23rd ANNUAL

KALMAN

RESEARCH SYMPOSIUM

SATURDAY,
APRIL 6, 2024

Bucknell UNIVERSITY

KALMAN RESEARCH SYMPOSIUM

INTRODUCTION

Spring 2024

Welcome to the twenty-third 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:

- Algin B. Garrett Undergraduate Research Fund in Animal Behavior
- Awigena Fund for Research in Cell Biology and Biochemistry
- Beavers Internship
- Bobko-Dennis Fund for Undergraduate Student Research
- Botanical Society of American Undergraduate Research Grant
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- Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities

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

- Geology Undergraduate Research
- Graduate Summer Research Fellowship
- Grand Challenges Scholars Program
- Harold W. Heine Undergraduate Research Fund in Chemistry
- Helen E. Royer Undergraduate Research Fund
- James L.D. and Rebecca Roser Research Fund
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- Juliet Shield-Taylor Fund for Undergraduate Research
- Kalman Fund for Biomedical Research Fellows
- Kalman Fund for Undergraduate Research in the Sciences
- The Katherine Mabis McKenna Environmental Internship Program
- Kimberly Jo McClymont '90 Fund
- Manning Intern Botanical Science
- Mayfield and Johnson Scholarship
- Mellon Humanities Academic Year Research Fellowship for Faculty-Student Collaboration
- Mellon Student Summer Research Fellowship (through the Bucknell Humanities Center)
- Michael Baker Jr. Summer Research Program
- Mozilla Just Computing Fellow Research
- NASA Artemis Student Challenge Grant
- NASA Solar System Workings Program and NSF's S-STEM Program #1742124
- National Institutes of Health
- National Science Foundation Grant (NSF)
- Neuroscience & Human Health
- Pennsylvania Firefly Festival
- Pennsylvania Wild Resource Conservation Program
- PIC Math, a Mathematical Association of America (MAA) program funded by the National Science Foundation (NSF) and the National Security Agency (NSA)
- The Pittsburgh Foundation
- Presidential Fellowship
- Program for Undergraduate Research
- Psychology Undergraduate Research
- Responsible Computing Challenge, a partnership of Omidyar Network, Mozilla, Schmidt Futures, Craig Newmark Philanthropies and Mellon Foundation
- Robert P. Vidinghoff Memorial Summer Internship
- Ruth Everett Sierzega Chair in Linguistics
- Schotz Family Interdisciplinary Fund
- Sigma Xi Grant-in-Aid of Research
- Stephen Glenn Hobar Memorial Research Award
- Steven E. Boyer '72 Geosciences Summer Experience Fund
- Summer Research Award 2022
- Susquehanna River Heartland Coalition for Environmental Studies
- Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences
- Thomas Spitzer Undergraduate Research Fund
- The Tom Greaves Fund for Research and Curricular Development
- Torrey Botanical Society Undergraduate Research Fellowship
- US Forest Service
- Walters Family Fund for Undergraduate Research in Animal Behavior
- Wayne Manning Internship Fund
- Wendell I. Smith Endowed Internships in Psychology
- William Corrington Renewable Energy Fund and Center for Sustainability & the Environment

Aiko Amano (Graduate Student)

Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, BIOLOGY; Professor Reggie Gazes, PSYCHOLOGY, ANIMAL BEHAVIOR; Professor Mizuki Takahashi, BIOLOGY

Funding Source: Graduate Summer Research Fellowship

The Relationship Between Social Measures and Salivary Cortisol in Tufted Capuchin Monkeys (Sapajus Apella)

Glucocorticoids (GCs) play a vital role in navigating both physiological and psychological challenges in vertebrates. Social animals are regularly faced with psychological situations that mediate GC release in the form of social stressors and social buffers. Generally, social stressors, such as received aggression, elicit GC release to allow for fast aggressive or defensive physiological responses. Conversely, social buffers, such as grooming and social support, have been shown to reduce or prevent GC release in the face of stressors. Understanding the complex interplay between GCs and social measures may help shine a light on how an animal's social situation relates to its physiological health. We trained our socially housed capuchin monkeys to voluntarily and reliably provide saliva samples in order to measure salivary cortisol (a type of GC) from each individual in the group. We examined how these cortisol levels related to measures of each individual's experienced social stressors (dominance rank, rank uncertainty, aggression received) and social buffers (social network centrality, grooming rate). Coupling the salivary cortisol measures with these social measures will allow us to characterize the relationship between GCs and social position in our capuchin monkeys.

