, and marginalization of African-Americans in the medical field that has limited their participation in defining core concepts within the medical field. I discuss strategies for creating a more inclusive approach to clinical decision making. Brain death is one aspect of the medical field, but it provides evidence of a much larger, systemic issue that must continue to be addressed. In order for our society to become more inclusive and progressive, we should allow people to choose between whole brain death and cardiopulmonary definitions of death, in order to accommodate the values and concerns of a broad range of patients.

Ethan Beachy '26

Faculty Mentor(s): Professor Ibrahim Sulai, PHYSICS & ASTRONOMY

Funding Source: Walthour Fellowship

Development of an Optically Pumped Atomic Co-magnetometer

The hypothetical particle, the axion, is theorized to couple to atomic spin in a similar fashion as magnetic fields; the effects of axions earn the title, pseudo-magnetic fields. Attempting to sense the effects of axions therefore involves building an apparatus, a co-magnetometer, that is ultra-sensitive to magnetic fields but then isolating this apparatus from magnetic signals to isolate axions' pseudo-magnetic signals.

The under construction co-magnetometer is a combination of atomic housing, magnetic shielding, and optical sensing. The construction of a heater circuit is crucial to holding the sensing atoms at the correct vapor pressure to be sensitive to optical pumping. The circuit had to be capable of heating the atoms to orders of magnitude greater than the atomic sensitivity bandwidth. Next, the pseudo-magnetic signals must be isolated from local magnetic fields using shielding. As the passive shielding was previously implemented, the active shielding, consisting of current coils, had to be adapted and characterized. After hardwiring the coil to a precision current supply, the induced magnetic field inside of the coil was graphed as a function of applied current. Implementation of noise canceling circuitry for the co-magnetometer sensor

followed characterizing the active shielding. Negative feedback was introduced to a passive current subtracting circuit, to keep the difference of the two current signals at zero so the common noise between the signals symmetrically canceled. No signal is lost however, as the output of the servomechanism is known. This marks the progress of co-magnetometer construction.

Greyson Belstock '28; CJ Simbiri '28; Emily Colasanti '28; Liv King '27

Faculty Mentor(s): Professor Deborah Abowitz, SOCIOLOGY & ANTHROPOLOGY; Professor Gulay Guzel, MARKETS, INNOVATION & DESIGN

Funding Source: Presidential Fellowship

Upward Mobility and The American Dream in Higher Education

This project examines upward mobility in higher education through the theoretical lens of Pierre Bourdieu, focusing specifically on how cultural capital, social capital, and habitus shape students' educational trajectories. While higher education is often framed as a pathway to the American Dream, not all students enter college with the same resources, networks, or implicit knowledge of institutional norms. Using qualitative interviews with first-generation and non-homeowning college students, this study explores how students perceive their own mobility and how they navigate academic and professional spaces that may not have been designed with their backgrounds in mind.

Drawing on Bourdieu's theory of capital, the research analyzes how students accumulate or lack access to forms of capital that influence persistence, confidence, and post-graduate aspirations. Interviews highlight themes of imposter syndrome, strategic adaptation, mentorship, and the role of familial expectations. At the same time, they reveal resilience and the active ways students work to convert educational attainment into economic and social mobility.

By connecting lived experience to sociological theory, this project challenges the idea that higher education alone guarantees upward mobility. Instead, it argues that mobility is mediated by unequal distributions of capital that shape opportunity long before and long after college enrollment. Ultimately, the study contributes to ongoing conversations about equity in higher education and the structural conditions necessary to make mobility more accessible and sustainable."

Amalia Benenati '28

Faculty Mentor(s): Professor Jayne Kubat, BIOLOGY; Professor Katherine Ward, PHILOSOPHY

Funding Source: Candland Educational Impact Grants

Ethics of Cell Lines as Human Remains

Some objects are inarguably human remains (e.g. skeletons, brains), while some are debatably human remains (e.g. fetuses, blood smears, cell lines). We have been thinking of the status of cell lines as human remains in the context of Henrietta Lacks, and our ethical obligations as we use cell lines in research

and teaching. Join us in our journey as we define human remains and justify whether cell lines should be included in our definition. Some questions we will explore are:

Why are human remains special? Should human remains be treated differently than other objects?

Why might cell lines count as human remains, given the case of Henrietta Lacks?

How does this involve informed consent?

Is de-identification necessary? What are the implications for privacy for the subject and for their family?

What if we have acquired human remains legally, but without informed consent?

Alyssa Bernard '27

Faculty Mentor(s): Professor Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Spatial Analysis of Seasonal Manure Application in Union County

Union County is a hotspot for animal agriculture. Manure runoff from farms pollute the waterways in Union County, which show consistent, high levels of *E. Coli* bacteria. These bacteria can make people sick. Nutrient Management Plans put together by the Conservation District show manure application data. This project maps manure application data from those plans using ArcGIS software. Using seasonal data, four maps were created showing seasonal manure application across land parcels in Union County. In addition, manure application per season for each sub watershed was calculated. The maps showed that manure application is greatest in the fall and spring. This means bacterial levels should fluctuate by season. In addition, basins downstream should have higher bacteria counts. Field testing can be done in the future to determine if this is accurate.

Josephine Bochicchio '27; Evelyn Hergenhan '26

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Low-Intensity Ultrasound Increases Pro-angiogenic Gene Expression in 3D Macrophage and Endothelial Cell Co-Culture

"The goal of this work was to investigate the effects of ultrasound on pro-angiogenic gene expression using reverse transcription polymerase chain reaction (RT-PCR). Low frequency, low intensity therapeutic ultrasound has been clinically shown to advance healing in chronic wounds. One possible way that ultrasound aids in wound healing is by promoting tissue repair through angiogenesis, or blood vessel formation. An increase or decrease of pro-healing cytokines, measurable through gene expression, affects the process of wound-healing.4 Vascular endothelial growth factor A (VEGFA) and fibroblast growth factor 2 (FGF2) are two pro-angiogenic

genes that are expressed by endothelial cells, or the cells that line the inside of blood vessels, which are promising in promoting tissue repair. The purpose of this study was to analyze the effects of low-frequency, low-intensity ultrasound on the expression of both VEGFA and FGF2. Human umbilical vein endothelial cells (HUVECs) and macrophages, a type of immune cell, were cultured together in order to simulate the dynamics between tissue repair and inflammation within chronic wounds. RT-PCR was used to quantify the expression of these cytokines and compare between ultrasound and sham groups. We concluded that VEGFA and FGF2 gene expression increase following exposure to low-frequency, low-intensity ultrasound 18 and 24 hours after exposure. These genes suggest that ultrasound may stimulate angiogenesis in chronic wounds.

Sawyer Bowser '28; Kenny Mineart; Dabrina Dutcher

Faculty Mentor(s): Professor Dabrina Dutcher, CHEMISTRY, CHEMICAL ENGINEERING; Professor Kenny Mineart, CHEMICAL ENGINEERING

Funding Source: Helen E. Royer Undergraduate Research Fund

Caffeine Characterization in Coffee Stouts

The mixing of caffeine and alcohol has been shown to have negative results in consumers. Mixing caffeine and alcohol has been shown to reduce the feeling of "drunkenness" but does not sober the consumer. In addition, caffeine has the potential to heighten the depressant effects of alcohol due to both substances inhibiting glutamate, which can control mood. Consumers have little knowledge of these negative effects, and the FDA does not require companies to label caffeine content in coffee stouts, due to coffee being a natural source of caffeine. The goals of this project are to quantify caffeine concentration in several off-the-shelf, coffee-infused beers and characterize parameters that affect caffeine concentration during the beer production process. High-performance liquid chromatography was used to measure caffeine concentration in all cases. Of the 21 store-bought coffee stouts tested, caffeine concentration ranged from 0 mg to 40+ mg per 12 oz serving. The data of the store-bought stouts collected demonstrated that of a bimodal distribution within this range. For in-house prepared coffee beers, several factors were considered, including alcohol content (ABV), color (SRM), duration of coffee infusion, coffee quantity, and the coarseness of coffee particulates. The beer-centric parameters, ABV and SRM, appear to have a slight effect on caffeine concentration. Alternatively, the coffee-focused parameters demonstrated an increase in concentrations proportional to the amount of coffee beans added. Another correlation of the data was that coffee beans cracked before infusion imbued beers with the highest caffeine content in the sample population.

Matthew Bucaloiu '26; John T. Ptacek

Faculty Mentor(s): Professor John Ptacek, PSYCHOLOGY

Funding Source: Gary & Sandy Sojka Fund for Research, Teaching & Scholarship in Developmental Disabilities, Neuroscience & Human Health

Factor Analysis of the Multidimensional Humility Scale

Humility is linked to improved relationship satisfaction and higher life satisfaction. Due to self-enhancement or modesty concerns, few self-report humility measures exist. We aimed to develop the Multidimensional Humility Scale and minimize these biases. Based on prior research, we generated 90 behavior and belief-focused items avoiding the word "humble." In our first study, 624 participants completed a survey and we conducted two exploratory factor analyses. Across both analyses, 38-items loaded on six factors: cultural humility, self-acceptance, self-suppression, limit-recognition, other-focus, and low superiority. All factors displayed acceptable internal reliability, aligning with the hypothesized factors. For validity checks, we assessed correlations with social desirability and the Honesty-Humility subscale of the HEXACO-PI-R. Three factors were positively associated with social desirability, albeit weaker than Honesty-Humility was. All factors had weak positive correlations with Honesty-Humility. In our next study, for which 322 adults participated, we will conduct confirmatory factor analysis and further validity checks.

Oren Bukowski '26

Faculty Mentor(s): Professor Jonathan Torres, MECHANICAL ENGINEERING

Funding Source: James L. D. and Rebecca Roser Research Fund

Torsion, Tensile, and Impact Performance of Additively Manufactured PA6 Carbon Fiber and Glass Fiber Composites

Additive manufacturing (AM) using fused deposition modeling (FDM) is increasingly applied to fiber-reinforced polymers, yet comprehensive experimental evaluation of their mechanical behavior remains limited. This study expands prior work on carbon-fiber (CF) and glass-fiber (GF) reinforced nylon by investigating the influence of print parameters, annealing conditions, and filament type on the tensile, fatigue, and torsional performance of reinforced and pure nylon specimens. Test coupons were iteratively fabricated using a dual-nozzle FDM system, with process refinements implemented to address support-material adhesion, filament moisture, and print variability. Mechanical properties, including tensile strength, Young's modulus, ductility, and torsional resistance, were extracted through standardized testing and custom data-analysis methods.

Results indicate that appropriate annealing improves consistency in CF and GF composites, though GF specimens exhibited higher print failure rates. Pure nylon demonstrated high ductility and irregular fracture behavior, likely influenced by moisture absorption and thermal history. Measured elastic moduli were generally lower than manufacturer specifications,

suggesting sensitivity to testing conditions and strain measurement methods. Torsional testing showed the greatest reproducibility in pure nylon, while chopped carbon-fiber reinforcement provided the strongest resistance to torsional deformation and fracture. Overall, significant variability across all materials highlights the strong dependence of mechanical performance on processing conditions. These findings contribute to improved understanding and optimization of FDM-printed nylon composites for structural applications.

Madelena Cagnina '27; Delaney N. Pascual '27; Kayla E. Lichtner (Graduate Student); Tori J. Chace '26; Nicole A. Joseph '25; Jack K. Dziubek '25; Benjamin D. Haussmann; Ryan T. Paitz; Zachary T. Bitzer; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY

Funding Source: Department of Biology, National Science Foundation Grant (NSF)

The Effect of Embryonic Corticosterone Exposure on Oxidative Damage and Telomeres

Exposure to maternal glucocorticoids during development can have marked effects on embryonic physiology. Previous studies in avian species report significant effects of prenatal corticosterone exposure, including increased levels of oxidative damage and reduction in telomere length. During oxidative stress, radical oxygen species can accumulate and target DNA, resulting in oxidative damage. However, telomeres help protect DNA, and their degradation can be used as an indicator of cellular health and thereby organismal health and lifespan. This study investigates how embryonic exposure to corticosterone affects oxidative damage and telomere length in developing domestic chicken embryos (*Gallus domesticus*). On embryonic day 0, all eggs were injected with either a sesame oil vehicle or corticosterone. Blood samples were collected on embryonic day 18 to measure erythrocyte DNA oxidative damage (8-OHdG) using HPLC-LC MS/MS and telomere length using the telomere restriction fragment assay. We found that the embryos prenatally exposed to corticosterone had decreased levels of oxidative damage, and we will discuss how this finding relates to telomere length. Contrary to previous studies, this result suggests that the physiological response to prenatal corticosterone exposure may be more complex than previously understood, and we will discuss how this contributes to our understanding of physiological programming during development.

Tue Nhi Cao '27; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE

Funding Source: James L. D. and Rebecca Roser Research Fund

Adaptive Fingerprint Recognition System for Aging and Bias Mitigation

Fingerprint recognition systems are widely used for identity verification, but may experience performance degradation due to aging effects and demographic bias. This work investigates gender bias and aging-related variability in fingerprint recognition using publicly available biometric datasets. Experiments are

conducted on the SOCOFing dataset, which contains fingerprints from 600 subjects with gender labels and synthetically altered samples, and the PLUS Multi-Sensor Longitudinal Fingerprint (PLUS-MSL-FP) dataset, which includes more than 100,000 fingerprint images collected from 59 individuals aged 25–78 across five acquisition sessions over a five-year period using multiple scanners. The evaluation pipeline includes fingerprint preprocessing through binarization using basic, Otsu, and adaptive thresholding, followed by skeletonization and feature extraction using minutiae-based matching and Scale-Invariant Feature Transform (SIFT). A pre-trained convolutional neural network is also used to analyze ridge and texture features. Performance is evaluated using fingerprint pair matching with 49,271 genuine pairs and 49,200 impostor pairs from the SOCOFing dataset. Experimental results show that adaptive thresholding improves recognition accuracy, achieving an overall accuracy of 88%, compared to 86.1% and 82% using basic and Otsu thresholding, respectively. Gender-based evaluation shows comparable performance across groups, with adaptive threshold accuracy of 98.61%, 88.13%, and 73.38% for male samples and 99.07%, 90.75%, and 74.95% for female samples under easy, medium, and hard conditions. These results provide empirical evidence of demographic bias and highlight challenges in maintaining reliable fingerprint recognition performance amid aging effects and acquisition variability.

Giang Cao '27; Priyanka Poplai '29

Faculty Mentor(s): Professor Jude Okolie, CHEMICAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

From Battery to Chemical Absorbent for Drug Removal from Wastewater

Upcycling spent lithium-ion batteries (LIBs) for the removal of pharmaceutical pollutants offers a double solution to persistent environmental problems including mitigating e-waste and addressing the presence of pharmaceutical pollutants in wastewater. This study explores the synthesis, characterization and evaluation of effectiveness of upcycling spent LIBs to an adsorbent. An efficient method to recover non-graphitized carbon from spent LIB cathode powder was proposed. The carbon was used for the production of activated carbon (AC) adsorbent while its performance for the removal of bisphenol from wastewater under controlled conditions were assessed. The adsorbent was characterized, and tested under different conditions (AC dosage, contact time, pH). The results show that activated carbon from spent LIBs cathode powder can be effectively produced through pyrolysis and activation. With clear structural and porous properties confirmed by XRD, SEM, BET and SEM-EDS functions. The material can rapidly and efficiently remove bisphenol within various controlled ranges of temperatures, this demonstrates a promising sustainable adsorbent for both e-waste management and water purification. Future work will be focusing on optimizing production, scale up, and test against more pharmaceutical pollutants in real wastewater.

Austin Carroll '26; Grayson White; Kelly McConville; Will Lindquist '27; George Gaines
Faculty Mentor(s): Kelly McConville, Director, DOMINGUEZ CENTER FOR DATA SCIENCE
Funding Source: USDA Forest Service, Rocky Mountain Research Station

Privacy Done Differentially

The Forest Inventory and Analysis (FIA) program of the USDA reaps several benefits from publishing its plot data. For instance, disclosure allows third-party researchers to help further its mission of monitoring forest trends in the U.S. However, privacy obligations complicate data sharing. To protect the location of its plots, the FIA must first randomly jitter plot coordinates before mapping plots to important auxiliary information. This procedure alters the statistical patterns of the data, which has implications for small area estimation. The goal of this project was to help the FIA determine whether a novel technique, Differential Privacy (DP), enhances both data privacy and accuracy. Of particular interest to the team was whether we could achieve these benefits by adding random noise to each plot coordinate and its corresponding auxiliary data. Our findings indicate that while we can theoretically design a DP mechanism to compute microdata, such a method is taxing in terms of utility. Therefore, we recommend that the FIA conduct research into DP computations that generate synthetic microdata that preserve trends in the original data.

Hunter Cassidy '28; Karlo A. Malaga

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Subthalamic Nucleus Thickness as a Predictor of Optimal Deep Brain Stimulation Electrode Location for Parkinson Disease

The goal of this research is to identify an anatomical feature that can help inform deep brain stimulation (DBS) targeting. In this study, subthalamic nucleus (STN) thickness was investigated as a potential feature.

This was a retrospective study that analyzed a dataset of 72 STNs from 40 Parkinson disease patients who previously received bilateral STN DBS. All patients had tissue properties derived from preoperative diffusion tensor imaging, STN data from preoperative MRI, and volume of tissue activation data from electric field modeling using stimulation parameters associated with optimal clinical outcomes.

Thick STNs had significantly larger radial diffusivity (RD) and mean diffusivity (MD) in the posterior region than the anterior region ($p = 1.7295e-6$ and $p = 9.3758e-4$). Thick STNs also had larger RD and MD in the lateral region than the medial region ($p = 0.0092$ and $p = 0.0168$). Anterior fractional anisotropy (FA) in thick STNs was larger than posterior FA ($p = 1.7295e-6$) and medial FA was larger than lateral FA ($p = 0.0039$). The same comparisons were made for thin STNs. Posterior axial diffusivity

and FA were larger than the anterior region ($p = 0.0020$ and $p = 0.0011$). Posterior RD was larger than the anterior region ($p = 0.0343$).

By looking at STN thickness on a preoperative MRI, surgeons may place electrodes in the most optimal location, overall making the DBS procedure more efficient and minimizing potential side effects and the need to wait long periods of time to get symptom relief.

Tori Chace '26; Kayla E. Lichtner(Graduate Student); Sarah E. Chapman '25; Axel A. Uribe '26; Samuel C. Neirink; Liam U. Taylor; Robert A. Mauck; Patricia L. Jones; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Douglas K. Candland Undergraduate Research Fund, Department of Biology, NSF Grant

Influence of Parental Feeding Dynamics on Offspring Corticosterone in Leach's Storm-petrels

During reproduction, pelagic seabirds must balance energy allocated to foraging flights and parental care. Leach's storm-petrels (*Hydrobates leucorhous*) address this challenge through biparental care, which results in unpredictable fasting and feeding periods for the chick. This natural variation in fed and fast states affects chick physiology. Corticosterone (CORT), a hormone involved in hunger, satiety, and metabolic regulation, may both reflect and mediate changes in a chick's physiological state. We previously found that chicks who were fed more often and more consistently by their parents had larger decreases in baseline CORT over the 20 day study period, while meal size had no significant effect despite high variation among chicks. Here, we further investigated these connections by monitoring chicks all the way from hatching to fledging. Burrow entrance scales allowed us to obtain robust data on feeding frequency, volume, and timing. Plasma samples collected weekly over the chick rearing period were used to measure baseline CORT levels, which were subsequently quantified using an enzyme-linked immunosorbent assay. We will discuss how variation in both fed and fasted periods affect nestling baseline CORT levels across development. This work reveals how parental energy allocation affects baseline CORT in storm-petrel chicks. Understanding the relationship between parental investment and chick physiology offers valuable insights into how early-life investment may ultimately affect a chick's long-term fitness.