Myleen Amendano '26; C. Tristan Stayton

Faculty Mentor(s): Professor Tristan Stayton, BIOLOGY

Funding Source: National Science Foundation Grant (NSF)

Exploring Variations in Strength and Mechanical Properties of Lumbar Vertebrae in Eulipotyphla

This study examines potential strength variations among lumbar vertebral units, driven by functional trade-offs. Microindentation testing is employed to elucidate mechanical property discrepancies across distinct vertebral units. Hypothetically, shrew lumbar vertebrae features will be correlated with mechanical attributes, including stiffness and load-bearing capacity. We are predicting that the vertebrae may show adaptations in strength with a trend of increasing strength as one descends the vertebral column. This could be driven by the need to balance the mechanical demands of supporting weight and providing stability with the requirement for flexibility and mobility in the lower lumbar region. In other words, the transition from weight-bearing to facilitating movement prompts a distribution of strength to address these functional trade-offs, consequently yielding the observed pattern.

Marina Anglo '25; Julieanna Nelson-Saunders '27

Faculty Mentor(s): Professors Nathan Ryan & Sara Stoudt, MATHEMATICS

Funding Source: Supported by the Responsible Computing Challenge, a partnership of Omidyar Network, Mozilla, Schmidt Futures, Craig Newmark Philanthropies and Mellon Foundation

Developing Tools for Critically Reading and Analyzing Media on the Intersection of Statistics, Justice, and Fairness

This research focuses on developing tools for critically reading and analyzing articles/journalism, specifically in relation to the intersection between data analysis, statistics, justice, and inclusion. Our main goal is to create reading guides that can facilitate discussions and analysis of texts/articles across various topics, while also asking students to incorporate statistical reasoning and cite evidence from the pieces. Our process involves crafting reading guides with an approach of starting with detailed, leading questions that progressively become more open ended so that students can learn to navigate and structure their own discussions. In these readings, we are looking at the role of statistics in shaping narratives around injustice and fairness and how that comes up in our daily lives. Being able to discern biases and understand evidence and data to critically engage with these texts will guide students towards developing a more nuanced and informed perspective on complex issues. These reading guides are to be used across a variety of data-related courses. These guides will provide professors with a framework to guide students through thinking critically, analyzing text, and creating a deeper understanding of complex issues of justice and fairness in society through the lens of statistical concepts.

Sethumte Asamoah-Nani '26

Faculty Mentor(s): Professor Andrew Sloboda, MECHANICAL ENGINEERING

Funding Source: Helen E. Royer Undergraduate Research Fund

Chaotic System Synchronization for Damage Detection

The aim of this research was to build knowledge about the synchronization of chaotic systems to explore potential avenues for future research. Initially, I spent time learning how to simulate relevant chaotic systems, learning the proper syntax in MATLAB to solve differential equations numerically. I relied on the differential equation solver ODE45 to run most of my simulations. I also learned various ways of interpreting and displaying the results of these simulations.

A literature review of relevant papers followed where I searched for, read, and summarized salient academic articles related to chaotic synchronization and damage detection. I then began to replicate the results of some previous academic works to consolidate the various skills I had developed.

Then, by simulating appropriately coupled chaotic systems, I attempted to see if I could determine the difference between parameter values in the equations of the two involved systems (damage). I did this by evaluating one of the output variable's properties.

The result was that I found two ways of reliably determining the value of unknown parameters in the driving equation by comparing the output values:

1) The value of the deviation in the first peak or trough of the transient dynamics.
2) The average of one of the output variables of the system.