Sarah Chapman (Graduate Student); Axel A. Uribe '26; Kayla E. Lichtner (Graduate Student); Tori J. Chace '26; Liam U. Taylor; Samuel C. Neirink; Patricia L. Jones; Robert A. Mauck; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology, National Science Foundation Grant (NSF)

Early-life Telomere Dynamics: Linking Nestling Growth and Parental Feeding in Leach's Storm-petrel

During development, environmental conditions can have profound effects on an individual's telomere dynamics. Telomeres, the protective structures at the end of eukaryotic chromosomes, have been used to understand how life history strategies affect patterns of senescence. Many studies show that telomere loss is greatest during rapid juvenile growth, while others show telomere lengthening during some developmental periods. Previous work in our lab found that Leach's storm-petrel nestlings (*Hydrobates leucorhous*) with the fastest wing growth showed the most attrition in telomere length, whereas body mass had no effect on telomere length. However, few studies have extensively examined telomere dynamics throughout postnatal development, particularly in species with slow life histories. Here, we investigated natural variation in growth and telomere length in Leach's storm-petrel nestlings by collecting daily body mass, weekly wing length, and weekly blood samples for telomere analysis throughout the 66-day nestling period. While there was no effect of body mass on telomere length, wing length was inversely related to telomere length on days 9, 23, and 37 ($F_{7,140}=3.5$, $p=0.0017$). Further, nestlings closer to fledge had more telomere loss than nestlings further from fledge during the last two sampling points ($F_{1,14}=7.2$, $p=0.02$). Telomere dynamics during nestling development are explained partly by early wing growth and proximity to fledging, suggesting that investment toward traits essential for fledging may occur at the expense of telomere maintenance. Future research should explore how environmental factors and changes in blood cell populations influence early-life telomere dynamics.

Aura Chuck Hernandez '27

Faculty Mentor(s): Professor Ted Hamilton, ENGLISH; Ilsa Allen & Carrie Pirmann, LIBRARY SERVICES
Funding Source: Digital Pedagogy & Scholarship Summer Research Program

Mujeres Juntas, "Women Together": Combating Data Driven Distortions of Mexican Femicide Through Narrative

This digital humanities project combines literary analysis with data visualization to portray the scale and urgency of femicide in Mexico. It features an interactive map tour that pairs Mexican novels about femicide with a color coded map showing femicide rates by state. The project also includes advocacy resources and learning guides to support deeper engagement. Through my work, I hope to emphasize the importance of bringing together data and narrative to foster a more holistic understanding of femicide and its impacts.

Jason Chung '26

Faculty Mentor(s): Professor Jessen Havill, COMPUTER SCIENCE
Funding Source: Bucknell Program for Undergraduate Research

EVE-X Results Viewer

Professor Jessen Havill created a program called EVE-X, which identifies the location of endogenous viral elements (EVEs) in mosquito specimens collected. While the program generates files for the results, it lacks a convenient way for a biologist to examine the results. Thus, EVE-X Results Viewer was created to address the issue. EVE-X Results Viewer displays the file structure that EVE-X generates in a user-friendly way, and depending on the name of the file, EVE-X Results Viewer displays it differently. For files containing diagrams in the form of a pdf, a user can open multiple diagrams in a smaller window to compare between. EVE-X generates aligned and unaligned DNA sequences of FASTA files for both viruses and specimens. In EVE-X Results Viewer, unaligned sequences are simply displayed where each line displays a sequence in the FASTA file, and aligned sequences files are color coded for each base to help see alignments more easily. The user can also see a zoomed-out version that would show the entire sequence, and indicators are used to represent where nucleotide bases are shown in the alignment file. Also, EVE-X generates files that cluster similar viral insertions, and those files display the alignments in a similar manner to aligned sequences files with the added feature that the user can change the cluster group if they wish.

Elmira Colpus '27

Faculty Mentor(s): Professor Zuhra Kasimova, HISTORY
Funding Source: Helen E. Royer Undergraduate Research Fund

From Hujum to Hadith: The Development of State-Sponsored Islamic Propaganda in the Soviet Union

Despite being a proclaimed "atheistic" nation, the post-Stalin era found the Soviet Union adopting a decisively less antagonistic policy towards religion. In particular, within the Central Asian Soviet Socialist Republics (SSRs) the religion of Islam was viewed in a more favorable light, even being promoted to other Muslim and Arab nations from the Khrushchev period onwards. This project analyzes the journal Muslims of the Soviet East, a pro-Islam propaganda piece which ran from 1968-1990. Working with the English language edition, three distinct and overarching themes were identified. The first theme is the Soviet relation to the Arab-Israeli conflict. The journal holds the same views as the Soviet government towards Israel. The authors equate Zionism with anti-Sovietness, racism, and colonialism, emphasizing Israel as a Western ally and extension of American imperialism. The second theme is the convergence of the "Soviet" and "Muslim" identities. The conflation of an inherently anti-religious nation and a religious identity seems impossible, but those who edited or submitted a story to Muslims of the Soviet East were deeply devoted patriots. They were not only proud of their religious cultural heritage, but of their nation. Lastly, the journal had

great emphasis placed on both secular and religious education. Authors promoted both the education provided by the Soviet government as well as the religious education present at maktabs, madrasas, and other theological institutions. In addition to those primary themes, the journal and its articles follow along with the geopolitical issues involving the Soviet Union during the publishing run.

Kate Contiliano '29; Justley Sharp '27, Maria K. Pisciotta '25; Morgan Benowitz- Fredericks

Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, BIOLOGY

Funding Source: Department of Biology

Investigating Ontogenetic Trajectories in Seabird Chicks: What Influences the Hormonal Response to Stress?

Rissa tridactyla, known as black-legged kittiwakes, are seabirds who exhibit physiological responses to stress at a very young age. These responses are facilitated by secretion of the hormone corticosterone- a glucocorticoid essential to regulating metabolism, energy expenditure, and maintaining homeostasis. Multiple variables, including age and food availability, could drive variation in a kittiwake's hormonal response. On day 5 of life, juvenile chicks produce adult-like levels of corticosterone following a 15 minute handling period, which may be caused by the intense sibling competition at this age. However, there is no information describing how corticosterone secretion changes with age. Our objective is to delineate how factors such as age and food availability contribute to the first-hatched chick's corticosterone levels. Blood samples collected on Alaska's Middleton Island provided both baseline and elevated corticosterone levels following a standardized stressor in the same chicks at day 5 (when sibling competition is high) and again at day 25 (when sibling competition is absent). To assess the effect of food availability on acute stress response, we collected blood samples from chicks in both food-supplemented and unsupplemented nests. We predict that if corticosterone secretion is primarily influenced by age, baseline and stress-induced levels will differ significantly from day 5 to day 25. However, if food availability is the primary determinant of corticosterone secretion, higher levels will be observed in the unfed chicks at both ages. Preliminary analyses suggest that corticosterone levels are consistently lower at day 25 independent of food supplementation.

Ethan Cowen '29; Zoey Zeng '28

Faculty Mentor(s): Professor Kate Suslava, ACCOUNTING & FINANCIAL MANAGEMENT

Funding Source: Bucknell Program for Undergraduate Research

Talking AI and Talking Money

From your homework to stock picks, AI search engines can do it all. In Q3 of 2025 alone, the proportion of S&P 500 firms discussing AI during earnings calls was 62%! Regardless of industry, AI will be affecting how a business operates and functions. At the same time, managers are grappling with

different views on AI, ranging from optimism to concern. In this project, we analyze corporate disclosures by reading extractions of AI discussions and classifying these extractions into costs and benefits of AI. In our findings, positive AI-related key words tend to emphasize growth and potential—such as opportunities, expansion, and innovation—whereas negative sentiment toward AI is more often associated with words like bias, concerns, and infringement. Next, we generate textual rules that extract costs and benefits of AI from 10-Ks, 10-Qs and earnings calls and calculate AI sentiment scores for each firm. Finally, we examine the trends of the AI sentiment across time and different sectors.

Kade Davidheiser '28

Faculty Mentor(s): Professor Greg O'Neill, MECHANICAL ENGINEERING

Funding Source: College of Engineering

The Emissions Impact of Electric Aircraft in the U.S. National Airspace System

Electric aircraft are becoming more prevalent in our skies, and they are currently being developed with short ranges and small payloads. Electric aircraft offer a solution for reducing the environmental impact of the NAS, and, as with advances in aircraft fuel efficiency, battery technology has continued to improve, advancing electric aircraft over time and reducing NAS emissions. Similar to integrating electric cars into the U.S. National Transportation System, an important question is: What is the environmental impact of integrating electric aircraft into the U.S. National Airspace System (NAS)? This research proposes a methodology to quantify the environmental impact of the NAS by optimizing electric aircraft for inclusion in the NAS and then creating a "mixed" NAS comprising petrol and electric aircraft. This mixture then changes as battery technology improves. Results of this research show that for one day of aircraft operations in the U.S., with battery technologies of 250, 350, 500, 1000, and 2000 Wh/kg, 2.25%, 4.82%, 8%, 13.8%, and 14.81% of all petrol aircraft in the NAS can be replaced by electric aircraft, respectively. This mixed NAS leads to a total reduction in NAS emissions of 0.26% (161 mt of CO₂), 0.688% (386 MT CO₂), 1.14% (746 mt of CO₂), 4.55% (2,017 mt of CO₂), and 6.92% (2,744 mt CO₂) for 250, 350, 500, 1000, and 2000 Wh/kg battery capabilities, respectively.

Aiden Davis '27; Tim Raymond; Ryan Snyder; Dabrina Dutcher

Faculty Mentor(s): Professor Dabrina Dutcher, CHEMISTRY, CHEMICAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Implementation of an Automated PID Control for Atmospheric Particle Processing

Accurately modeling aerosol-cloud interactions is critical for reducing uncertainties in global climate predictions, as the phase state of atmospheric particles directly influences their ability to act as cloud condensation nuclei. This work outlines the optimization of a relative humidity (RH) control system

designed to replicate the atmospheric processing conditions described by Freedman et al. (2015). The experimental set-up utilizes a PID-controlled valve to modulate the ratio of wet and dry air within a sealed chamber, allowing for real-time microscopic optical recording of phase transitions in organic-inorganic droplets.

To meet the experimental requirements of the process, rapid humidification followed by a precise drying rate of 1% RH per minute, two primary enhancements were implemented: mass transfer optimization and interface integration. The mass transfer optimization was achieved by replacing standard bubblers with fine-pore varieties to increase surface area of the bubbles and allow better humidification of the wet stream, and the interface integration was achieved through a mobile application to improve tuning agility and responsiveness while being user friendly to those conducting the experiment.

System behavior was characterized through a series of step-tests, mapping valve response to RH fluctuations. This empirical data was processed via tuning software to generate a predictive model for the PID controller. The resulting automated system provides the stability, linearity, and replicability required to accurately identify the specific RH levels at which particle phase changes occur, providing essential data for more robust aerosol-cloud modeling.

Susan Deering '26; Shalom Beyene; Dave Klawon

Faculty Mentor(s): Professor Tyler Jacks (MIT), MIT Department of Biology

Funding Source: Bernard S. and Sophie G. Gould Fund

Impact of Neoantigen Subcellular Localization in Lung Cancer Development and Tumor-associated Immunity

Cancer mutations may result in “neoantigens” that are exclusively expressed by cancer cells and can be targeted by neoantigen-specific T cells. The molecular characteristics of neoantigens that determine the nature of the immune response are incompletely understood, representing a challenge to cancer immunotherapies. The subcellular location of neoantigens may direct the tumor-associated immune response via cancer cell-intrinsic or -extrinsic mechanisms, yet this remains largely unexplored. We first aimed to determine whether nuclear localization impacts the density of neoantigen presented on the surface of cancer cells. We established an in vitro cytotoxicity assay using lung cancer cells (KP4) engineered to express a model neoantigen (OT-Ip) and specific CD8+ T cells (OT-I). OT-I T cells killed cancer cells expressing nuclear or cytosolic neoantigen at equal rates, suggesting that nucleus-derived neoantigens are not preferentially targeted by cytotoxic T cells. Next, we sought to determine whether subcellular localization impacts the immune response in vivo. We observed higher tumor burden in mice orthotopically transplanted with KP4 cells expressing nuclear neoantigen compared to mice bearing tumors with cytosolic neoantigen or no neoantigen. However, we were unable to detect neoantigen-specific T cells in any setting, suggesting that the effects were not related to the neoantigen. Our future studies aim to further

characterize the impact of nuclear neoantigen expression on tumor burden and the associated T cell response throughout development using an autochthonous murine model of lung adenocarcinoma.

Sumit Dhar '27

Faculty Mentor(s): Professor Peter McNamara, MATHEMATICS & STATISTICS

Funding Source: None

Colorings of Directed Graphs and their Symmetry

We study directed graphs, which are a collection of vertices with some directed edges between them. Graphs can model various networks. For example, consider a social network like Instagram where the accounts are the vertices, with an edge from A to B whenever A follows B. A coloring of a graph is an assignment of colors to the vertices, and it is called “proper” if vertices that are connected by an edge get different colors. The study of proper graph colorings goes back to 1852 when Francis Guthrie posed the famous Four-Color Conjecture. We take a more contemporary approach by encoding all the colorings of a directed graph in an algebraic object called a “chromatic quasisymmetric function (CQF).” Can two different directed graphs have the same CQF? For what directed graphs is the CQF symmetric? We will present partial answers to these questions and some enticing unsolved cases.

Jasleen Dhillon '26; Megan Simpson '26; Janani Hariharan

Faculty Mentor(s): Professor Janani Hariharan, BIOLOGY

Funding Source: The Katherine Mabis McKenna Environmental Internship Program, Department of Biology

Acid Rain Effect on Microbial Community Composition

Acid rain has been a critical issue impacting water sources and ecosystems in central Pennsylvania for decades. Several streams in Union County and surrounding areas have been affected, including a stream in the Buffalo Creek watershed that has undergone remediation to restore its natural pH. Despite acid rain's known impacts on aquatic flora and fauna, few studies have addressed the effects of acid rain on microbes. Microorganisms are essential for soil health, carbon and nutrient cycling, and are crucial components of the food chain in many ecosystems. We collected triplicate sediment samples from a total of seven various inlet and outlet points at the remediation site to assess the impact of the acid remediation treatment on Buffalo Creek, and compare the microbial state of the treated waters to an untreated control. We extracted DNA using the DNeasy PowerSoil Pro Kit and performed metagenomic sequencing to identify the differential composition of the microbial community across the natural pH gradients in the watershed, as well as extract information about specific microbial functions and biogeochemical cycles that might be disrupted by acid rain disturbances. We hope to find microbes that can serve as “indicator taxa” of ecosystem health and recovery levels, and whether we could someday build microbial solutions to aid stream remediation and recovery.

Eryn Drobins '29

Faculty Mentor(s): Professor Paul Barba, HISTORY

Funding Source: None

The Brutality of Prostitutes: A Study on Society In America Between 1775-1783

Women during colonial America were widely misrepresented, even in scholarly research after the time. This treatment was even worse for “women of the night.” Many of these women would serve in the trade of sexual deeds as prostitutes as a form of survival, resorting to this when they have nothing else left. Unfortunately, records, contemporary and modern, are left with heavy bias. The question of morality of the trade of sexual actions comes long before the colonial era, but remains prominent during the time. This creates problems in modern studies as talk of prostitutes during the time spoke on bias related to immorality and male victimhood. These women held an important role in the structure of the war as they increased the fear of disease, particularly venereal disease, among soldiers. This fear they created extended the bias against them during the time, a sentiment that has prevailed through research, and is something I will unravel in this study.

Tyler Dunn (Graduate Student)

Faculty Mentor(s): Professor Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: Graduate Summer Research Fellowship

Coupling Microbial Source Tracking with Quantitative Microbial Risk Assessment to Evaluate Fecal Bacterial Pollution in Union County

Surface water contamination from fecal sources can cause gastrointestinal illness among recreational users. Eleven sites across Union County, Pennsylvania were sampled to assess standard water quality parameters and fecal source contributions. Sixty-eight water samples collected during summer 2025 were analyzed using five quantitative polymerase chain reaction (qPCR) assays targeting human, bovine, swine, avian, and E. coli OP50 markers. Quantitative microbial risk assessment was integrated with microbial source tracking to estimate gastrointestinal risk associated with recreational exposure at each site. Mixed fecal contamination was detected across sites; E. coli OP50 was present in nearly all samples, while human and bovine markers were frequently detected. Modeled risk estimates exceeded the United States Environmental Protection Agency recreational water quality benchmark for swimming at multiple sites, indicating elevated potential health risks for users.

Elio Dzhurbiy '28

Faculty Mentor(s): Professor David Del Testa, HISTORY

Funding Source: Douglas K. Candland Undergraduate Research Fund

Effects of Nazi Propaganda on Citizens of Interwar Germany

Over the summer, I worked with Professor David Del Testa in the History department researching the impact of Nazi eugenic

films on youth in classrooms during the interwar period. I began by learning about Nazi propaganda broadly, then focused on film propaganda. I met with librarians, archivalists, and professors to understand the structure of the Nazi propaganda machine, including its control over film, cinema, and the education system. Nazi propaganda took many forms: cinema, books, clothing, music, and newspapers, but I chose to focus on film.

There were five main types of Nazi films: newsreels, documentaries, historical films, political/social films, and entertainment films. My research concentrated on newsreels, specifically eugenic films. Eugenics is a pseudo-science that claims desirable traits can be reproduced to replace “undesirable” ones. Nazis aimed to promote the “ideal” Aryan race of light skin, blue eyes, and blond hair. These films were shown to all ages, but I focused on those presented to youth in classrooms.

Through reading and viewing these films, I learned they promoted forced sterilization of those deemed “hereditarily ill” or unfit, reinforced racial hygiene, and asserted Aryan superiority while demonizing Jews. They often portrayed people with intellectual or physical disabilities as burdens to society, reinforcing harmful social hierarchies and ideologies. This research gave me insight into how visual propaganda shaped attitudes and policies, particularly targeting impressionable youth, and highlighted the interplay between education and state-controlled media in promoting Nazi ideology.

Vitoria Fernandes de Araújo (Graduate Student)

Faculty Mentor(s): Professor Alomir Favero, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: College of Engineering

Performance-Based Design of Shallow Foundations Considering Soil Variability and Climate Change Effects

Traditional geotechnical design relies on deterministic methods and prescriptive safety factors that often fail to account for inherent soil heterogeneity and dynamic environmental shifts. This research proposes a shift toward a Performance-Based Design (PBD) framework for strip footings, by integrating stochastic modeling with climate-driven hydro-mechanical coupling. The methodology utilizes Smoothed Particle Hydrodynamics (SPH), an advanced mesh-free numerical approach capable of modeling highly nonlinear behavior and large-deformation processes. The framework is developed in three phases: (1) establishing a deterministic baseline validated against classical analytical benchmarks; (2) incorporating Random Field Theory to quantify and include spatial soil variability on settlement analysis; and (3), including hydro-mechanical coupling to simulate soil behavior under transient rainfall infiltration. The hydro-mechanical coupling is necessary to evaluate wetting-induced collapse and the degradation of shear strength and stiffness caused by extreme rainfall events. The primary contribution of the work is a comprehensive set of reliability-based design abaci that will enable practicing engineers to directly correlate foundation geometry with

specified probabilities of exceeding serviceability limit state thresholds related to settlement, based on stochastic distributions of soil properties and evolving rainfall pattern likelihoods. By explicitly integrating geotechnical uncertainty and climate resilience, this work provides a quantitative tool for risk-informed decision-making, ensuring that shallow foundation systems remain functional and safe under increasingly variable environmental and subsurface conditions.

Mia Fitzmaurice '27

Faculty Mentor(s): Professor David Del Testa, HISTORY

Funding Source: Schotz Family Fund

From Erasure to Empowerment: Charter Schools as a Path to Educational Sovereignty for Native Nations

In the United States, the dismantling of DEIA protections, the withdrawal of President Biden's 2021 executive order advancing educational equity for tribal universities, and the suspension of nearly \$3 trillion in federal assistance, including funds for the Bureau of Indian Affairs and Indian Health Service, signal a return to the erasure of Native American tribal identities. Historically, Native communities have endured staggering systemic discrimination, state-sanctioned efforts to suppress cultural practices, and the promotion of Euro-American hegemony. President Trump's Executive Order 14191, directing the Secretary of the Interior to explore allowing families eligible for Bureau of Indian Education (BIE) schools to use federal funds for private, charter, and faith-based schools, introduces a complex debate over whether such policies could empower tribal nations to reclaim authority over education through the creation of tribally-controlled charter schools. Interviews with seven Indigenous education coordinators, policymakers, and curriculum developers across six states revealed broad support for tribally controlled charter schools. Schools such as Kwiyyagat Community Academy (KCA) in Colorado or Native American Community Academy (NACA) in New Mexico were cited as evidence that culturally grounded models can thrive. Still, concerns persist over regulatory and certification barriers that could restrict tribal autonomy. The political debate surrounding charter schools remains divided: political conservatives praise charter schools as market-based reforms rooted in choice and competition, while critics argue charter schools prioritize profit and efficiency over student's educational needs. Yet innovative tribally controlled charters may offer a path toward more equitable, culturally relevant education for Indigenous and non-Indigenous students alike.

Regina Flores '28

Faculty Mentor(s): Professor Elizabeth Durden, SOCIOLOGY & ANTHROPOLOGY

Funding Source: Douglas K. Candland Undergraduate Research Fund

Sabor y Sociedad: Immigrant Restaurants as Bridges in Central Pennsylvania

Immigrants play a crucial role in shaping the foodways and communities they are part of. The following research examines the intersection between local Hispanic restaurants and their surrounding communities. By looking at immigrant restaurants in central Pennsylvania, the incorporation of immigrants and their foodways into the communities around them was studied. The central research questions for this project are: Do ethnic restaurants help immigrants connect with the rest of the community? What impacts do immigrants have on the food industry and their customers? and How well-received are the immigrant restaurants in these rural Pennsylvania communities? Cultural restaurants were found by doing a search on Google Maps before the visits around the areas of Milton, Sunbury, and Harrisburg. The study looked at interactions between the customers and owners, language use, decoration, food presentation, and staff interactions, as these can expose a mix of cultural traditions and adjustment to the local society. Efforts were made to conduct interviews with owners of each establishment to get their perspective on the role they play in impacting the community around them.

Karyna Fowler '26; Rebecca Bonomo (Graduate Student); Zoe Mendel '26; Margaret Rodriguez Sanchez '26; Morgan Daily '27; Bill Flack; Erica Delsandro

Faculty Mentor(s): Professor Erica Delsandro, WOMEN'S & GENDER STUDIES; Professor Bill Flack, PSYCHOLOGY

Funding Source: Bucknell Program for Undergraduate Research

Formal vs. Informal Disclosure of Campus Sexual Assault: Social Reactions, Institutional Responses, and Associated Post-traumatic Stress

While disclosure of campus sexual assault (CSA) is often viewed as a catalyst for healing, the quality of social reactions, whether supportive or invalidating, often dictate psychological outcomes for victim-survivors. This mixed-methods study investigates the CSA disclosure patterns of Bucknell University students, comparing the utilization of informal resources (peers, family) and formal resources (Title IX, the counseling center, public safety). Through quantitative surveys and semi-structured interviews, this research evaluates how the nature of social and institutional reactions correlates with posttraumatic stress symptoms and resilience. Data collection concludes in February 2026, with final findings to be presented at the Kalman Research Symposium to promote trauma-informed campus policy.

Zakaria Frane '28

Faculty Mentor(s): Professor SingChun Lee, COMPUTER SCIENCE

Funding Source: Bucknell Program for Undergraduate

Research Exploring 2D and 3D Facial Recognition and Its Security

Two-dimensional (2D) face recognition is widely deployed for authentication and security, yet it remains vulnerable to spoofing attacks using printed photos, replay videos, and deepfakes. Its reliability also degrades when real-world conditions drift from the enrollment image, especially under changing lighting, facial expressions, and occlusions such as masks or glasses, creating ongoing concerns about both security and robustness. Three-dimensional (3D) facial recognition is often presented as a stronger alternative because it can exploit depth and facial geometry, but its practical resilience and attack surface under adversarial conditions still need clearer, reproducible evidence.

This study evaluated and compared the accuracy, robustness, and security of 3D facial recognition systems against 2D baselines, benchmarking open-source pipelines across public datasets and controlled laboratory experiments. Testing systematically varies illumination (direction and intensity), expression changes, and occlusions, measuring performance in verification and identification tasks. To assess security, the systems were exposed to spoofing attempts using printed media and 3D-printed facial models, recording attack success rates and characteristic failure patterns.

We revealed where 3D methods provide meaningful gains (for example, reduced sensitivity to harsh lighting and certain occlusions) and where weaknesses persisted (for example, vulnerability to high-fidelity 3D replicas or sensor-specific artifacts). By linking failure modes to specific conditions, the work aims to propose targeted upgrades, such as depth-consistency checks, temporal liveness cues, and multi-modal fusion, to harden 3D recognition. Overall, the research clarified trade-offs between 2D and 3D facial recognition and supports the development of more robust and secure 3D authentication in realistic environments."

Delaney Gordon '26; Katelyn Callahan '28; Janani Hariharan

Faculty Mentor(s): Professor Janani Hariharan, BIOLOGY

Funding Source: Department of Biology

Investigating Microbial Nutrient Sharing Based on Amino Acid Exchange and Population Densities

Within microbial communities, many microbes rely on cooperation with each other to survive. One of those relationships is cross-feeding, where one species provides nutrients for the other. This study investigated the sharing of the amino acid methionine between *Priestia megaterium* (*P. megaterium*) QMB 1551, a natural producer of methionine, and methionine-auxotrophic mutant strains of *Escherichia coli* (*E. coli*) (MG1655 Δ metE and MG1655 Δ metE Δ methH). We explored the presence and dynamics of the cross-feeding interaction

between *P. megaterium* and *E. coli*. Additionally, we studied how population densities impact their relationship to help uncover if it is altruistic, mutualistic, or parasitic.

E. coli and *P. megaterium* were grown in M9 minimal media in a 96-well plate. Optical density (OD) at 600 nm (OD600) and GFP fluorescence measurements were taken every 15 minutes to monitor temporal dynamics and changes induced in the co-culture compared to the monocultures. Cell counts per μ L were calculated using a hemocytometer and normalized with OD values to obtain population density ratios.

We show that the *E. coli* mutants need *P. megaterium* to grow in the absence of methionine or vitamin B12. New ratios of *P. megaterium* and *E. coli* are being tested to identify the nature of this relationship, and whether there is an upper limit on the size of the auxotrophic population that can be supported by *P. megaterium* or other providers. The findings from this project will provide insight into the ecological drivers behind microbial relationships and cooperation."

Nicole Gross (Graduate Student)

Faculty Mentor(s): Professor Michael Krout, CHEMISTRY

Funding Source: Department of Chemistry, Chemistry Graduate Research Fund, Department of Graduate Studies

Development of a Selective Synthesis of Allo Bile Acids

Bile acids are a class of polycyclic steroidal molecules which hold much potential in advancing medicine, bioanalysis, and synthesis methods. Typical bile acids feature a cis fusion between the first two rings (A and B). Allo bile acids, on the other hand, contain a trans AB ring fusion, which is consistent with a C5 stereocenter of the opposite orientation compared to regular bile acids. They have unique properties, including potential to aid in immune regulation and cancer detection. However, allo bile acids are relatively difficult to achieve through synthetic methods. Because of this, a reaction with the desired control over C5 stereoselectivity via hydrogenation is crucial to identify. Evaluation of several methods to achieve the C5 allo (trans) orientation revealed a promising approach in the Manganese-Catalyzed Hydrogen Atom Transfer (MHAT) reduction. MHAT conditions were optimized to control the stereochemical outcome in favor of the allo bile acid stereoisomer in a 98:2 ratio and with a yield nearing 90%. In doing so, a foundation was established upon which we can develop the understanding of why and how the reaction is successful in achieving desired selectivity, and what further applications this chemistry could be utilized in.

Kellan Guinn-Bailey '27

Faculty Mentor(s): Professor Chris Mitsch, COMPUTER SCIENCE

Funding Source: None

Plexa: A Foundational Tool for Responsible AI Education

AI in education is a hot topic, and for good reason. Professors and Universities are searching for the answers of how they can prepare their students for the future, but the tools available do not provide for their needs. Existing tools fall short in at least one of a few key ways: They are not pedagogically forward, they do not respect data provenance, they are expensive and opaque. Plexa provides educators with the ability to create highly customizable lesson plans for their students to use in a controlled environment, so that they may promote AI literacy and prepare their students for careers in specific disciplines and lives in the age of AI. Chats are restricted to lesson instances; no free form chats. This structure encourages accountable usage, and keeps the focus of the tool on pedagogy. The tool is local first: all data is stored on premise, with the ability to run models within the institution's network, or outsource compute to any provider of their choice. Plexa will always be fully free, open-source, and permission-less-ly licensed so institutions can examine/modify the code and deploy their own versions without any license related headaches or paying a cent. With this framework, I present a new way forward for what AI education can look like.

Jesse Gunn Cheu '26; Ava Hendrix '28; Ken Field; Brian King

Faculty Mentor(s): Professor Ken Field, BIOLOGY

Funding Source: Department of Biology

Immunoglobulin Gene Annotation Refinement using Machine Learning Classifiers

The gene annotation process can be both tedious and difficult especially when it comes to immunoglobulin genes. Machine learning has become an ever more versatile and applicable tool especially in the realm of biology. Applying machine learning methods to gene annotation can be beneficial in both reducing user workload and in identifying subtle commonalities across genes. Using both decision trees and logistic regression classifiers I was able to create a model that produced 100% recall, 78% precision, and an F1 score of 88% and allowed for identification of heptamers that may relate to determining accurate immunoglobulin genes.

Cowan Hahn '28; Ibrahim Sulai

Faculty Mentor(s): Professor Ibrahim Sulai, PHYSICS & ASTRONOMY

Funding Source: Walthour Fellowship

Snipe Hunt: The Search for Dark Matter

Induction magnetometers offer a cost-effective solution for sensitive field measurements, though careful considerations need to be made to reach fundamental limits. We cover the method by which we construct and calibrate our equipment

to achieve pT/√Hz sensitivity across a 1000 Hz bandwidth, the process of achieving this with both a current measurement and a voltage measurement and going over the importance of factors such as electrical shielding, cable type and length and comparing the performance of the measurement types. We also apply these methods for our integration with the SNIPE project attempting to extend our coverage of the dark photon parameter space.

Ava Hendrix '28; Jesse Gunn-Cheu '26; DeeAnn Reeder; Luis Viquez Rodriguez; Imran Ejotre; Lisa Powers; Lucas Canesin; Ashley Reers; Michael Hiller; Hannah K Frank; Ken A Field

Faculty Mentor(s): Professors Ken Field & DeeAnn Reeder, BIOLOGY

Funding Source: Walthour Fellowship

Assembling the Genome of a Bat (*Epomophorus labiatus*) with an XO Sex Determination System

Several members of the Pteropodidae family of bats are among the few mammals described without a Y chromosome. In these animals, sex is presumably determined by the dosage of the X chromosome. Additionally, bat genomes can reveal the genes involved with viral tolerance, as bats are notably asymptomatic to certain viruses. Therefore, we assembled the genome of a male epauletted fruit bat (*Epomophorus labiatus*) using Pacbio HiFi reads and Hi-C sequencing data to generate chromosome-scale scaffolds. The resulting assembly spans 2.1 billion bases, with a BUSCO completeness score of 99.56%. With visualization tools PretextView and HiGlass, we manually curated the assembly into 17 autosomes and an X chromosome. Annotation was performed with the pipeline Funannotate, which integrates gene predictions from the Braker3, Toga, and Stringtie pipelines. These annotations will enable us to perform comparative genomics to identify positively-selected immune-related genes across bat lineages. Additionally, we will obtain a karyotype from testes samples collected in Uganda to confirm the absence of a Y chromosome in this species. We are currently identifying the genes under selection that facilitate this XO sex determination, including genes found on autosomes that are present on Y chromosomes in other bat species. Ultimately, this work will increase our understanding of the evolution of mammalian sex determination and the evolutionary genomics of bat immunity.

Katie Herald '27; Iona Pitkins '25; Sasha Munyeki '27

Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: College of Engineering, Civil Engineering

Computational Modeling and Optimization of Tension-only Members within a Miura-Ori Frame Structure

Preliminary research has demonstrated both the feasibility and potential advantages of a Miura-Ori frame structure when compared to a traditional 3D space frame. This project parametrically modeled the Miura-Ori frame in Rhino3D and performed first-order analysis to determine which tension-

only frame members could be optimized as wires and which members must remain as rigid rods. Through this optimization, the kinematic or folding mechanisms and geometrical efficiency of the system were maintained and several tension-only members were identified. The parametric modeling is key for next steps in this project which involve scaling the model for emergency shelter situations and the identification of tension-only members is beneficial for the ongoing prototype development.

Logan Hill '28

Faculty Mentor(s): Professor David Rojas, LATIN AMERICAN STUDIES

Funding Source: Douglas K. Candland Undergraduate Research Fund

Governmental-NGO Infrastructure Networks for Homeless Resources In Western Michigan

This study seeks to understand how current state policy trends of empowering local, non-governmental agencies within the state of Michigan through grants may impede or enable preventative or restorative objectives, and how these organizations translate their available resources into a functional infrastructure of service and treatment. This work was comprised of five qualitative, semi-structured, intensive interviews with a variety of professionals responsible for Michigan's homeless prevention and treatment infrastructure, including police social workers, community developers, state-employed coordinators, and directors of local planning bodies and/or housing assessment resource agencies. Methodology was centered around encoding interview transcripts to determine common themes across different perspectives, specifically around inter-organizational cohesion and resource distribution. Findings have revealed a number of emerging topics in the discussion of policy and the nuances of implementation, including the efficacy of non-congregate shelter programs, dysfunctional procedures regarding state grants, the role of economic and political incentives upon key actors within infrastructure, and the distribution of resources between rural and urban areas. This work is being adapted into a comprehensive examination of Michigan's homeless infrastructure, which will map all parties responsible for outreach, resource distribution, data collection, and oversight, which are duties delegated by the state to a patchwork of disconnected organizations and individuals.

Isaac Horst '27

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING

Funding Source: Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Low-Frequency, Low-Intensity Ultrasound Increases Pro-Angiogenic Protein Secretion in 3D Macrophage-Endothelial Co-Cultures

Chronic wounds often stall in the inflammatory phase, creating a significant clinical burden. This study investigated Low-Frequency, Low-Intensity Ultrasound (LFLI US) as a non-invasive intervention to trigger the proliferative phase of healing by

stimulating pro-angiogenic signaling. Researchers utilized a 3D porcine collagen scaffold to co-culture M1 macrophages and HUVECs, successfully simulating the complex wound microenvironment.

The experimental results confirmed that LFLI US significantly enhances the production of Vascular Endothelial Growth Factor (VEGF), a protein essential for forming new blood vessels. Following a 15-minute exposure, all treated groups (50, 100, and 150 mW/cm²) showed elevated VEGF levels compared to the untreated control. While a clear dose-dependent response was observed between the 50 and 100 mW/cm² groups, a plateau occurred at 150 mW/cm². This suggests a biological saturation point, identifying 100 mW/cm² as the optimal therapeutic intensity for maximizing cellular response without diminishing returns.

Ultimately, these findings demonstrate that LFLI US can effectively shift the wound environment toward a pro-healing phenotype by modulating the behavior of key immune and vascular cells. This study provides a foundational framework for using ultrasound as a non-invasive tool to accelerate tissue regeneration. Future research will likely expand on these results by exploring macrophage polarization and testing more complex, clinically relevant models to further validate LFLI US as a viable treatment for chronic ulcers.

Grace Ifiegbu '26

Faculty Mentor(s): Professor Michael Krout, CHEMISTRY

Funding Source: Walthour Fellowship, Department of Chemistry

Comparing Nucleophilic Substitution Rates for Bile Alcohols

Bile acids are molecules with a steroid backbone naturally synthesized from cholesterol in the liver. Their amphipathic properties, arising from alcohol or carboxyl groups (hydrophilic) and methyl groups (hydrophobic), enable micelle formation, which plays a key role in fat emulsification and drug delivery. Bile acids can be synthesized in vitro, and the derivatization of their many reactive positions is chemically possible and useful. This project aimed to identify reaction conditions that would functionalize a single hydroxyl (-OH) group on a bile acid. The Mitsunobu reaction was used to study the selective substitution at the secondary C-3 and primary C-24 alcohol positions on a modified lithocholic bile acid. Acetone cyanohydrin was the nucleophile used to substitute an -OH group for a -CN group. Competition experiments were conducted using two substrates: one with only the C-3 hydroxyl accessible and the other with only the C-24 hydroxyl accessible. Percent yields were used to quantify relative reactivity. This reaction system demonstrated high selectivity for the C-24 position over the C-3, even at increased reagent equivalents. These findings suggest that the conditions utilized provide a viable strategy for the selective modification of primary bile alcohols using acetone cyanohydrin or very similarly reactive nucleophiles.

Bernard Iringire Nkusi '27

Faculty Mentor(s): Professor Benjamin Wheatley,
MECHANICAL ENGINEERING

Funding Source: Tague Family Fund for Undergraduate
Research in Biomedical, Biological and Biochemical Sciences

Investigating Muscle Fatigue During a Wall Sit with Wearable Sensors, Including Muscle Oxygen Saturation

Muscle fatigue during sustained isometric exercise is a key indicator of lower-limb strength and functional readiness, yet so far current clinical assessments rely heavily on subjective observation rather than direct muscular measurement. This research explored a non-invasive approach to quantifying fatigue during a wall-sit task using three wearable sensors: surface electromyography (sEMG), an inertial measurement unit (IMU), and a muscle oxygen saturation (SmO₂) sensor. Healthy adults (18+) with no recent lower-body injuries performed a wall sit to volitional fatigue while sensors placed on the dominant leg—sEMG and Moxy SmO₂ on the rectus femoris, IMU on the knee joint—recorded synchronized physiological and kinematic data.

Data processing in MATLAB revealed three consistent fatigue-related trends. First, the mean frequency of the EMG signal decreased over time, reflecting classical neuromuscular fatigue as neural signals decrease with increasing fatigue. Second, IMU-derived area-under-the-curve values increased throughout the trial, indicating growing postural instability most noticeable by knee-joint wobble. Third, SmO₂ declined steadily during the early phase of the exercise before plateauing, suggesting an initial drop in oxygen availability followed by a stabilized metabolic state near failure. Together, these findings demonstrate that combining mechanical, electrical, and metabolic indicators provides a richer understanding of fatigue progression than any single measure alone. This work supports the feasibility of developing a wearable, clinic-friendly tool for assessing hip and lower-limb strength and highlights future directions including standardized protocols and a need for deeper investigation into metabolic contributors such as lactic acid accumulation.

Nihad Jafarov '28

Faculty Mentor(s): Professor Benjamin Wheatley,
MECHANICAL ENGINEERING

Funding Source: James L. D. and Rebecca Roser Research
Fund

Improvements to a Motion Analysis Markerset Towards Markerless Motion Capture

Accurate evaluation of human movement is essential in rehabilitation, sports medicine, and neurological assessment; however, traditional marker-based motion capture systems are expensive, time-intensive, and difficult to scale for widespread clinical use. Markerless alternatives such as OpenCap offer a promising, low-cost solution, but their adoption depends on demonstrated accuracy relative to gold-standard systems. The purpose of this project was to prepare and partially validate

a comparison between OpenCap and a marker-based motion capture system (VICON) for activities that impose high knee joint loads, specifically squatting and stair ascent/descent.