While the results varied for different chaotic systems, in most cases one or the other (or both) gave a good estimate of the changed parameter value.

Ramon Asuncion '25

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

Sentence Risk Assessment Tool Analysis

The Pennsylvania Commission on Sentencing has developed a Sentence Risk Assessment Tool (SRAI) that is an actuarial tool used to estimate the risk of recidivism, which refers to the likelihood of reoffending after being released. The SRAI utilizes various risk factors that the Commission considers relevant in predicting recidivism. By analyzing these factors, the tool provides an assessment of an individual's risk level. This information is used in determining sentencing decisions and determining appropriate interventions and/or programming for individuals within the criminal justice system. However concerns arise about potential racial disparities inherent in the instrument. To investigate questions of fairness and equity in its application, this project seeks to statistically recreate the SRAI and to evaluate its impact on different racial groups to help highlight any biases or inequities that may exist.

Michaiah Augustine '24

Faculty Mentor(s): Professor Cymone Fourshey, CRITICAL BLACK STUDIES, HISTORY, INTERNATIONAL RELATIONS
Funding Source: Program for Undergraduate Research

Their Fight for Civil Rights: Studies of Black Bucknellians

The research question is whether Bucknell's efforts from the start of the Civil Rights Movement to current day have had any lasting success? If any, by whose measure of success? Through a study of artifacts and documents spanning decades, what can be deduced about the Black Bucknellian experience and Bucknell's future at retaining and increasing Black Student enrollment?

Oscar Bain Moreno de Vega '26

Faculty Mentor(s): Professor Will Kerber, CHEMISTRY
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Synthesis of Fluorinated Basic Zinc Carboxylates

This work focuses on the synthesis of multinuclear complexes, more specifically, fluorinated basic zinc carboxylates. Basic zinc carboxylates are important due to their function as nodes in metal-organic frameworks, and they can be precursors for zinc oxide nanoparticles. Basic zinc carboxylates were synthesized from fluorinated benzoic acid derivatives. Once the crystals were grown, we used X-ray crystallography, mass spectrometry, and ATR-IR to characterize the produced compound and determine whether it matched our desired product. To determine the ability of the basic zinc carboxylate to undergo cluster growth, we used NMR analysis to look at the stability and solubility of three different concentrated solutions containing the basic zinc carboxylate. The data suggests that we were able to grow zinc carboxylates which in solid state are normal zinc carboxylates (ZnL2), and in solution basic zinc carboxylates (Zn4OL6). Basic zinc carboxylates were most stable in a more concentrated environment with a higher tendency to react in the presence of water.

Kelsey Boyle '24; Enzo Ottaviani '23

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING
Funding Source: Program for Undergraduate Research; Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities

Effects of Ultrasound on RNA Expression of Growth Factors in Endothelial Cells

The purpose of this study was to understand if ultrasound promotes angiogenesis through the increase in growth factor RNA expression using reverse transcription-polymerase chain reaction (RT-PCR). Every year, 500,000 people are treated for venous ulcers, a type of chronic wound that takes 6 to 12 months to heal1. Low-intensity, low-frequency ultrasound has shown increased promise in treating these wounds. The goal of this study was to determine the effect of ultrasound on the RNA expression of Vascular Endothelial Growth Factor-A (VEGFA) and Fibroblast Growth Factor-2 (FGF2), two key growth factors in the promotion of angiogenesis, using RT-PCR. To do so, 80,000 human umbilical vein endothelial cells (HUVEC) were seeded and exposed to ultrasound intensities of 50 mW/cm2, 100 mW/cm2, and 150 mW/cm2 for 15 minutes (n=3). Cells were collected and lysed 48 hours after exposure. RNA was collected and analyzed using the comparative CT-TaqMan setting.