Due to time constraints, this phase of the project focused on optimizing the marker-based motion capture workflow and collecting reliable reference data. Pilot testing revealed substantial tracking errors during deep squat movements, primarily caused by pelvis marker occlusion and anatomically unreliable upper-body marker placements. To address these limitations, the marker set was systematically modified. Adjustments included the addition of lateral pelvis markers to mitigate occlusion, reassignment of selected upper-body markers to scaling-only roles, and the introduction of marker asymmetry to improve automatic labeling performance. The labeling pipeline was further optimized using manually generated templates for common movement tasks. OpenSim simulations were refined by adjusting marker weights and excluding unreliable arm markers.

Following these modifications, simulations achieved errors below 2 cm for all participants, representing a significant improvement over initial pilot results, though still above the ideal 1 cm threshold. Persistent error sources were identified in knee flexion and spinal alignment during deep squat tasks.

Olivia Janas '28

Faculty Mentor(s): Professor Alomir Favero, CIVIL &
ENVIRONMENTAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in
the Sciences

Development of a Laboratory Methodology to Manufacture Mine Tailings

Recent failures of tailings storage facilities have demanded a greater understanding of the behavior of tailings. However, characterization of tailings properties can be challenging due to limited access to representative samples. Hence, this study aimed to develop a methodology to recreate tailings in the laboratory that reproduce field characteristics. To accomplish this goal, we performed self-learning on the topic, laboratory investigation, and analysis of the samples created. Various geotechnical and mechanical properties of soils were studied to gain an understanding of the properties that would be tested and examined. Material characterization, sample preparation, and sample testing standards were reviewed and then applied to Ottawa sand and bentonite clay. These standard materials are accessible and readily available for laboratory use, which would allow for easy replication of the methodology created. Additionally, these materials have characteristics, for example, plasticity and shear strength, that, when mixed, would resemble field tailings. As a result of the work, a preliminary observation is that Ottawa sand has a large grain size and may not be the appropriate material for the final tailings sample, as tailings usually have a very fine grain size. Further research showed that it is possible to obtain silt-sized soils by crushing Ottawa sand, which would allow us to make a sample that is similar to field tailings and still maintains other tailings properties. Future research includes investigation of the silt-

sized soil and bentonite clay mixtures to find the proper ratio of these materials to recreate tailings and then their strength properties.

Erin Kenny '28

Faculty Mentor(s): Professor Austin Wadle, ENVIRONMENTAL STUDIES & SCIENCES

Funding Source: Kalman Fund for Undergraduate Research in the Sciences, Presidential Fellowship

Adsorption of Cadmium to Bacterial Nanoparticles

This study examines the coprecipitation of cadmium and calcium carbonates by biogenic nanoparticles produced by *Bacillus subtilis*, building on prior work on bacterial nanoparticle mediated calcium carbonate precipitation and expanding that research to include cadmium. Cadmium is a transition metal that is toxic to humans and other animals. Previous research has shown that human exposure to cadmium commonly occurs through contaminated drinking water and is associated with increased cancer risk, as well as broader environmental harm through soil and water contamination. This occurs in nearby geographies, such as West Islip, New York, where cadmium contamination has been documented in groundwater originating from the former Dzus Fastener Company site. Additionally, this occurs globally, most famously including the mass poisoning in Japan in 1912 causing Itai-Itai disease. This research sought to understand the role of bacterial nanoparticles in cadmium cycling. To address this question, *B. subtilis* was cultured in high nutrient KB media and high calcium B4 media and nanoparticles were isolated from spent culture media for precipitation experiments. While nanoparticle suspensions from KB media were successful in precipitating metal carbonates, insufficient quantities of nanoparticles were isolated from B4 media, resulting in no observable precipitation. In coprecipitation experiments, cadmium recovery rates of 87.2% and 97.6% were observed, indicating limited cadmium removal from the aqueous phase. However, this does indicate a strong affinity between Cd and bacterial nanoparticles. Although the results differed from initial expectations, they provided valuable direction for future research, focusing on adsorption of Cd onto nanoparticulate surfaces.

Ben Khant '27

Faculty Mentor(s): Professor SingChun Lee, COMPUTER SCIENCE

Funding Source: James L. D. and Rebecca Roser Research Fund

Building and Documenting a Reproducible Low-Cost Open-Source Optical See-Through AR Headset for Computing Education (Work in Progress)

Students in introductory computer science courses often struggle to understand how algorithms and data structures evolve over time, as traditional flat-screen visualizations require learners to mentally track abstract state changes, limiting spatial and embodied engagement. Augmented reality (AR) offers a promising way to make these processes visible and

interactive, yet existing optical see-through head-mounted displays are often too costly for widespread classroom adoption.

To address this barrier, this project focuses on building and systematically documenting a low-cost, open-source optical see-through AR headset for computing education. Inspired by Project North Star, we adapt and refine an existing open-source design with an emphasis on accessibility, reproducibility, and classroom deployment. The system incorporates modular 3D-printed structural components, commodity micro-displays and driver boards, and a repeatable optics calibration workflow based on checkerboard alignment patterns to correct distortion and misalignment.

A working hardware prototype has been constructed, and we will share detailed documentation including a reproducible bill of materials, wiring diagrams, 3D-printable models, and step-by-step assembly and calibration procedures. The calibration workflow includes representative results and troubleshooting guidance to support replication. While interactive AR software is still under development, this work establishes a transparent and replicable foundation that lowers financial and technical barriers for educators seeking to adopt optical see-through AR systems in computing classrooms.

Elliott Kilgallen '26; Maddie Whitsitt '24; Ellie Lowe '23

Faculty Mentor(s): Professor Brian Smith, CHEMISTRY

Funding Source: Department of Chemistry

Selective Polymorphic Crystallization of Acetaminophen Through Environmental Control and Sugar Additives

Polymorphism is the ability of a molecule to crystallize in more than one distinct crystal structure. Acetaminophen, the active ingredient in Tylenol, is a polymorphic system with three crystal forms including Form III, which is considered elusive and difficult to reliably crystallize. In this work, we investigate how recrystallization conditions and additives influence polymorph selectivity using melt recrystallization. Differential scanning calorimetry was used to monitor phase transitions and identify crystallization paths. We demonstrate that environmental factors, particularly humidity, strongly control the selectivity of Form III over Form II. Additionally, we examine sugar additives as impactful in polymorph selectivity. We find that both the identity and quantity of the sugar significantly influence which polymorphic form is preferentially nucleated, but also the extent to which that crystallization occurs. At low concentrations, all sugars tested facilitate Form III crystallization. However, different sugars produce distinct stability windows and variable amounts of Form III crystallization at higher concentrations. These results highlight the combined influence of environment and additive selection on crystallization outcomes and provide insight into strategies for accessing otherwise difficult-to-obtain polymorphs.

Christopher Kirby '26; Margo Donlin

Faculty Mentor(s): Professor Margo Donlin, MECHANICAL ENGINEERING

Funding Source: James L. D. and Rebecca Roser Research Fund

Haptic Feedback Significantly Increases Knee Flexion and Ankle Dorsiflexion to Increase Toe Clearance

Introduction: Stroke-induced gait asymmetries, such as reduced knee flexion, increase tripping risks. While haptic (vibrotactile) feedback shows promise in correcting gait, its effectiveness in increasing toe clearance remains under-researched. This study evaluated haptic feedback's ability to modify knee flexion and ankle dorsiflexion in healthy individuals to inform future stroke rehabilitation strategies.

Materials and Methods: Thirty-six healthy participants (mean age 37.5) performed overground walking trials under three conditions: normal walking, knee flexion feedback, and ankle dorsiflexion feedback. SageMotion IMUs collected 100 Hz kinematic data and delivered vibrotactile cues when joint angles failed to reach a personalized threshold (8% above baseline). Data were processed in MATLAB using paired t-tests.

Results: Haptic feedback significantly increased peak knee flexion from $56.36^\circ \pm 6.55^\circ$ to $74.30^\circ \pm 15.99^\circ$ ($p < 0.001$) and peak ankle dorsiflexion from $8.72^\circ \pm 3.95^\circ$ to $11.77^\circ \pm 3.98^\circ$ ($p < 0.001$). Participants responded to feedback in 91.23% of steps in knee trials and 65.50% of steps in ankle trials. Consistency across trials suggested stable adaptation without desensitization.

Conclusions: Real-time haptic feedback effectively modifies gait parameters essential for toe clearance. The higher response rate for the knee likely stems from its larger range of motion compared to the ankle. These results demonstrate that personalized, wearable haptic systems can successfully guide gait modification, offering a scalable solution to reduce tripping risks and improve functional mobility in stroke rehabilitation.

Hannah Klanderman '26

Faculty Mentor(s): Professor Chase Gregory, ENGLISH

Funding Source: James L. D. and Rebecca Roser Research Fund

Les Be Critical

What began as a project aiming to compare lesbian representation in films before and after the legalization of same-sex marriage became a project focused on the question "What is 'good' lesbian representation?". Historically, gay men, specifically white gay men, have been prioritized over lesbian women in the queer community. Not only has the need for lesbian representation in mainstream media been a struggle throughout time, but the need for "good" lesbian representation is even greater. An assumption I began this project with, that my research confirmed throughout my work, is that not all representation is good representation—so how can we find it? Comparing and analyzing the 2023 film *Bottoms*

and the 1999 film *But I'm a Cheerleader*, I was able to pinpoint a list of things that can aid in one's ability to identify "good" lesbian representation in films. My final product was a zine accumulating the readings I did, my methods, and my findings. Zines are closely intertwined with the queer community and allow the creator to share information freely and cheaply, a form of media that is not typically used in academia, but that I felt was important to my research.

SooAh Lay '27

Faculty Mentor(s): Professor Jude Okolie, MECHANICAL ENGINEERING

Funding Source: Dean's Fund for Summer Undergraduate Research in STEM

Bringing Space to Classrooms: A Modified Hands-on CanSat Program for Promoting STEM Education and Career Aspirations

The primary goal of this study is to investigate how participation in a CanSat project influences students' understanding of engineering concepts, interest in STEM fields, and their identification with the role of an engineer. Traditional CanSat initiatives, originating from Stanford University, engage students in building soda can-sized model satellites to simulate space missions, fostering problem-solving, teamwork, and interest in STEM careers. However, they often require advanced skills, limiting accessibility.

This study proposes a modified program featuring simplified hardware (a four-layer PCB system with Arduino microcontroller, nRF24L01 communication, sensors like BMP180 and MPU6050, and GPS), intuitive software tools (a web-based learning platform with virtual Arduino IDE and ground station GUI for real-time data visualization), and a structured five-day curriculum (4 hours/day) emphasizing hands-on activities from space introduction to launch and analysis.

Piloted with 15 students in the Lewisburg, Pennsylvania area, the program yielded positive outcomes: 90% reported better understanding of engineering roles, increased STEM interest, and envisioned future careers; all recommended it. Qualitative gains included technical confidence, data literacy, and collaboration. Broader impacts featured local media coverage. Overall, this research contributes to understanding how project-based, experiential learning opportunities can inspire the next generation of engineers.

Minh Le '28; Kenny Mineart

Faculty Mentor(s): Professor Kenny Mineart, CHEMICAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Optimizing Non-Ionic Surfactant Vesicle (Niosomes) Production: Comparison with Established Liposome Preparation

In 2025, about 2.0 million people in the United States were diagnosed with cancer, and an estimated 618,120 deaths are expected, underscoring the need for better therapies. Liposomes are widely used drug delivery systems because they can encapsulate hydrophilic and hydrophobic drugs, improve tumor targeting, and reduce systemic toxicity, but they can be expensive, storage sensitive, and difficult to reproduce. These limitations have increased interest in niosomes, nonionic surfactant vesicles that may offer lower cost and greater stability. However, many niosome methods rely on sonication, which limits size control and rarely produces vesicles near 100 nm. This research focuses on developing an extrusion based procedure for preparing niosomes using thin film hydration followed by extrusion and comparing outcomes with established liposome preparation methods. Niosomes and liposomes were formulated with the goal of producing spherical vesicles with uniform size distributions and were characterized by dynamic light scattering to determine effective diameter (ED) and polydispersity index (PDI). Niosomes prepared using Tween 85, Tween 80, and Span 60 with cholesterol produced average sizes of 1134.5 nm, 7372.3 nm, and 387.7 nm, respectively. Process improvements included reducing total mass and concentration, replacing freeze thaw cycling with a thermal process, testing alternative surfactant to cholesterol ratios, and using smaller extrusion membranes. Span 60 with a 1:2 cholesterol to Span 60 ratio showed the most promising results, with an ED of 259.7 nm and a PDI of 0.185, though further work is needed to confirm reproducibility.

William Le '28

Faculty Mentor(s): Professor Vaska Atta-Darkua, ACCOUNTING & FINANCIAL MANAGEMENT

Funding Source: PPL Undergraduate Research Fund

Unlocking Potential: The Case for Digital Asset in the U.S. College Endowment Funds

Since 2017, crypto assets have emerged as a prominent and transformative financial instrument globally. While major financial institutions such as BlackRock, Fidelity, and Franklin Templeton have widely adopted these digital assets and legislation surrounding crypto holdings has become increasingly clear, college endowment funds have remained hesitant to embrace them. Known for their traditionally conservative investment strategies, most endowment funds have yet to integrate crypto assets into their portfolios. To date, only a few prominent institutions, such as Ivy League schools and Emory University, have included crypto assets in their treasuries or invested in crypto projects as private equity. However, this cautious approach began to shift in 2025, as endowment funds started to seriously explore the potential

of crypto assets. With their capacity to deliver high returns, mitigate risks inherent in traditional markets, and diversify investment portfolios, crypto assets align closely with the strategic goals of endowment funds. These goals include fostering intergenerational equity and engaging with younger generations.

This paper will analyze the current state of college endowment fund assets, including key investment considerations such as Environmental, Social, and Governance (ESG) factors, propose diverse strategies for integrating crypto assets, and highlight the potential benefits of incorporating digital assets into college endowment fund portfolios.

Khoi Nguyen Le Quang '28; Cyrus Kuhn '28; Darwin Juca '28; Nathaniel Saltgiver '28; Mohammed-Mehdi Hamdaoui '28

Faculty Mentor(s): Professor Amal Kabalan, ELECTRICAL & COMPUTER ENGINEERING

Funding Source: None

Stationary Comparison of Model Performance of GaAs and Si Nanowires in GAAFETs

When transistors approach 1 nm in size, silicon, the conventional workhorse in semiconductors, comes up against physical limitations imposed by quantum physics. At such small sizes, the silicon channel thickness approaches a few atomic layers, resulting in excessive gate tunneling, scattering, and reduced mobility. However, in an attempt to address such issues, the paper chooses to explore another channel material called gallium arsenide, abbreviated as GaAs, suitable for gate-all-around FETs (GAAFETs).

Our models were created with COMSOL Multiphysics software version 6.3. We compared micro-scale MOSFETs and nano-scale GAAFETs in gallium arsenide and silicon semiconducting layers. However, due to the software limitations in computing transient current, certain parameters need to be calculated post-computation, such as the conduction band ($E_{CB}(x)$), electron density ($n(x)$), carrier drift speed ($v(x)$), and the ballistic parameter (L/λ) calculated based on the mean free path. All results relate to charge transport efficiency and the boundary between the diffusive and ballistic regimes.

Kira Leclercq '26; Lorelei Curtin; Nicholas L. Balascio; R. Scott Anderson; Stephen Wickler; William J. D'Andrea

Faculty Mentor(s): Professor Lorelei Curtin, GEOLOGY & ENVIRONMENTAL GEOSCIENCES

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Alkenone-Based Temperature Record from Lake Lauvdalsvatnet, Lofoten: Understanding Human-Climate Interactions

Holocene temperature records provide important context for modern climate change, particularly in the warming Arctic. This study presents a 7,600-year lake water

temperature reconstruction from a sediment core collected from Lauvdalsvatnet (68°14'07" N, 13°54'22" E; 53 m a.s.l.), a freshwater lake on Vestvågøy in the Lofoten Islands. The site lies near Borg, a Viking-age cultural center with evidence for agricultural activity dating back to the Bronze Age (Johansen et al., 1990). Because the region lacks long-term Holocene temperature records but has a long history of human settlement, this study provides insight into long-term human-climate interactions. Past temperatures were reconstructed using lacustrine alkenones, lipid biomarkers produced by haptophyte algae and preserved in lake sediments. An age-depth model was developed using radiocarbon dates from terrestrial plant macrofossils (Topness et al., 2023). Using a published Lofoten-specific alkenone calibration (D'Andrea et al., 2016), lake water temperatures were inferred from alkenone unsaturation ratios. Results indicate a mean lake water temperature of 6.0 °C over the past 7,600 years. The warmest intervals occurred around ~6200 and ~4900 yr BP, with peak temperatures of 9.8 °C and 8.0 °C. A cold period occurs near ~3900 yr BP with a minimum of 3.9 °C, and the record shows an overall Holocene cooling trend. Unpublished pollen data show increased *Picea* after 4000 yr BP and *Poaceae* after 3000 yr BP, while *Hordeum* appears ~3500 yr BP, indicating early agriculture. Polycyclic aromatic hydrocarbons peak ~800 yr BP and ~200 yr BP, reflecting landscape modification (Topness et al., 2023).

Katherine Lewis '28; Alexandra Lozanguiez '27

Faculty Mentor(s): Professors Moria Chambers, Professor Sarah Lower & Benoît Béchade, BIOLOGY

Funding Source: Department of Biology

Investigating the Effects of Symbionts on Firefly Survival

Fireflies are insects cherished worldwide due to their recognizable bioluminescent flashes. Diet, habitat, bacterial infection, and seasonality can all influence firefly survival; however, it is unknown how fireflies are impacted by symbiotic bacteria. Many firefly species harbor Mollicutes, a bacterial group that includes symbionts of several insects. We hypothesized that Mollicutes are beneficial for immune support and protection against pathogenic bacterial infection in fireflies. We collected *Photinus pyralis* and *Photuris versicolor* group fireflies from two natural areas surrounding Lewisburg, PA. First, we exposed them to different antibiotic mixtures aimed to select either for or against bacterial symbionts, while tracking survival. *Photuris* fireflies had higher mortality when not exposed to any antibiotics. *P. pyralis* initially had higher mortality when exposed to Mollicute-targeting antibiotics; however, there was no difference in survival across treatments at 21 days. To assess whether curing fireflies of symbionts impacts susceptibility to infection, we next injected antibiotic-treated fireflies with pathogenic bacteria. We found that fireflies that had been exposed to Mollicute-removing antibiotics had slightly higher mortality following infection; however, mortality was the highest for fireflies that had not been exposed to antibiotics. This research not only provides a better understanding of the effects of the microbiota on a firefly host, but is also essential for understanding patterns between symbiotic relationships and immune response across host species.

Kayla Lichtner (Graduate Student); Sarah Chapman (Graduate Student); Tori Chace '26; Axel Uribe '26

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY

Funding Source: Department of Biology, National Science Foundation Grant (NSF)

The Unfolding Interactions Between Environment and Metabolism During Early-life Seabird Development

Mitochondria are the primary producers of cellular energy and play a critical role in metabolic flexibility. This study explores how seabird parental provisioning influences mitochondrial respiration and DNA oxidative damage in nestling Leach's storm-petrels (*Hydrobates leucorhous*), and assesses the metabolic flexibility of nestlings during natural periods of fasting. At our field site on Kent Island, New Brunswick, we collected blood samples from nestlings on day 35 and 58 post-hatch to measure DNA oxidative damage (8-OHdG) and mitochondrial respiration. Using high resolution respirometry, this study provides an in-depth analysis of each nestling's energetic profile, highlighting various mechanisms of mitochondrial efficiency and flexibility during early-life development. Our findings demonstrate that mitochondrial working capacity increases as nestlings develop, suggesting that nestlings may be assimilating to respiration rates comparable to adults. Additionally, we found that nestlings presented significantly higher levels of DNA oxidative damage in fed states, as opposed to fasted states. We will discuss the interplay between early-life nutrition and bioenergetics that may underlie the life history of this long-lived seabird.

Odilon Ligan '27; Jean Marie Ngabonziza' 26; Grayson White; Kelly McConville; Andrew Lister

Faculty Mentor(s): Kelly McConville, Director, DOMINGUEZ CENTER FOR DATA SCIENCE

Funding Source: USDA Forest Service, Rocky Mountain Research Station

Detecting Landcover from Satellite Images Using AI and Elmer

The Forest Inventory and Analysis (FIA) program plays a critical role in monitoring the health and status of forest ecosystems across the United States. As the demand for timely, accurate, and scalable forest data increases, FIA is exploring innovative ways to integrate Artificial Intelligence (AI) into its workflow to enhance efficiency and precision. The objective of this project is to explore how Large Language Models (LLMs) might assist in processing satellite images for land cover classification and landscape change detection. A key component of this effort is not only to test new AI tools but also to rigorously quantify their performance using spatial data and ground-truth comparisons. After exploring many AI tools, we opted for Elmer, an R package that allows a user to interact with LLMs directly in the R environment. We developed a workflow for loading images, classifying them with an LLM, and then comparing those classifications to the National Land Cover Database's (NLCD) classifications.

Though AI was not perfect, our results show that it was able to detect some land cover correctly as described by NLCD. However, there is more work to be done. In the future, we envision

improving accuracy by revising prompts given to AI to describe in detail the sub-classifications and using a more sophisticated generative AI to increase accuracy.

Madison Loterina '26

Faculty Mentor(s): Professor Jennifer Thomson, HISTORY
Funding Source: Schotz Family Fund, Bucknell Humanities Center Research Grant

The Interconnected History of Deinstitutionalization and Mass Incarceration

Deinstitutionalization formally began during John F. Kennedy's presidency in 1963 with the Community Mental Health Center's (CMHC) Act. The CMHC Act aimed to replace state psychiatric institutions with local mental health centers. What initially was a promising effort to locally support those with mental illnesses later turned into a federal failure, in which the U.S. government neglected to build half of the proposed centers. Those that were constructed were almost entirely concentrated in affluent and suburban areas. Following DI, thousands of patients were discharged from state mental institutions and transferred to other inpatient care centers such as nursing homes, homeless shelters, and predominantly, jails or prisons, in a process known as transinstitutionalization (TI). The shift from psychiatric to carceral institutions was further exacerbated by the expansion of the United States carceral system, brought on by economic struggles and the War on Drugs, in which black men suffering from mental illnesses and substance abuse disorder were encountering law enforcement more often than healthcare providers.

My Ly '27; Jude A. Okolie

Faculty Mentor(s): Professor Jude Okolie, CHEMICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Optimizing the Recovery of Precious Metals During Lithium-Ion Battery Recycling

Lithium-ion batteries (LIBs) have become integral to modern technology due to their broad range of applications. However, the growing demand for LIBs raises geopolitical challenges in sourcing critical metals and poses significant environmental risks during improper disposal. Recycling introduces greener pathways towards recovering precious metals from spent LIBs. In heat-based recycling, LIBs are typically subjected to incineration and smelting. Although effective, thermal treatments can heavily consume energy while emitting air pollution. Alternatively, liquid-based pathways like leaching utilize a solvent to extract metal particles into an aqueous solution for collection. With low energy consumption and low waste gas emission, leaching can be considered environmentally friendlier. Ascorbic acid (AA) and deep eutectic solvent (DES) are promising leaching agents because of their high metal-dissolution efficiency, low toxicity, biodegradability, and tunable chemical properties. However, comprehensive comparisons of both solvents under the same testing conditions are scarcely reported in the literature, which motivates this study.

In this research, inductively coupled plasma mass spectrometry was used to quantify the concentration of precious metals in each sample post leaching. Preliminary results show that across all metals, AA has extracted more metals from the LIB powder compared to DES. The introduction of glucose, a common reductant, has shown synergistic effects with DES at certain temperatures, and inverse effects with AA overall. Currently, the chemical structure and composition of pre- and post- leaching samples are under assessment. Kinetic studies will be conducted on the best leaching pathways to observe how metals are extracted at each time interval.

Odomneath (Neath) Ly '28; Karlo A. Malaga

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Gary & Sandy Sojka Fund for Research, Teaching & Scholarship in Developmental Disabilities, Neuroscience & Human Health

Comparative Validation of Gel-Based and Gel-Less Electroencephalography Systems for Future Neurophysiological Studies

This study compares gel-based and gel-free electroencephalography (EEG) systems using the OpenBCI Cyton+Daisy board, a low-cost, open-source platform increasingly utilized in neurotechnology research. While gel electrodes are known for superior signal quality, they require extensive setup and can cause user discomfort. Gel-free systems offer greater convenience, but may introduce higher noise and signal instability. Prior studies have assessed these trade-offs using clinical-grade hardware, but few have evaluated performance specifically within OpenBCI systems.

Five healthy participants completed EEG tasks including resting-state (eyes-open/closed) and motor tasks (finger tapping, spiral drawing) using both caps. Signal quality was evaluated through alpha-to-beta (A:B) ratios, signal-to-noise ratio (SNR), impedance levels, and ICA-derived artifact proportions. Usability was assessed through setup time, impedance stability, and a user comfort survey.

The gel-based system showed stronger and more consistent A:B elevation during eyes-closed conditions, though group differences were not statistically significant. SNR values were similar between systems (gel: 13.63 ± 22.46 dB; gel-free: 19.22 ± 17.55 dB), with one gel outlier likely due to setup error. Artifact proportions were higher in gel data, while impedance was lower and more stable compared to gel-free. Survey results indicated similar comfort, with minimal post-use discomfort or cleanup issues.

Despite a small sample size, both systems effectively captured relevant neural signals. Gel-based systems showed marginally greater consistency, while gel-free systems offered setup advantages. These findings provide early insights for selecting EEG systems based on specific research needs. Future work will explore additional metrics such as spectral stability and topographical reliability across broader populations.

Dante Mancino '27; Emly Dryden

Faculty Mentor(s): Professor Emily Dryden, MATHEMATICS & STATISTICS

Funding Source: Hoover Fund for Undergraduate Math Research

Can You “Hear” the Shape of a Polygon?

The question of whether you can “hear” the shape of a drum has its roots in the 1960s and still has open questions related to it to this day. In our research, we consider a drum whose mass is concentrated along its boundary, and explore when it is possible to “hear” the different boundaries of such drums when the boundaries are triangles or quadrilaterals.

Deana Marchuk '28; Karlo A. Malaga

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING

Funding Source: Gary & Sandy Sojka Fund for Research, Teaching & Scholarship in Developmental Disabilities, Neuroscience & Human Health

Comparing Functional and Anatomical Division of the Subthalamic Nucleus as a Predictor of Clinical Outcomes in Deep Brain Stimulation

The subthalamic nucleus (STN) is one of the most common targets for deep brain stimulation (DBS), a treatment for alleviating the motor symptoms of Parkinson disease (PD). DBS involves implanting electrodes into the STN to deliver electrical stimulation, with the goal of reducing motor symptoms and improving quality of life for patients with PD. However, its success strongly depends on where within the STN the stimulation occurs. This study aims to determine which segmentation method more closely correlates with motor symptom improvement in DBS.

40 PD patients who previously underwent bilateral STN DBS were included for analysis. Outcomes were measured as percentage improvement across rigidity, tremor, bradykinesia, and overall motor symptom. Anatomical segmentation was performed by dividing each STN into six regions using its center of mass as a reference point. Functional segmentation was derived using the Accolla atlas, which labels the STN into motor, associative, and limbic zones. The atlas was registered to each STN and then the volume of tissue activation relative to the total volume of the STN was calculated to quantify stimulation.

Results showed that functional motor zone activation weakly correlated with rigidity improvement, while other functional zones showed no significant associations. In contrast, anatomical dorsal STN stimulation significantly correlated with rigidity and distinguished responder groups. The dorsal anatomical region demonstrated stronger clinical relevance.”

Paige Mattucci '28; Ryan Snyder; Dabrina D Dutcher; Timothy Raymond; Brian King

Faculty Mentor(s): Professors Dabrina Dutcher, Tim Raymond & Ryan Snyder, CHEMICAL ENGINEERING

Funding Source: Walthour Fellowship

Evidence of a γ Polymorph of Suberic Acid: Influence of Solvent Concentration on Crystallization Pathways

Polymorphism occurs when a substance can crystallize into multiple solid structures, each with distinct physical properties. Suberic acid, an organic compound used in drug synthesis, delivery, and medical materials, has two known polymorphs (alpha and beta), with beta being more stable. Evidence suggests a possible third polymorph, gamma, that may form under specific conditions. Our research investigates whether this gamma polymorph exists and what conditions promote its formation.

To test this, suberic acid was dissolved in organic solvents, aerosolized, and dried to form airborne particles. The resulting crystals were collected using an impaction system and analyzed with X-ray diffraction (XRD) to identify their crystalline structures. Over the summer, we focused on acetone solutions at concentrations of 5 g/L, 1 g/L, 0.5 g/L, and 0.2 g/L. Results showed that as concentration decreased, XRD peaks corresponding to the proposed gamma polymorph became increasingly prominent, suggesting that lower concentrations favor its formation.

Maura Michalczyk '28; Frank Chimezie Onwudinjo (Graduate Student); Jude A. Okolie

Faculty Mentor(s): Professor Jude Okolie, CHEMICAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Co-Liquefaction of Food Waste and Waste Cooking Oil: Reaction Mechanisms, Product Characterization and Ozonation of the Aqueous Phase

Food waste (FW) and waste cooking oil (WCO) make up a large portion of organic waste and are disposed of in ways that create environmental challenges. However, this waste can serve as valuable sources of sustainable energy and materials. This study investigates the hydrothermal liquefaction (HTL) of carbohydrate-rich FW and WCO to evaluate potential to produce biocrude as a sustainable aviation fuel (SAF) precursor, while examining HTL byproducts and post-treatment strategies. HTL experiments were conducted at temperatures between 280 and 320 °C and reaction times of 20–60 minutes with varying ratios of WCO and FW. Biocrude was extracted using diethyl-ether and acetone. The study results indicate reaction temperature strongly influenced product yields and conversion pathways. Increasing the temperature from 280 to 300 °C during FW liquefaction increased biocrude yield from 55.7 to 62.7 wt.%, while increasing the temperature to 320 °C reduced yield to 50.5 wt.%. Extending the reaction time to 60 minutes reduced byproduct formation while maintaining moderate biocrude yields.

Co-liquefaction of FW and WCO at a 1:1 ratio and 320 °C for 60 minutes produced the highest biocrude yield (77.1 wt.%).

Biocrude composition varied with HTL severity and feedstock, with lower temperatures favoring oxygenated compounds and higher temperatures increasing hydrocarbons and aromatics. The addition of WCO altered the aqueous phase composition, and subsequent ozone treatment further oxidized and simplified organic species, improving suitability for downstream treatment. Overall, this study demonstrates a promising pathway for food waste valorization with environmental and resource recovery benefits.

Jacob Mudge '28; Max Clark '26; Isaac Horst '28

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING

Funding Source: Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Effects of Low-Frequency, Low-Intensity Ultrasound on the Secretion of IL-6 in 3D Macrophage-Endothelial Co-Culture

Chronic wounds remain stuck in the inflammatory stage of wound healing which results in disruption of the regenerative process and makes successful healing in chronic wounds difficult to achieve in many patients. The difficulty of chronic wound treatment results in extremely high medical costs along with the risk of serious complications such as amputations. Low-frequency, Low-intensity ultrasound (LFLI US) has been shown to significantly decrease healing time of chronic wounds. However the underlying biological mechanisms behind ultrasound treatment in chronic wounds remain unknown. Macrophages are immune cells that play an important role in regulating the stages of healing in acute wounds. These actions are driven by inflammatory cytokines which upregulate the immune response and recruit additional immune cells. Therefore, the goal of this work is to understand how ultrasound affects the secretion of the inflammatory cytokine IL-6 in a macrophage-endothelial co-culture.

Human endothelial cells and macrophages were seeded into 3D collagen scaffolds and exposed to ultrasound at intensities of 50, 100, or 150 mW/cm² for 15 minutes. After 48 hours, IL-6 levels in the culture media were measured using ELISA, and statistical analysis was performed using one-way ANOVA with Tukey post-hoc testing.

We saw a significant decrease in IL-6 secretion in the 50 mW/cm² group compared to the control (p <0.01). The data from the 50 mW/cm² group supports our hypothesis that LFLI US may decrease pro-inflammatory cytokine secretion as a mechanism of ultrasound-mediated healing.

Brennan Newcomb '26

Faculty Mentor(s): Professor Austin Wadle, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Extracellular Vesicle Isolation and Characterization of Stagonospora

Acid Mine Drainage (AMD) is a recurrent issue in Central Pennsylvania due to the significant quantity of abandoned coal mines. AMD is the toxic runoff resulting from improper management of these mines, which contaminates streams with metals like manganese (Mn). Passive treatment of AMD often relies on bioactive limestone beds where microorganisms, including the filamentous fungi species Stagonospora, oxidize soluble species of Mn found in AMD, subsequently precipitating insoluble, bioavailable manganese oxides. It is known that oxidations can occur by extracellular proteins. There is growing interest in the capacity of biogenic nanoparticles like extracellular vesicles (EVs) to perform similar functions. This project sought to investigate fungal growth and EV production in the presence and absence of Mn. Several Stagonospora samples were measured and EVs were isolated using filtration and ultracentrifugation. Total mass of EVs isolated was quantified using the Bradford Assay and determined that the total mass of EVs to be unaffected by Mn presence. Using Nanoparticle Tracking Analysis (NTA), the size distribution of such proteins was quantified. In both Mn and Non-Mn samples, particles were found to range in size between 150-250 nanometers (nm), indicating that these particles were EVs. Fungal growth was recorded throughout the duration of the project, and Mn presence or absence was found to have no effect on growth. These results suggest that EV production occurs regardless of Mn presence, thus inviting future research on the Mn oxidation potential of fungal EVs.

Brennan Newcomb '26; Sean Oakey '26; Rhodenischelah Limage '26; Alessia Cusick '26

Faculty Mentor(s): Professor Austin Wadle, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: Bucknell University China Institute Travel Grant

Environmental Impacts of 'Galamsey' in Northern Ghana

Illegal, small-scale gold mining, termed galamsey by local communities, pervades the region of Northern Ghana. Due to an intense, prolonged dry season for half the year, combined with unreliable water-related infrastructure which causes the region to face severe water scarcity. This challenge is underscored by high levels of contamination, both with biogenic diseases and chemical constituents. Galamsey is known to pollute the natural environment through land degradation and the leaching of metals such as Iron (Fe) and Mercury (Hg), among others, into surface waters and their beds. These mining practices often involve miners from the Chinese diaspora, of which over 50,000 individuals have migrated to Ghana since the early 2000s. This project took samples of surface water and sediment from the White Volta River near Tamale, Ghana, as well as ephemeral ponds used by the small community of Larabanga, Ghana. The sediment samples will be analyzed using X-Ray Fluorescence

(XRF) Spectroscopy and Microwave Digestion, and the water samples will be run through Ion Chromatography (IC) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). This data will then be compared with other regions in and around Northern Ghana. This research aims to characterize a facet of the complex relationship between the Sinosphere and Ghana, and seeks to document and better understand the impacts of practices like galamsey on surface waters to improve designs for drinking water treatment systems.

Fayrene Nguyen '26; Will Lindquist '27; Jean Marie Ngabonziza '26; Odilon Ligan '26; Grayson White; Kelly McConville; George Gaines; Tracey Frescino; Rebecca Beneroff

Faculty Mentor(s): Kelly McConville, Director, DOMINGUEZ CENTER FOR DATA SCIENCE

Funding Source: USDA Forest Service, Rocky Mountain Research Station

Can We Capture The True Distribution of Forest Attributes Through Synthetic Populations?

The Forest Inventory and Analysis (FIA) program aims to provide comprehensive data on national forest resources. However, challenges in accessing all forest areas necessitate estimating forest attributes from sampled data. Determining which estimator to use requires assessing estimator properties on a synthetic population of forest attributes. These synthetic forest populations are only useful if they accurately reflect the variability of the actual forest characteristics. This project evaluates the fidelity of KBAABB (k-Nearest-Neighbors approximated to Bayesian bootstrap) synthetic forest populations, which were generated to emulate the true distribution of forest attributes in the United States.

Our team approached this multifaceted project from various perspectives, each focusing on different states, yet all contributing to the overarching objective of validating these synthetic datasets. The analysis suggests that KBAABB synthetic populations do indeed serve as effective proxies for the true FIA data. This efficacy is supported by several key findings: the alignment of the synthetic data points population and spatial structures with well-known ecological zones, the close replication of FIA distributions, and the approximate preservation of important spatial patterns and underlying relationships within the data. These characteristics collectively indicate that the KBAABB artificial populations are credible and suitable for use in simulations where a representative forest population is required.

Ken Nguyen '27; Charles Kim

Faculty Mentor(s): Professor Charles Kim, MECHANICAL ENGINEERING

Funding Source: James L. D. and Rebecca Roser Research Fund

Layer Jamming-Variable Stiffness Compliant Mechanism

Lamina jamming mechanism has emerged as a new, exciting compliant mechanism that enables the design and fabrication of variable stiffness structures. Lamina Jamming (LJ) is a technique where multiple layers of thin sheet material, typically printing paper or cardstock, are stacked together and enclosed in an airtight envelope with a vacuum pumping mechanism. By applying vacuum pressure, the interface (contact) between layers creates friction, dramatically increasing over stiffness, allowing for transition between flexible and stiff states. Upon further investigation into existing compliant mechanisms, we decided to incorporate the Lamina Emergent Mechanism (LEM) into the jamming unit for its ability to deform out of the plane of manufacture. The goal of this project is to combine the knowledge of LJ and LEM to design and parametrize a variable stiffness joint: layer jamming joint (LJJ).

Anthony Nyoyoko (Graduate Student); Peter Mark Jansson

Faculty Mentor(s): Professor Peter Jansson, ELECTRICAL & COMPUTER ENGINEERING

Funding Source: Open Discourse Coalition (ODC)

Control System Optimization for a Smart Residential Microgrid

This thesis began with a simple objective: to restore and optimize the control system of a smart residential microgrid so it can respond intelligently to electricity prices while remaining safe and reliable on low-cost embedded hardware. The central research question is whether artificial intelligence can improve economic dispatch decisions without compromising system stability.

The work required restoring a legacy microgrid commissioned in 2015. Data acquisition was rebuilt using a Raspberry Pi 4 and an AcuRev smart meter to log voltage, current, power, power factor, and frequency at five-minute intervals. A stable data pipeline was achieved with over 99 percent local logging uptime and 93 percent cloud upload reliability. This phase transformed the project from a control study into a grounded cyber-physical systems investigation.

A two-layer artificial neural network framework was developed. Layer 1 predicts next hour's PJM Real-Time Locational Marginal Prices using historical and time-based features, explaining about 92 percent of price variation. Layer 2 integrates predicted prices with real-time electrical measurements to guide operational modes such as load management and islanded operation. Although the controller achieved measurable economic improvement over a rule-based baseline, its performance was limited by constrained historical and seasonal data. Nevertheless, the implementation validated the complete data-to-decision pipeline and established a practical foundation for refinement.

The key finding is that economic optimization alone is insufficient. Safety must be explicitly enforced through hybrid control combining AI prediction with rule-based protections.