The results, although not significant, may suggest that increasing ultrasound intensity decreases the RNA expression of VEGFA in endothelial cells. In this study, FGF2 did not demonstrate a strong dose-dependent trend. From this, it can be appreciated that ultrasound does affect gene expression in VEGFA and FGF2 in HUVECs. These genes are involved in angiogenesis, which further supports that ultrasound may advance healing through the modulation of gene expression. The mechanism behind chronic wound healing using ultrasound needs to be further investigated, but gene expression of pro-angiogenic growth factors is shown to be involved.

Matt Brennan ’24

Faculty Mentor(s): Professor Kenny Mineart, CHEMICAL ENGINEERING
Funding Source: Schotz Family Interdisciplinary Fund

Physical Stability of Liposomes

Liposomes have proven to be effective nanocarriers of various drugs and pharmaceutical compounds. Their spherical lipid bilayer composition enables the entrapment of such molecules in their internal aqueous environment. A concern with these nanocarriers is their stability over time. Specifically, I investigated how liposomes degrade in different pH buffer solutions over an 8-day period. Fabrication of liposomes was accomplished by extruding DOPC lipids in buffer solutions of varying pH through a 100 nm pore size polycarbonate membrane. The samples were stored in a 70 °C recirculatory bath throughout the experiment and were tested daily. To characterize degradation, I utilized Dynamic Light Scattering (DLS) and UV-Vis spectroscopy. The DLS was used to determine average liposome size and the UV-Vis was used to determine light transmittance. We found liposome diameter increased for all pH’s with a significant increase in polydispersity among all samples. While some pH’s did cause greater increases than others, we were unable to make a strong correlation between the rate of degradation and the pH. The UV-Vis was not useful as the initial solutions were too opaque. The overall increase in polydispersity is significant because it points towards a “soup” of particles that may form from the various degradation products. These products may include various sized liposomes, long cylindrical micelles, and surfactant particles. Further study of these particles may give insight into the degradation processes occurring.

Anna Brown ’25; Rachel Malison; Kilynn Groen; Tristenne Cranford; Chester Wooldridge; Jared Glass

Faculty Mentor(s): Professor Steve Jordan, BIOLOGY
Funding Source: Department of Biology

Thermal and Oxygen Plasticity of Aquifer Stoneflies in the Flathead River of NW Montana

Aquifer stoneflies, of the order Plecoptera, are aquatic macroinvertebrates that have important differences from their common counterparts found in streams. They live in high abundance in some alluvial aquifers like those of the Flathead River’s Nyack floodplain in northwestern Montana. Increased risk of climate change has had multiple documented effects on these environments including, most prominently, rising temperatures as well as secondary effects on the ecosystem such as decreasing oxygen availability. This research was conducted to assess the plasticity of individual aquifer stoneflies responding to such manipulated changes in temperature and oxygen levels. We collected samples from the Nyack floodplain by pumping aquifer wells. We then subjected the stoneflies to a range of conditions in the lab, including four treatment groups: manipulations of temperature (warm/cold) and oxygen level (normoxia/hypoxia). We observed survival rates over several three-week acclimation periods, with additional tests of relative growth rate, critical thermal maximum, and respirometry rates measured post-acclimation. Preliminary results suggest slight plasticity surrounding changes in temperature and oxygen availability. However, detailed statistical analysis and further lab testing are still needed. Based on low survival rates, certain changes should be implemented in future experiments to ensure robust and reproducible data, including slower initial acclimation changes and isolation of the pumps in each tank to prevent unnecessary additional mortality.

Caitlin Bucceri ’25

Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: James L.D. and Rebecca Roser Research Fund

Computational Evaluation of the Buckling Capacity of Thin Plates within a Miura-ori Fold

Structural engineering applications inspired by origami are emerging due to the potential for a high strength-to-weight ratio and configuration flexibility. Prior to implementation, it is necessary to understand and characterize the structural behavior of origami-inspired systems.The goal of this project is to model the Miura-ori fold using SAP2000 to evaluate buckling and crushing behavior. Using Timoshenko’s elastic buckling theory, the behavior of thin plates with various loadings and end conditions was verified. This was important to ensure the computer models and analysis were producing accurate results. After the initial model verification, the focus of the project was to model the behavior of individual plates, skewed and slanted from 0 to 55 degrees, to represent the plates that make up the Miura-ori form. Eigenvalue and linear static analyses were developed to characterize both crushing and buckling behavior. To be able to directly compare the results with experimental results from a complementary study on 3D-printed specimens, a model of a single cell of 4 connected plates, all of which are both skewed and slanted corresponding to 3 primary configurations (30, 45, 60 degree) was created and analyzed. The correlation with the experimental results continues to be a work-in-progress and future work will involve modifications to the computational models.