Nhial Jongkuch Nyuon '27

Faculty Mentor(s): Professor Ramona Fruja, EDUCATION
Funding Source: Culliton Family Fund for Undergraduate Research

Navigating Barriers: A Positional Study of Refugee Youth Experiences in Access to Higher Education in Kakuma Refugee Camp

Amid record global displacement, access to higher education for refugees remains profoundly limited. Despite the UNHCR's "15by30" target, global refugee tertiary enrollment sits at just 3%. This study investigates the barriers and pathways to higher education for youth in Kenya's Kakuma Refugee Camp, where fewer than 5% of high school graduates transition to post-secondary education. Such low progression rates stem from compounded structural constraints, including under-resourced schools, acute financial hardship, restricted mobility, and scarce scholarship opportunities. Grounded in critical refugee studies, this qualitative research utilizes interviews and focus groups with refugee youth, educators, and administrators, complemented by an analysis of global education initiatives. By centering lived experiences, the study highlights the systemic drivers of educational exclusion while emphasizing the critical agency of youth navigating these obstacles. Ultimately, the findings offer evidence-based insights to inform responsive policies and programs designed to expand equitable higher education access in protracted refugee settings.

Sean Oakey '26; Austin Wadle

Faculty Mentor(s): Professor Austin Wadle, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Isolation and Characterization of Extracellular Vesicles Derived from Filamentous Fungus *Acremonium strictum*

Acid mine drainage (AMD) from abandoned coal mines introduces problematic loadings of acidity and metal pollutants, including manganese (Mn). Passive remediation systems rely on filamentous fungi like *Acremonium strictum*, among other fungi and bacteria, to oxidize soluble Mn (II) into insoluble Mn (III/IV). Although extracellular proteins are known to oxidize Mn, the role of extracellular vesicles (EVs) in this process remains unexplored. EVs, nanoparticle structures containing diverse biomolecules, are hypothesized to contribute to manganese cycling through extracellular electron transfer and mineral precipitation. Here we report the first successful isolation and characterization of EVs from *A. strictum*. A range of techniques, including Nanoparticle Tracking Analysis (NTA), Zeta Potential measurements, and Atomic Force Microscopy (AFM), were employed to measure the concentration, size, surface charge, and image EVs. We show that *A. strictum* cultures exposed to Mn produce a greater quantity of EVs, which were smaller in size compared to cultures grown in control conditions.

The results revealed EV size distributions of 128.1 +/- 5.7 nm for samples exposed to manganese and 158.9 +/- 1.0 nm for pristine samples. As a means of confirming the sterile isolation technique, both pristine and Mn samples were dosed with a detergent, Triton X-100, to observe cell lysis via NTA and AFM. The overall results suggest that Mn exposure influences the production and physical properties of the EVs produced by filamentous fungi. This indicates the potential for EVs to play a functional role in Mn cycling and contribute to efficient passive remediation of AMD.

Omolara Olatunji '28; Janani Hariharan (Omolara Olatunji '28; Janani Hariharan)

Faculty Mentor(s): Professor Janani Hariharan, BIOLOGY
Funding Source: Department of Biology, Robert P. Vidinghoff Memorial Summer Internship

Exploring Natural Products from 23 Marine Bacteria for Novel Antibiotic Discovery

Advances in genome mining and bioinformatics have opened new approaches for scientists to search for novel antibiotics from microorganisms. In this study, we use two genome mining tools, antiSMASH and BAGEL4, to predict and analyse Biosynthetic Gene Clusters (BGCs) from 23 marine bacteria to further explore the strains' potential for novel antibiotic production. Results from the predicted secondary metabolite gene clusters showed that all 23 strains had the capacity to be antibiotic-producing with different numbers of antibiotic-producing genes. To test computational predictions, we selected three strains (*Maritimibacter alkaliphilus* DSM 10037, *Salipiger thiooxidans* DSM 10146, *Vibrio ruber* DSM 16370) to screen and evaluate for antibiotic production potential.

Gustavo Oliveira (Graduate Student)

Faculty Mentor(s): Professor Alomir Favero, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Graduate Summer Research Fellowship

Numerical Analysis of Vane Shear Test

The Vane Shear Test (VST) is widely used in geotechnical engineering to determine the undrained shear strength of soft and sensitive clays due to its simplicity, low cost, and suitability for in situ conditions where high-quality sampling is challenging. Despite its extensive application in foundation design and stability analyses, its traditional interpretation is limited to the determination of undrained shear strength. However, there is potential for the test to provide further insights into the soil's constitutive behavior. Hence, this research explores the use of numerical models validated using experimental results to extract more information from the VST. To do so, we used the Smoothed Particle Hydrodynamics (SPH) method, to model the VST. To validate and calibrate the numerical framework, an experimental program including field VSTs, Cone Penetration Tests (CPT), and triaxial tests was conducted to characterize soil behavior at a local site, and obtain constitutive parameters for the numerical model. The model calibration was then achieved by tuning input numerical parameters to match simulated VST torque-rotation curves with experimental results.

Subsequently, a parametric study was conducted to evaluate the influence of a set of constitutive parameters on simulation behavior to extract further information from the test, such as stress-strain relationships with torque and rotation, and in situ lateral earth pressure coefficient (K0). The work contributes to the improvement of the interpretation of VST data and proposes new procedures and correlations to obtain additional constitutive parameters of the soil from the test.

Christian Owens '26; Kenny Mineart

Faculty Mentor(s): Professor Kenny Mineart, CHEMICAL ENGINEERING

Funding Source: College of Engineering

Quantifying Interfacial Changes in Organogel Stiffness Gradients via Thermal Fusing

The use of spatially-tunable organogel stiffness gradients holds promise for various biomedical and soft materials applications. For example, orthotic devices require controlled stiffness profiles in order to enhance user support and comfort. In organogels, there is a link between mechanical properties and polymer concentration, with higher concentrations resulting in stiffer gels. Organogel "puzzle-pieces," each at a distinct polymer concentration, were thermally fused through melt-pressing to form gradients. This project specifically aimed to assess the effect of thermal fusing time – at a fixed temperature – on mechanical gradients in organogels. A method of gradient visualization (using Blue 1 dye) was also developed and applied to further validate mechanical gradients since they are invisible to the human eye. The local stiffness of organogels, in the form of relative modulus, was quantified using a micro-indenter equipped with a 1.57-mm diameter, cylindrical probe. The spatially-resolved Blue 1 dye concentration was quantified through the use of UV-Vis spectrophotometry (at a peak of 634 nm). Qualitatively, results from both micro-indentation and UV-Vis spectrophotometry display broadening interfaces as fusing time is increased. To provide quantification of interface evolution, micro-indentation and spectroscopy data were fit with an interfacial width model. The present work provides a pathway to quantitatively describe spatially-dependent organogel properties and interlinks mechanical and optical approaches to doing so.

Delaney Pascual '27; Madelena M. Cagnina '27; Kayla E. Lichtner (Graduate Student); Sarah E. Chapman (Graduate Student); Tori J. Chace '26; Nicole A. Joseph '25; Jack K. Dziubek '25; Benjamin D. Haussmann; Ryan T. Paitz; Zachary T. Bitzer; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY

Funding Source: Department of Biology, National Science Foundation Grant

Exposure to Corticosterone is Associated with DNA Oxidative Damage in Embryonic Domestic Chickens

Exposure to maternal glucocorticoids during development can have marked effects on embryonic physiology. Previous studies in avian species report significant effects of prenatal

corticosterone exposure, including increased levels of oxidative damage and reduction in telomere length. During oxidative stress, radical oxygen species can accumulate and target DNA, resulting in oxidative damage. However, telomeres help protect DNA, and their degradation can be used as an indicator of cellular health and thereby organismal health and lifespan. This study investigates how embryonic exposure to corticosterone affects oxidative damage and telomere length in developing domestic chicken embryos (*Gallus domesticus*). On embryonic day 0, all eggs were injected with either a sesame oil vehicle or corticosterone. Blood samples were collected on embryonic day 18 to measure erythrocyte DNA oxidative damage (8-OHdG) using HPLC-LC MS/MS and telomere length using the telomere restriction fragment assay. We found that the embryos prenatally exposed to corticosterone had decreased levels of oxidative damage and had no changes in telomere length. Contrary to previous studies, this result suggests that the physiological response to prenatal corticosterone exposure may be more complex than previously understood, and we will discuss how this contributes to our understanding of physiological programming during development.

Sophia Perkins '26

Faculty Mentor(s): Professors Ken Field & DeeAnn Reeder, BIOLOGY

Funding Source: Walthour Fellowship

Historical Gradient of Host-Pathogen Dual Transcriptomics in White-Nose Syndrome

White-nose syndrome (WNS) is a deadly disease caused by the fungus *Pseudogymnoascus destructans* (Pd) in hibernating bats. Since its discovery in 2006, WNS has spread across 40 states killing over 90% of bats in some species including *Myotis septentrionalis*, *Myotis lucifugus*, and *Perimyotis subflavus* (Cheng et al., 2021). Despite its detrimental ecological impact, limited knowledge exists regarding the disease progression and how its host-pathogen interactions change over time.

We analyzed mRNA sequenced from Pd-positive wing biopsies collected from three populations of little brown bats (*M. lucifugus*) captured during hibernation in November 2021. These populations represent varying WNS exposure histories: an experienced population from New York (≥ 10 years of exposure), a naive population from Montana (≤ 1 year), and an intermediate population from Wisconsin (~ 5 years). Following capture, all bats were challenged with Pd and continued hibernation under controlled environmental conditions. Our analysis found that Pd expressed different transcripts between NY, MT, and WI, but also shared a group of transcripts that are activated in all three populations. Pd may elicit transcript expressions that are specific to an experienced host's tolerant response or a naive host's resistant response.

Using differential transcript expression techniques, we found that Pd on WNS-affected bats will up- or down-regulate different transcripts in response to hosts across a historical gradient. These findings aim to provide insight into Pd fungal physiology and disease progression to identify potential targets for prevention and treatment of WNS.

Ava Persing '28

Faculty Mentor(s): Professor Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Enumeration of *E. coli*: Plate Culturing versus qPCR

Escherichia coli (*E. coli*), an indicator coliform, is a stand-in for fecal matter polluting waterways. My work aimed to determine the relationship between counts of cultured *E. coli* and the results of quantitative polymerase chain reaction (qPCR) using an *E. coli* primer-probe assay, and investigate whether water sample DNA degraded in a -80°C freezer. This was part of the overall study in Professor Sills's lab. The goal for the overall study is to determine the source of fecal pollution in the impaired waterways of Union County, PA, and implement Microbial Source Tracking (MST) methods into that process. Experiments involved growing *E. coli* strain OP50, plating serial dilutions, and performing qPCR on extracted DNA. I graphed plate results vs. qPCR instrument results; reported colony forming units/milliliter (CFU/mL) versus. gene copies/milliliter (GC/mL). The samples I analyzed in the summer had a high correlation between gene copies and number of colonies grown. In addition, samples that were frozen are undergoing analysis.

Iaroslava Polusmak '28

Faculty Mentor(s): Professor Eric Faden, ENGLISH - Film & Media Studies

Funding Source: James L. D. and Rebecca Roser Research Fund

Preserving Japanese Paper Films

My summer research project had two parts. The first was a two-week trip to Japan, where we traveled Japan with the showcase of our project, scanned 50 paper films and made six new film discoveries.. We also visited cultural sites and met with many collectors and researchers who work with paper films. After returning to the USA, I worked on the preservation of the films we scanned, using DaVinci Resolve, a video editing and visual effects software.

The preservation process has several steps:

1. I process each film through our project's custom software. The code detects each frame by its perforations and creates a pre-stabilized version.
2. I create a 6K timeline in the Color tab and make a highly saturated version of the film with bright pink perforations.
3. Using the tracking tool, I stabilize the film by detecting the black-pink-black pattern of the saturated perforations, stabilizing the film.
4. I divide the entire film into individual shots. In each shot, I find a stationary element and track the shot.
5. Finally, frame-by-frame stabilization. I use a reference frame to refine the image stabilization and align it with the frames before and after it.

Throughout my summer research project, I learned a lot about Japanese art and culture. I also found new ways to make the

stabilization process faster. The biggest outcome of my project was the more than 20 films I finished that are now preserved in our new project database funded by Yanai initiative.

Brooke Psznick '26

Faculty Mentor(s): Professor Sarah Smith, CHEMISTRY, CELL BIOLOGY/BIOCHEMISTRY

Funding Source: Walthour Fellowship

Directed Evolution of Bacterial Resistance to Cecropin AMPs

This project investigates how antimicrobial peptide (AMP) pressure drives genomic and evolutionary changes in *Providencia* species. As AMPs are a key component of innate immunity, understanding how bacteria adapt to them can reveal resistance mechanisms relevant to host-pathogen interactions and future therapeutic design. Insects such as the fruit fly, *Drosophila melanogaster*, produce cecropin AMPs that directly inhibit *Providencia*. Previous research has shown that small structural changes in cecropins significantly alter their ability to inhibit bacterial growth. We expect that relatively small changes in the bacterial genetic code may lead to rapid resistance to cecropins as the peptide-membrane interaction changes.

Over 10 weeks, I performed experimental directed evolution of *Providencia burhodogranariae* B in the presence of CecB. Almost all evolved wells showed an increase in the minimum inhibitory concentration (MIC), or the minimum concentration of peptide required to inhibit bacterial growth, compared to the ancestral strain. As bacteria become resistant to AMPs, higher peptide concentrations are required to prevent growth. Some lineages increased resistance to AMPs by more than 64-fold. The ancestral *P. burhodogranariae* B strain was sequenced along with evolved *P. burhodogranariae* B strains for comparative genomic analysis. Phylogenetic analysis showed evolved isolates clustered closely together on phylogenetic trees, indicating small genetic changes were responsible for the AMP resistance.

Building on these findings, this project will further investigate why bacterial strains exhibit varying levels of resistance to different AMPs and identify genetic mechanisms driving this adaptation, including potential membrane modifications or changes in protein expression associated with AMP resistance.

Judith Ramos '26

Faculty Mentor(s): Professor Julie Gates, BIOLOGY

Funding Source: Robert P. Vidinghoff Memorial Summer Internship

Determining the Function of Arf1 in *Drosophila melanogaster* during Dorsal Closure

Have you ever wondered what happens after you cut your finger? Your body begins healing that wound right away. Dorsal closure in *Drosophila melanogaster* can be used as a model for this process. Dorsal closure is the process of closing a gap in the epidermal sheet on the dorsal surface of a *Drosophila* embryo. Previously, a genetic screen was carried

out to identify novel proteins required for dorsal closure. One of these proteins was Arf1, which is a small GTPase, found in both active and inactive forms within the cell. When activated, Arf1 has been shown to assist in the formation of vesicles that mediate cellular transport from the Golgi apparatus to various cellular locations in mammalian cells. It does this by initiating a cascade of protein activation that leads to polymerization of actin filaments. Actin filaments are necessary for dorsal closure and are found in two types of cells required for the process, epidermal and amnioserosal cells. This research focuses specifically on the actin-myosin belt, which is an actin based structure that decreases the surface area occupied by the gap in the epidermal sheet by contracting, using myosin. I propose that the activation of Arf1 is responsible for maintaining the integrity of the actin-myosin belt. Analysis of Arf1 mutant embryos was conducted to identify defects in the actin-myosin belt and if those defects disrupt dorsal closure. The results of these experiments should provide insight into how Arf1 regulates actin structures needed to complete dorsal closure.

Ethan Ratner '26

Faculty Mentor(s): Professor Robert Rosenberg, ENGLISH

Funding Source: Douglas K. Candland Undergraduate Research Fund

The Art of Stealing Moves: Learning how to Write by Studying the Masters

My eight-week PUR session working with Professor Robert Rosenberg from the Creative Writing Department was an immensely formative experience. My project focused on reading and writing fiction set in contemporary America, exploring themes ranging from disillusioned youth to a rapidly gentrifying Brooklyn. The goal was to produce short stories I would feel comfortable submitting to university literary magazines while developing my skills and discipline as an emerging writer.

The primary result of my efforts was two substantial, heavily revised short stories that drew from both personal experience and observations of a changing cultural landscape. The most valuable lesson I gained was not a concrete finding, but an appreciation for the time, scrutiny, and sustained attention required to produce even a single page of fiction that meets both professional and personal standards.

Throughout the eight weeks, I often spent entire days revising one page—tightening language, restructuring scenes, cutting dialogue, and sometimes reimagining stories entirely. I also learned to “steal moves,” as Professor Rosenberg described, from masters such as Jennifer Egan’s inventive use of perspective and Adam Ross’s experimentation with temporality.

This experience taught me how to function as a writer beyond simply sitting at a computer: how to sustain daily creative stamina, manage time, and build productive routines. Combined with close mentorship and focused reading, the PUR session strengthened my commitment to pursuing writing beyond academia and produced two stories I am proud to continue refining.

Brian Rios-Saldivar '27; Amanda Ortiz '27; Aditi Vijayvergia; Amal Kabalan

Faculty Mentor(s): Professor Amal Kabalan, ELECTRICAL & COMPUTER ENGINEERING

Funding Source: Engineering Success Alliance

Design of a Sensor-Based Glove Interface for Controlling a Robotic Arm in Nursing Applications

This project investigates the feasibility of using a wearable, sensor-based glove to control a robotic arm for healthcare applications. The goal is to improve motion precision, responsiveness, and usability compared to earlier robotic arm prototypes. The end goal is to use the system in healthcare settings that reduce direct patient contact, especially when the risk of clinical contamination is high.

The system uses a glove embedded with flex sensors and inertial measurement units to detect finger bending and wrist orientation. Sensor data are processed by a microcontroller and transmitted wirelessly via Bluetooth to a six-degree-of-freedom robotic arm. The robotic arm integrates multiple servo motors and a stepper motor to enable smooth, coordinated movement. A second, smaller prototype was also developed to evaluate alternative motor configurations and physical designs.

Results demonstrate that the glove interface successfully enables real-time control of the robotic arm with improved precision, stability, and responsiveness. The system achieved an average Bluetooth signal-to-motion response time of approximately 1.8 seconds. Comparative testing showed that motor size and arm scale affect task suitability, with larger designs better handling heavier medical tools and smaller designs excelling in confined manipulation tasks.

Margaret Rodrigues Sanchez '26; Rebecca Bonomo (Graduate Student); Allison Bates '27; Morgan Daily '27; Olivia DeLoca '27; Karyna Fowler '26; Charlotte Higgs '27; Pippa Thomas '27; & Caroline Wieland '27

Faculty Mentor(s): Professor William Flack, PSYCHOLOGY; Professor Erica Delsandro, WOMEN'S & GENDER STUDIES

Funding Source: Helen E. Royer Undergraduate Research Fund

Prevalence Rate & Temporal Risk for Campus Sexual Assault

In campus sexual assault (CSA) research, risk rises and falls with the academic calendar, concentrating in predictable windows tied to arrivals, transitions, and social surges (Cranney, 2015). Previous studies have supported this concept across a variety of college campuses, showing that harm is front-loaded in the first few semester at college rather than equally distributed throughout the college experience (Gross, Winslett, Roberts, & Gohm, 2006), meaning that rates of sexual assault are higher in the first couple years of college. Particular emphasis is given to the first-year, highlighting that first-years have more reports of sexual assault incidents than any other school year (Cranney, 2015). At one university, more first-year students reported incidents of sexual assault than second-year college students,

indicating a “red zone” in the first year of college, but specially the fall semester (Kimble et al., 2008). Evidence on clearly defined “red zones” is mixed, and social or cultural differences across campuses may shape the timing of increased risk of CSA.

Sanoosha Sahni '26; Oscar Bain Moreno de Vega '26; Will Kerber

Faculty Mentor(s): Professor Will Kerber, CHEMISTRY

Funding Source: Harold W. Heine Undergraduate Research Fund in Chemistry

Modeling Iron Oxide Nanoparticle Precursors: Growth of an Undecanuclear Iron(III) Cluster

Nanoparticles (NPs) are extremely small materials, typically tens of nanometers across, placing them between the size of individual atoms and visible particles like grains of sand. Iron oxide nanoparticles (IONPs) are a specific type of NP made from iron and oxygen atoms at their core and are commonly produced by growing small starting molecules, called precursors, into nanoparticles using an established method called thermal decomposition. Iron oxide nanoparticles are of great significance in materials science and medicine because of their unique size-dependent magnetic properties. The purpose of this research is not to make nanoparticles themselves, but to understand how these small molecular precursors assemble and transform before nanoparticle formation occurs. Although thermal decomposition reliably produces IONPs, the molecular steps that precede this process remain poorly understood. Previous studies have shown that the choice and makeup of the precursor strongly influence the size, shape, and properties of the final nanoparticles, highlighting the importance of understanding precursor behavior on its own. To investigate these early-stage processes, a simplified model system was developed: a triiron complex bound by 4,4,4-trifluorobutyric acid (H-TFB). The introduction of fluorine allows structural changes in the precursor complexes to be tracked at the molecular level using fluorine-19 nuclear magnetic resonance (¹⁹F-NMR) spectroscopy, a sensitive and minimally invasive technique. This work focuses on studying a model precursor synthesis using iron(III) chloride and H-TFB and using ¹⁹F-NMR as a structural probe to track and tune the formation of tri- and undecanuclear carboxylate precursor complexes prior to nanoparticle growth.

Gabriella Santos Meltzer '27

Faculty Mentor(s): Professor Kevin Gilmore, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: Bucknell Center for Sustainability & the Environment

Nutrient Loading Reduction Capability in Aged Green Roofs

As climate change accelerates, intense rain events have been persistent, damaging communities in unprecedented ways. Green roofs are a type of sustainable infrastructure that has been implemented on top of modern buildings to adapt to the effects of climate change. However, the presence of nutrients important to plant life, such as nitrogen and

phosphorus, in stormwater runoff can deeply damage nearby waterways through eutrophication. This research focuses on the capabilities of the four green roof test plots atop Academic East to reduce stormwater volume, how the green roof may affect nutrient loading in stormwater runoff, and how changing plant cover may affect these parameters. To do this, the green roof testing lab found in Academic East was restored and redesigned for side-by-side analysis of the test plots. Although the project could not be fully completed in one summer, it was found that the green roof, with no changes, considerably reduced stormwater volume, peak flow rate, and ammonium mass loading for one large storm event. For this same storm event, nitrate and phosphate mass loading in the runoff appeared to increase. In the future, more research focusing on the effects of changing plant cover plans needs to be done.

Katelyn School '28

Faculty Mentor(s): Professor Hannah Yocum, CHEMICAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Development and Assembly of Plasmids for Biodegradable Plastic Using the Golden Gate Toolkit in *Yarrowia Lipolytica*

Reliance on single-use plastics continues to harm the environment as toxic chemicals leach into waterways, threatening plants, animals, and ecosystems. To help address this issue, I worked to develop a biodegradable plastic alternative that could reduce environmental damage while maintaining similar performance properties. My objective was to design and compare several plasmids to determine which would be most effective for producing biodegradable plastics. Using Benchling, I selected compatible components from the *Yarrowia lipolytica* Golden Gate Toolkit and combined them with PHB genes. I chose a diverse set of genetic parts to increase the likelihood that at least one plasmid design would successfully produce the target polymer. To guide my selections, I referenced the publication “A Modular Golden Gate Toolkit for *Yarrowia lipolytica* Synthetic Biology.” After finalizing the designs, I assembled the plasmids using Golden Gate assembly, which allows multiple DNA fragments to be joined in a single reaction. Each plasmid included inserts from three genes—PhaA, PhaB, and PhaC—which encode enzymes required for synthesizing polyhydroxybutyrate (PHB), a biodegradable polymer that can serve as an alternative to conventional plastics. I analyzed gene sequences in Benchling and designed forward and reverse primers for each insert. The genes were amplified using PCR and verified through gel electrophoresis. After several iterations, the plasmids were successfully assembled, transformed into competent cells, and confirmed through colony PCR to match the expected DNA lengths.

Shaan Sekhon '27

Faculty Mentor(s): Professor Joe Wilck, ANALYTICS & OPERATIONS MANAGEMENT

Funding Source: Presidential Fellowship

Foreign Investment in Brazilian Soccer

Foreign Investment in Brazilian Soccer has seen a dramatic rise due to the 2021 law Sociedade Anônima do Futebol (SAF) allowing clubs to transform into private companies, allowing up to 90% ownership by investors. Traditionally, clubs were formed and operated by the local communities and areas in which they reside. Dues-paying members elect presidents every three to four years, who in turn manage the club. However, since 2021 many clubs are transitioning to SAF and are forming hybrid-type models in which fans vote on club leadership, but professional managers run the business or entirely toward complete private ownership. In order to predict the effects this may have on Brazilian soccer, we used European leagues as a comparison tool. Many European leagues and clubs started off as community based or member based. However, in the recent era of sports, there have been large investments from private investors who control and manage the club. We investigated how investments from foreign have impacted the club's results. This will enable us to predict the effects of investment into Brazilian soccer clubs.

Victoria Semenov '26; Krishna Prasad; Maddy Thomas; George Gittes

Faculty Mentor(s): Professor Elizabeth Capaldi, BIOLOGY, NEUROSCIENCE

Funding Source: Neuroscience & Human Health

Sex and Diet Shape Streptozotocin-Induced Diabetes and β -Cell Identity in Mice

Streptozotocin (STZ) is an antibiotic commonly used to induce type 1 diabetes in mice by selectively causing DNA damage in insulin-producing pancreatic β -cells. However, STZ responses vary by mouse sex, strain, and diet, introducing confounding variables into experimental models. No definitive mouse model exists for type 2 diabetes (T2D) that captures both insulin resistance and beta cell failure. This study examined the impact of sex, diet, and STZ dosage on islet health and β -cell identity in a mouse model for T2D. Male and female C57BL/6 mice received either no STZ, a moderate dose (2X50 mg/kg X 2), or a high dose (50 mg/kg X 5) and were maintained on a regular diet (RD) or a high-fat diet (HFD). Glucose tolerance tests (GTT) assessed hyperglycemia, and pancreata were harvested for immunohistochemistry (IHC). One week after STZ, GTT showed that RD males needed a high dose to raise blood glucose, while HFD males needed a moderate level. RD females were STZ-resistant, and HFD females required a high STZ dose to elicit a response. Higher STZ doses reduced β -cell area, particularly in males. Image analysis using Pearson's and Mander's coefficients revealed altered co-expression of insulin+/GLUT2+ and insulin+/Aldh1a3+ post-STZ. Rather than dying, these β -cells may change their identity, a process known as dedifferentiation. This study shows that sex and diet strongly influence STZ-induced diabetes, with STZ potentially altering β -cell identity in addition to causing cell loss. Future work will

examine earlier post-STZ timepoints to better understand early β -cell responses.

Tim Shan '28; Yuning Qin '28

Faculty Mentor(s): Professor SingChun Lee, COMPUTER SCIENCE

Funding Source: Bucknell Program for Undergraduate Research

Systematic Literature Review of VR Text Input Methods

When prevention efforts follow the academic calendar year, rather than a college campus calendar, a substantial amount of harm is unaddressed by school policy and training. Temporal analysis can therefore turn broad messages into targeted action, and clarify when to increase campus safety personnel and where to focus outreach.

Abyssinia Shiferaw '28

Faculty Mentor(s): Professor Benjamin Wheatley, MECHANICAL ENGINEERING

Funding Source: Helen E. Royer Undergraduate Research Fund

Designing a Drop Test Tower to Study Impact Behavior in Bovid Horns

Animals that are members of the Bovidae family have horns that play a big role in defense. These horns sustain significant stress during ramming or wrestling. Understanding how these stresses affect horn structures is important for learning about their mechanical properties. I worked with Professor Wheatley to continue working on previous research at Bucknell that focused on making a drop test mechanism to allow us to replicate how horns vibrate in real-life situations so we can study it. This new understanding can be used to develop new technology where impact absorption is important, including military armor. I focused on designing and refining a modular drop test tower capable of simulating impact conditions experienced during horn collisions. Bryce's design was able to mimic the vibration of horns but had some shortcomings. I focused on creating a more robust system to collect more consistent data. The redesigned tower consists of an 80/20 aluminum frame for rigidity, with a laser-cut acrylic base platform. Another adjustment was the impactor release system. I created a solenoid-triggered release system to have more controlled drops of the impactor, ensuring consistent release height. I also improved the design by replacing the shock absorber of unknown stiffness with a wave spring attached to a 3D-printed structure. After finishing this setup, I recorded a horn model and did a mock test. I am currently learning to analyze that motion using a program called Tracker, which allows me to trace and quantify the horn's vibrational behavior frame by frame.

Ian Shultz '26; Andrea Halpern; Haley Kragness; Molly Malaby

Faculty Mentor(s): Professors Andrea Halpern & Haley Kragness, PSYCHOLOGY

Funding Source: Kimberly Jo McClymont '90 Fund

Surprise! Developmental Change in Sensitivity to Melodic Expectations

Previous studies of children's tonal expectations asked participants whether melodies sounded "good" or "bad", or which of two melodies should "win a prize". However, melodic violations can be pleasant or unpleasant. This study examined melodic surprise in children around the age that tonality profiles begin to emerge (6-7) and a slightly older group (8-9). We hypothesized that even the youngest children would rate violations as more surprising than non-violations, implying tonal understanding. We predicted stronger differentiation with age/ Younger children, older children, and undergraduates from North America participated in a supervised online task. On each trial, participants rated surprisal of the phrase-final note using a novel emoji scale (four emojis, "not surprising"- "super surprising"). The note contained low or high information content (IC) according to IDyOM trained on a corpus of Western melodies and verified by adult goodness-of-fit ratings. All participants also completed measures of musical engagement, and older children completed measures of working memory and auditory short-term memory (digit spans; these analyses are ongoing). We analyzed participants (41/71 younger children, 50/72 older children, 39/40 adults) whose responses in a control task indicated that they understood the scale.

All age groups rated high-IC endings as more surprising than low-IC endings. There was a significant interaction between Age Group and IC, indicating the effect of IC differed by age. The mean difference in surprisal scaled with age, with the youngest age group showing the smallest difference and young adults showing the largest difference.

Richard Sintim (Graduate Student)

Faculty Mentor(s): Professor Ellen Herman, GEOLOGY; Professor Molly McGuire, CHEMISTRY

Funding Source: Department of Chemistry, Graduate Summer Research Fellowship

Water and Sediment Geochemistry of the Excelsior Mine, Shamokin Creek Watershed

The purpose of this study was to determine the reality of semester-based "red-zones" for CSA timing at Bucknell University. This is crucial because if prevention, event standards, and survivor services are concentrated during the weeks when incidents cluster, efforts will miss a disproportionate share of harm that occur later in the college experience. Furthermore, at Bucknell University in particular, sophomore-fall recruitment coincides with the observed multi-semester concern. Greek recruitment likely increases social density and event exposure during a defined period, which can amplify timing-based risk of sexual assault. The present dataset does not test causation, but recruitment is flagged as a plausible contextual contributor because of temporal overlap and campus operations, warranting targeted inquiry.

Katie Skinner '26

Faculty Mentor(s): Professor Ellen Herman, GEOLOGY; Professor Molly McGuire, CHEMISTRY

Funding Source: Department of Chemistry, Department of Geology & Environmental Geosciences

Raman Microscopic Study of Phosphate Adsorption to AMD Precipitates

Abandoned Mine Drainage (AMD) causes high concentrations of iron (Fe) in water systems. Phosphate contamination from wastewater and fertilizer runoff is a separate environmental issue that causes eutrophication and algae blooms in waterways. When these water quality issues occur in the same body of water, AMD may affect phosphate levels because Fe oxide precipitates, such as ferrihydrite and goethite, adsorb phosphate. To better understand the factors that affect phosphate adsorption and remobilization in AMD-affected water sources, laboratory studies of phosphate uptake by synthetic Fe oxides were performed. Raman microscopy was used to compare the differences in the structures of adsorbed phosphate to get a more complete picture of the binding mechanisms of phosphate to synthetic ferrihydrite and goethite.

Quinn Smith '27; Karlo A. Malaga

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING

Funding Source: Gary & Sandy Sojka Fund for Research, Teaching & Scholarship in Developmental Disabilities, Neuroscience & Human Health

Establishing the Effectiveness of the OpenBCI EEG System in Identifying Physiological Markers of Healthy Brains

Parkinson disease (PD) is the second most common neurodegenerative disorder in the United States, affecting 1.1 million people. However, ~20% of PD patients are misdiagnosed because diagnosis often relies on subjective motor assessments by doctors. Electroencephalography (EEG) is a non-invasive, accessible tool that records neural activity using electrodes placed on the scalp, and can be used to improve diagnostics with objective neural biomarkers of PD. The Computational Neuromodulation Laboratory bought the OpenBCI EEG system last spring, and this project sought to identify the reliability of the system. Three experiments were conducted with healthy volunteers. The data for each experiment was preprocessed using EEGLAB to isolate neural data from electrical noise. Then, MATLAB's signal processing toolbox was used to extract the neural features. The first two experiments looked for robust neurological biomarkers of healthy data identified with more advanced EEG systems. With subjects alternating between eyes open and eyes closed states in the first experiment and performing 30 trials of finger tapping in the second experiment, two nonmotor biomarkers and one motor biomarker were successfully identified. The third experiment had patients perform finger tapping and spiral drawing bilaterally, replicating motor tasks in PD assessments. With this data, three biomarkers known to differ between PD and healthy subjects were identified in this healthy cohort,

consistent with the data in the literature. Having identified these biomarkers, the reliability of the OpenBCI system was verified and a comparative study between healthy subjects and PD patients will be conducted to identify novel PD biomarkers.

Travis Stanitis '26; Morgan Benowitz-Fredericks; Alexander Kitaysky

Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, BIOLOGY

Funding Source: Department of Biology

Pacific Decadal Oscillation Predicts the Physiology and Survival in Black-Legged Kittiwake Chicks

Climate fluctuations have impacted wildlife populations, causing significant behavioral shifts associated with survival and breeding. Some of the climate factors that influence seabird populations are captured in the Pacific Decadal Oscillation climate index (PDO). PDO variation in sea surface temperature anomalies might contribute to interannual differences in chick physiology and survival. We tested relationships between physiology, mortality, and ecological factors, including food availability and climate. Low PDO years are associated with an increase in prey availability. Environmental stressors, such as food availability and brood competition, are relevant to understanding the impacts of climate on demographics and could potentially be predicted by circulating ketone concentrations in seabird chicks. Ketones enable seabirds to maintain energy during periods of poor food availability and are practical to quantify with a small volume of blood. Other physiological factors relevant to the survival of seabird chicks include corticosterone levels and morphological measurements. We analyzed data compiled from five breeding seasons of seabird chicks (black-legged kittiwakes; *Rissa tridactyla*) from Middleton Island, Alaska. To test how food availability interacts with climate and influences chick physiology and mortality, chicks came from one of two treatment groups: nests receiving daily food supplementation and control nests without food supplementation. The food-supplemented chicks exhibited lower ketone levels as expected; contrastingly, ketone levels were elevated during lower PDO years when conditions should have been better for kittiwakes. Given this compelling paradox, possible explanations of ketone increases under favorable PDO conditions include maternal experience from previous breeding seasons, nutritional stress, and parental buffering.

Aleena Sultan '27; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE

Funding Source: James L. D. and Rebecca Roser Research Fund

Investigating Gender Bias in Accelerometer-based Gait Recognition Systems

This research examined potential gender bias in accelerometer-based gait recognition used for authentication. Such systems may be deployed in public-sector contexts, including access control in government facilities or parole monitoring, where

classification errors at strict thresholds can lead to significant consequences, such as wrongful access denials or excessive monitoring. Following prior work, baseline authentication models were developed using feature-based representations and three classifiers: Neural Network, Random Forest, and Support Vector Machine. On a benchmark dataset, the best-performing baseline achieved 97.9% accuracy. To assess potential bias, model performance was evaluated separately for male and female users. Detection Error Tradeoff (DET) curves and Equal Error Rates (EERs) were analyzed to compare false acceptance and false rejection behavior across operating points. Two-sample Kolmogorov-Smirnov tests were also applied to compare score distributions and detect distributional shifts that could amplify bias under strict or relaxed thresholds. Gender-specific EERs were nearly identical, and Kolmogorov-Smirnov tests indicated minimal differences in score distributions between groups. The results indicated no observable gender-related performance degradation for this dataset. Future work will extend this analysis to additional datasets and model classes, including deep learning approaches, to evaluate whether these findings generalize across data sources and model architectures.

Sanda Tan '28

Faculty Mentor(s): Professor Heidi Lorimor, LINGUISTICS

Funding Source: Helen E. Royer Undergraduate Research Fund

Syntax and Sensibility: A Corpus Study of Sentence Structures in Children's Literature and Implications for Reading Comprehension

Research Question:

Do the books that school-aged children are reading contain complex sentence structures they need to learn to be successful readers?

Method:

A collection of texts popular with 2nd graders like Mercy Watson, Magic Tree House, Fly Guy, and more were analyzed using an NLP parser from Stanford University called Stanza. Stanza marked the relationship between words in a sentence and extracted grammatical information. For example, if a sentence has a relative clause, it determines whether that is a full or reduced relative clause. Finally, the data was loaded into a database.

Results:

There was strong correlation between lexile and syntactic complexity, meaning that as a student progresses in reading and receives a higher lexile score, they are getting challenged both in vocabulary and sentence structure.

Comparison between different book categories showed variability in sentence complexity for illustrated and chapter books whereas graphic novels tend to be less complex overall. Nonfiction books contain more complex sentences than fiction books.

The chapter book and graphic novel versions of Dinosaurs

Before Dark have drastically different lexile scores (510 and 110 respectively). The sentence length of the graphic novel is skewed right with a huge number of 1-worded sentences like "Help" or "Giggle" with just the picture to set the scene."

Noah Thorpe '27

Faculty Mentor(s): Professor Jude Okolie, CHEMICAL ENGINEERING

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Discharge Process Optimization and Evaluation of Waste Streams from Spent Lithium Batteries

Lithium-based batteries are increasingly replacing traditional battery technologies, leading to a growing accumulation of spent lithium batteries. These used batteries contain valuable heavy metals that can be recovered through various recycling methods. Due to their residual voltage, they must first be safely discharged before dismantling can occur. This research investigates optimal solvents for discharging lithium-based batteries to a safe voltage level for handling and recycling. Additionally, the study evaluates the environmental impact of the discharging process, with a focus on potential pollution risks if the resulting waste enters the environment without further treatment. Analytical techniques were employed for waste liquid analysis and waste solid characterization. Three solvents were tested: sodium chloride (NaCl), sodium sulfate (Na₂SO₄), and iron sulfate (FeSO₄). NaCl had the highest discharge efficiency, nearly 40%. At this voltage, the batteries can be safely dismantled. Preliminary results show that NaCl produced the highest heavy metal ion concentrations, with nickel, lithium, and magnesium being the most abundant. Na₂SO₄ produced lower concentrations overall but still showed elevated levels of nickel, copper, and zinc. GC-MS analysis confirmed that none of the solvents caused leakage of volatile organic compounds. Waste solid characterization revealed that sodium chloride use leads to precipitates of iron oxide (Fe₂O₃) and some unreacted NaCl. Sodium sulfate use results in the formation of solid copper sulfate (CuSO₄). Although no volatile organic compounds were detected, the high heavy metal concentrations and precipitate formation indicate that the waste could cause significant environmental pollution if not treated further.

Kiet Tran '27

Faculty Mentor(s): Professor Kat Wakabayashi, CHEMICAL ENGINEERING

Funding Source: Helen E. Royer Undergraduate Research Fund

Enhancing Polymer Performance with Waste Coffee Ground Products

Plastic waste is a growing environmental problem. While recycling and biodegradable plastics offer partial solutions, improving the sustainability and performance of conventional plastics remains a significant challenge. On the other hand, the coffee industry generates substantial amounts of organic wastes annually which are typically discarded despite their

potential values. From a chemical engineering perspective, these waste products can be treated as useful fillers in composite formation. Recent studies show that biochar derived from different biological sources can improve mechanical strength, thermal stability, and barrier properties of plastics.

This research investigated the viability of using coffee-derived waste products as filler for different polymer matrices to enhance their material performance. Waste coffee residues were treated and pyrolyzed to generate biochar, then compounded into semi-crystalline PLA, amorphous PLA and HDPE through melt-mixing and cryomilling. Composite samples were analyzed for their mechanical (tensile strength, modulus, elongation) and thermal (DMA storage modulus, glass transition) properties. At 5 wt% loading, biochar consistently increased stiffness but reduced ductility across all three polymers, indicating a negative relationship between strength and flexibility. DMA testing shows small increases in storage modulus and a slight upward shift in glass transition temperature, especially in semi-crystalline PLA.

The results indicate that coffee-derived waste products can be used as a filler to increase stiffness and modestly improve thermal resistance in plastics. Although the loss in ductility remains a limitation and requires a better method of material treatment, this research demonstrates the feasibility of compounding coffee waste into functional composite materials.

Kenny Truong '26

Faculty Mentor(s): Professor Austin Wadle, CIVIL & ENVIRONMENTAL ENGINEERING

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Ca and Mg Partitioning and Nanoparticle Production by *Bacillus subtilis* in Environmentally Relevant Media

In many natural systems, bacteria play crucial roles in element cycling by altering their surrounding environment through metabolic processes, often precipitating minerals. One model organism used to study this capacity is *Bacillus subtilis*, alongside its numerous other biotechnological applications. Previous studies on *B. subtilis* have shown that these bacteria precipitate minerals depending on their environmental conditions. Different metals and their ratios in the culturing media produce different carbonate precipitates. Additionally, nanoparticles, such as extracellular vesicles (EVs) and flagella, released by bacteria, have the potential to dissolve or precipitate minerals. This study focuses on the capacity of *B. subtilis* to grow and precipitate carbonates in environmentally relevant conditions and the contribution of biogenic nanoparticles to metal mass balance. Using literature media, YY% of total Ca was sequestered into the solid phase, a mixture of bacterial biomass and solid calcium carbonate, ZZ% was in the aqueous phase, with XX% associated with soft nanoparticles. In contrast, the cultures derived from surface river water from the West Branch Susquehanna River showed substantial bacterial growth; these cultures were supplemented with 1.5% yeast extract and 0.25% dextrose. The Susquehanna

River-derived cultures yielded a YY% of total Ca and AA% of Mg in the solid phase, with ZZ% in the aqueous phase and XX% associated with nanoparticles. These results indicate that the nanoparticle-associated fraction of major elements in bacterial cultures is quantifiable and that using surface waters for bacterial biomineralization for any application will require substantial chemical additions.

Axel Uribe '26; Sarah E. Chapman (Graduate Student); Kayla E. Lichtner (Graduate Student); Tori J. Chace '26; Samuel C. Neirink; Liam U. Taylor; Patricia L. Jones; Robert A. Mauck; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology, National Science Foundation Grant (NSF), Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Incubation Effort and Telomere Dynamics in Leach's Storm Petrels

Avian embryos cannot regulate their own temperature, necessitating parental thermal buffering to stabilize developmental conditions throughout incubation. Many pelagic seabird pairs take turns between incubation and foraging during the breeding period. However, because of unpredictable food resources and fluctuating environmental conditions, breeding pairs often differ in how they divide parental tasks. This variable parental care during the incubation period may impose a physiological cost, which can be investigated using cellular biomarkers. Telomeres—the protective, terminal caps on linear chromosomes—are one biomarker of organismal cellular health. In previous studies of seabirds, shorter telomeres have been linked to improved reproductive performance, which could suggest that decreased energy expenditure towards self-maintenance has a cellular cost on telomeres. Here, we examine the impact of incubation effort on telomere dynamics in Leach's storm petrels (*Hydrobates leucorhous*). To assess changes in telomere length, blood samples were collected from adults approximately 10 days post-egg lay date and 3 days before expected hatch date (average incubation period: 41.7 ± 2 days). Erythrocyte telomere length was measured using the telomere restriction fragment assay. We will discuss telomere length changes at both the individual and pair level to evaluate how incubation effort may trade off with somatic maintenance. This study improves our understanding of the physiological costs of parental investment during incubation, with potential long-term effects on organismal physiology and future reproductive outcomes.

Isabella (Ella) Uriu '26

Faculty Mentor(s): Professor David Del Testa, HISTORY
Funding Source: Bobko-Dennis Fund for Undergraduate Student Research

Sangha: Displacement and Memory in Nikkei Altadena and Pasadena

Sangha: Displacement and Memory in Nikkei Altadena and Pasadena" explores how place-making, memory-work,

community care, and cultural practice has both produced, and continues to anchor, the Pasadena Buddhist Temple and the Altadena and Pasadena Nikkei-American (Japanese-American) community. The Pasadena Buddhist Temple, as well as the community care and cultural practice that takes place there has been key in sustaining the Nikkei-American community in Altadena and Pasadena (Dena) across several major displacements, including the forced removal and incarceration of people of Japanese ancestry during World War II, the displacement of Nikkei from their cultural hub in Old Pasadena by the construction of the I-210 and SR-710/SR-134 Freeway Project during the 1960s, and most recently, the Eaton Fire, which has displaced tens of thousands of Denans, including a small, but historically significant Nikkei-American population. While these displacements have shaped and continue to shape the Nikkei-American community in Altadena and Pasadena, investigating Nikkei-American community care and place-making also reveals enduring resistance to forces of displacement, othering, and assimilation. This project utilizes an interdisciplinary, mixed-methods approach that combines oral histories and archival research with theories in Human Geography and Memory Studies.

Mia Valente '27; Thupten Palmo '27; Mizuki Takahashi

Faculty Mentor(s): Professor Mizuki Takahashi, BIOLOGY, ANIMAL BEHAVIOR
Funding Source: Waters Family Fund for Undergraduate Research in Animal Behavior

Conservation of Imperiled Giant Salamanders: Is Local Ecological Knowledge Reliable?

Japanese Giant Salamanders (*Andrias japonicus*) are fully aquatic, stream salamanders, endemic to Western Japan. Despite federal protection as a special national monument, it is threatened with extinction, and the declining trend continues due to habitat destruction, such as dam and concrete bank construction, as well as hybridization with Chinese Giant Salamanders. Wara in Gifu Prefecture, Japan, is one of the critical habitats for *A. japonicus*. However, information about the species is still largely based on local ecological knowledge (LEK), and only a few preliminary surveys have been conducted. Integration of LEK and citizen science into the monitoring of rare or threatened species has become a popular approach in conservation biology. Yet, the accuracy of LEK has rarely been assessed. To test the accuracy of LEK, we (1) conducted formal interviews with the locals, (2) investigated the fine-scale distribution of *A. japonicus* via environmental DNA (eDNA) and nighttime surveys, and (3) evaluated the accuracy of LEK based on the comparison between the interview results and the field surveys. With IRB approval, we distributed 200 surveys across Wara during the summer of 2025, yielding 96 responses. We collected water samples from various streams and estimated eDNA concentration of each sample using qPCR. With a few discrepancies, the interview results largely agreed with the field surveys. Our findings contribute to conservation biology and provide insights into the accuracy of LEK as a tool to assess the status and location of endangered species.

Juliette VanLuven '26; Lorelei Curtin; Ellen Chamberlin; Craig Kochel

Faculty Mentor(s): Professors Ellen Chamberlin & Lorelei Curtin, GEOLOGY & ENVIRONMENTAL GEOSCIENCES

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Paleoflood Chronology for the West Branch of the Susquehanna River Using Abandoned Chute Channel Sediments, Pennsylvania, USA

Anthropogenic climate change is altering the hydrologic cycle, increasing flood frequency and severity. This is associated with increasing risks to the population of the Susquehanna River Valley, which supports over 600,000 people today. By studying slackwater sediments from an abandoned chute channel in the Robert Allen Natural Area near Williamsport, PA, we can extend the existing flood records using paleoflood sediments along the West Branch of the Susquehanna River. We collected 355cm of sediment from an abandoned chute in the Sylvan Dell wetland using a Vibracore (core 1) and a 107cm core with a Livingstone piston corer (core 2). The first core included 70cm of silt and modern soil, then transitioned to 36 layers alternating between fine sand and silt, indicating a history of flooding. Radiocarbon dates 56.5cm and 280.5cm into the core report dates from 1963 and 1967, drastically changing our inferred timeline of the sediment deposition. The second core, made up of silt and peat, resulted in a radiocarbon date of 9,579 years ago, just 34.5cm down, indicating erosion of younger sediments in the main channel. Elemental analysis of the first core was completed via X-ray Fluorescence of sand and silt layers (n = 127) for potential patterns between grain size and elemental composition. Sediment size analysis was also completed to better understand grain size variation within the cores. Further research and analysis are being completed to better understand the deposition of these sediments and the history of flooding in the area.

Da'Mirah Vinson '26

Faculty Mentor(s): Professor Janet Adomako, GEOGRAPHY; Professor Apollonya Porcelli, SOCIOLOGY

Funding Source: Douglas K. Candland Undergraduate Research Fund

Environmental Degradation and Food Systems in Ghana: Gold Mining and Synthetic Pesticides

This research examines the relationship between environmental degradation and food systems in Ghana. While existing studies explore the effects of gold mining on farmers (Gilbert and Albert 2016; Agariga 2021; Kwang and Blagogie 2025), little attention has been given to how these impacts extend to market vendors and transporters. Even fewer studies analyze food and land through a sociocultural lens. My research addresses these gaps by asking: How do environmental degradation practices—specifically gold mining and chemical use—affect food production, distribution, and security in Ghana? And how does the decline of arable land reshape cultural food identity (Parasecoli 2014)? To explore these questions, I used qualitative interviews, policy analysis, and a review of existing scholarship. Over three months, I

conducted 35 semi-structured interviews (20–60 minutes each) with small-scale farmers, cash crop farmers, and market vendors in Cape Coast, Agona, Kumasi, Obuasi, Busia, Tarkwa, Ho, and Mankessim. This approach centered local perspectives while capturing the broader structural context (Gyan and Mfoafo-M'Carthy 2021; Thow et al. 2021; Ahmed et al. 2021). Findings indicate that while mining has long been part of Ghanaian society, its mechanization under British colonial rule intensified environmental harm, disrupting food production and distribution and deepening food insecurity. Those in lower economic tiers—farmers, Indigenous miners, and non-mining community members—bear the greatest burdens. Chemical use reflects unequal access to quality inputs and pressures to maximize cash crop yields, degrading land and risking health. Participants also expressed concern over cultural loss as farmland diminishes, though some resist by revitalizing traditional agricultural practices.

Jack Walter Pollock '28

Faculty Mentor(s): Professor Ibrahim Sulai, PHYSICS & ASTRONOMY

Funding Source: Walthour Fellowship

Palladium Spectroscopy

We report the laser spectroscopy of metastable palladium in a hollow cathode lamp as a probe of the nuclear structure of palladium. The goal of the project was to study the absorption spectra of palladium in order to get higher resolution scans that have clearly defined resonant spikes for each isotope of natural palladium. The project was a continuation of work that previous students began in prior summer sessions. Our goal this year was to implement new instruments to give the operator of the experiment more criteria to change in hopes of getting those higher resolution scans. Specifically, I helped install various optics, such as lenses, polarizing beam splitters, and waveplates. I also helped install an Acousto Optical Modulator (AOM) that allows for variable frequency chopping of our laser beam, which was not available in the past. Preliminary results were promising and can be built on by future teams.

Zi Wang '27; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE

Funding Source: James L. D. and Rebecca Roser Research Fund

Evaluating Security of Smartwatch-Based Gait Biometrics

Smartwatch-based gait biometrics have emerged as a promising modality for continuous and unobtrusive user authentication due to the stable placement of wrist-mounted inertial sensors. While prior studies report high identification accuracy under benign conditions, the security of these systems against determined adversaries remains largely unexplored. Our work aimed at evaluating the robustness of smartwatch-based gait authentication under adversarial settings, focusing on dictionary-based attacks. We developed a custom smartwatch application and used it to collect data

from 19 individuals walking at 12 different levels of 4 factors (speed, step length, arm rotation, and arm trajectory). We also curated and preprocessed 9 publicly available datasets. We are analyzing these datasets including the one we created to investigate the performance of Smartwatch-based gait biometrics in practical adversarial environments. The work is ongoing and we expect to add more users to our dictionary and publish our findings.

Jinliao Wu '27

Faculty Mentor(s): Professor SingChun Lee, COMPUTER SCIENCE

Funding Source: James L. D. and Rebecca Roser Research Fund

Enhanced Landscape and Building Detection Using Deep Learning

Unmanned aerial vehicles (UAVs) can capture high-resolution images of urban scenes, but interpreting these images requires automatic scene understanding. This project develops a deep learning model for semantic segmentation of drone imagery, classifying every pixel into categories such as buildings, roads, vegetation, and objects. We leverage the Semantic Drone Dataset (400 training images with pixel-wise annotations in 24 classes) to train a U-Net convolutional neural network. The U-Net architecture was implemented from scratch in PyTorch and trained with data augmentation and early stopping. Our model achieved an overall pixel accuracy of about 78% and a mean Intersection-over-Union (mIoU) of ~0.55 on a test set, indicating it segments major structures well while struggling with very small or rare classes. Qualitatively, the model outputs realistic segmentation maps that outline large features (buildings, roads, vegetation) with good detail, though small objects like people or poles are sometimes missed. We discuss the model's performance relative to state-of-the-art approaches and identify key challenges such as class imbalance. Overall, the project demonstrates a successful application of U-Net to drone image segmentation and provides a baseline for further improvements (e.g. using deeper or transformer-based models and addressing rare classes).

Hao Yang '27; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE

Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Robotic Attack On Swiping-Based User Authentication

Researchers have shown that touch gestures on touchscreen devices can be used to verify user identity. However, most existing studies evaluate their verification systems under the assumption that human touch gestures cannot be imitated. In this work, we investigate whether a robot can be trained to reproduce human touch gestures to a degree that prevents verifiers from distinguishing genuine swipes from robot-generated ones. Inspired by prior work, we developed a LEGO-based robotic platform capable of generating general

touch gestures, although it does not yet replicate user-specific swipes. We are refining the system to control key parameters, including speed, acceleration, angle, pressure, contact area, and trajectory. Our goal is to construct a structured dictionary of robotic swipes generated across different levels of these factors. In parallel, we collected and preprocessed publicly available touch datasets and implemented position-aware verification models. The resulting dictionary of robotic swipes will be used to benchmark both existing and newly proposed touch-based authentication systems.

Angel Yanga '28; DeeAnn Reeder; Ashlyn Sak (Graduate Student); Thomas Mazzarulli; Luis Viquez-Rodriguez; Ken A. Field

Faculty Mentor(s): Professor Ken Field, BIOLOGY

Funding Source: Walthour Fellowship

A Low-cost Modular Passive Integrated Transponder (PIT) Tag Logger for Monitoring Bat Activity

Passive Integrated Transponder (PIT) tags are a frequently used tool for tracking the roosting behavior of individual bats. Commercial PIT tag logging systems are expensive, proprietary, and often need customization to accurately track bat entrances and exits. The Bucknell University BatLab has created a modular system that is flexible, field-adaptable, and cost-effective and that utilizes open-source hardware and software. Each recording system was built for ~\$180 USD. Data from FDX-B PIT tags (134.2 kHz) (i.e., Biomark HPT9) were read using a flexible antenna that surrounded the bat box opening; data were fed into an RFID module that connected to a Teensy 4.1 Development Board. The addition of an RTC module and a microSD card module facilitated the storage of timestamped data. Data on detections were saved in a CSV file for further processing in R. Systems were tested during our Ebola virus-like particle (eVLP) experimental infection trials in three captive colonies of bats: Brazilian free-tailed bats (*Tadarida brasiliensis*, at Bucknell University), Angolan free-tailed bats (*Mops condylurus*, at Muni University in Arua, Uganda), and Big Brown bats (*Eptesicus fuscus*, at Bucknell University). Additionally, bat body (skin) temperatures were monitored with modified iButton temperature loggers adhered to bats' backs. Collectively, we were able to monitor bat thermoregulatory decisions and responses, roostmate choices, and roost entry and exit timing.

Sophia Yoo '27

Faculty Mentor(s): Professor Yan Choi Lam, CHEMISTRY

Funding Source: Kalman Fund for Undergraduate Research in the Sciences, John M. Hustler Undergraduate Research Fund, Department of Chemistry

Computational Analysis of Work Terms and Reorganization Energies in Proton Transfer Reactions for Metal Hydride Formation

This computational study investigates the factors governing proton transfer (PT) reaction rates in cobalt-pyridine complexes (CoPy4 and CoPy5) relevant to metal hydride formation for renewable energy storage. Using density functional theory

(DFT) calculations with the ORCA software, we computed reaction free energies (ΔG°), reorganization energies (λ), and reactant work terms for systems including 2-methylpyridinium, benzoic acid, and 4-chlorophenol. Results reveal that CoPy4 systems exhibit large reactant work terms (e.g., 14.01 kcal/mol for 2-methylpyridinium), which dominate the activation barrier and slow the reaction. In contrast, CoPy5 systems display smaller work terms and reorganization energies (e.g., 4.79 kcal/mol for benzoic acid), suggesting faster kinetics. These findings highlight how structural differences between complexes affect the thermodynamic and kinetic parameters of proton transfer reactions. This work provides insight into the design of efficient metal hydride systems for energy storage and enhances the broader understanding of metal hydride complexes.

Bella Young '26

Faculty Mentor(s): Professor Ellen Herman, GEOLOGY;
Professor Molly McGuire, CHEMISTRY

Funding Source: Department of Chemistry

Dissolved Methane in Abandoned Coal Mines, Northumberland County, PA

Abandoned coal mines can release coalbed methane produced through coalification when plant material turns into coal and methane from anaerobic methanogenic bacteria and archaea. This greenhouse gas can dissolve into water when the coal mine is abandoned and water fills it. As this water moves through and out of the mines, the dissolved methane can release into the atmosphere. The quantity of methane in the abandoned mines of the anthracite coal region of Pennsylvania is unknown. Water samples from an abandoned coal mine discharge in Northumberland county were analyzed using headspace gas chromatography with a flame ionization detector (GC-FID) to identify and quantify the methane dissolved in this water.

Zoey Zang '28; Ethan Cowen '29

Faculty Mentor(s): Professor Kate Soslava, ACCOUNTING &
FINANCIAL MANAGEMENT

Funding Source: Bucknell Program for Undergraduate
Research

Talking AI and Talking Money

From your homework to stock picks, AI search engines can do it all. In Q3 of 2025 alone, the proportion of S&P 500 firms discussing AI during earnings calls was 62%! Regardless of industry, AI will be affecting how a business operates and functions. At the same time, managers are grappling with different views on AI, ranging from optimism to concern. In this project, we analyze corporate disclosures by reading extractions of AI discussions and classifying these extractions into costs and benefits of AI. In our findings, positive AI-related key words tend to emphasize growth and potential—such as opportunities, expansion, and innovation—whereas negative sentiment toward AI is more often associated with words like bias, concerns, and infringement. Next, we generate textual rules that extract costs and benefits of AI from 10-Ks, 10-Qs and earnings calls and calculate AI sentiment scores for each firm. Finally, we examine the trends of the AI sentiment across time and different sectors.