Phuong Cao ’26

Faculty Mentor(s): Professor Joshua Stough, COMPUTER SCIENCE
Funding Source: Program for Undergraduate Research

Domain Adaptation of Convolutional Neural Networks for 2D Echocardiography Segmentation

Convolutional neural networks (CNNs) perform excellently in echocardiography image segmentation. However, their performance drops when applied to new domains due to data variations. Domain adaptation addresses this issue by improving generalization. Cai et al. [6] proposed a co-learning framework combining Unet and Cycle GAN, outperforming previous Unet-GAN models on CAMUS data. However, reaching human-level accuracy remains challenging.

Our goal is to develop an enhanced Unet-GAN model for segmentation. We conduct four main experiments. First, we validate prior Unet models by Stough et al. (2020) and Toon et al. (2021) using 5-fold cross-validation on CAMUS. Both achieve strong performance, with average Dice Overlap scores of 0.93 and 0.95.

Next, we sample and stratify 1200 EchoNet images into 5 folds. When evaluating the CAMUS-trained models on EchoNet, Toon et al.'s model performs better on CAMUS but shows limited generalization ability compared to Stough et al.'s model.

The last two experiments fit the models into Junyang's domain adaptation system. With Stough et al.'s model, generalization ability increases, raising Dice Overlap on EchoNet from 0.87 to 0.89. However, we observe significant variations when adapting Toon et al.'s model despite similar architectures.

Future work will investigate these variations between models with similar architectures but different parameters. Overall, our study validates prior Unet models and provides directions to improve generalization across echocardiography datasets.

Zoe Carlson-Pietraszek '25

Faculty Mentor(s): Dr. David Scadden, DEPARTMENT OF STEM CELL AND REGENERATIVE BIOLOGY AT MASSACHUSETT GENERAL HOSPITAL
Funding Source: Thomas Spitzer Undergraduate Research Fund

Clonal Dynamics in Leukemia and Microenvironments

This summer I had the opportunity to study how clonal changes in the stroma influence the leukemic cell, and differential sensitivities to treatment from specific leukemic clones. We are specifically studying Acute Myeloid Leukemia (AML), as it kills over 50% of the ~18,000 adults in the U.S. diagnosed each year (Aitbekov, et al. Asian Pac J Cancer Prev, 2022). In practice, we use two methods of barcoding cells to obtain clonal information from both the stroma and leukemia: the CARLIN-Cas9 model and lentiviral integration. Both systems require a barcode library to obtain single cell resolution, and are designed to track single clones. The barcodes are later read out by sequencing before and after treatment and leukemia are introduced into the leukemia and stroma, respectively. These barcode readouts determine if certain clones are more resistant to leukemia treatment. If resistant clones are identified, treatments can be modified to target these specific clones so that relapse in AML patients is less likely. I conducted my own in vitro experiment testing the three most common AML drugs in clinical settings, Venetoclax, Azacitidne, and Cytarabine, on our EAS12 leukemia cell line. From the data that I obtained this summer, I concluded that the AML treatments are successful in killing the leukemic cells, the combination of Venetoclax (300 nM) and Azacitine (3 uM) was the most successful treatment in three groups of different cell numbers, and we had successful barcoding of our EAS12 cells that were injected into our mice on July 14.

Clara Carroll '25; Dr. Rebecca Switzer

Faculty Mentor(s): Professor Rebecca Switzer, BIOCHEMISTRY/CELL BIOLOGY, CHEMISTRY
Funding Source: California Healthcare Undergraduate Research

Investigating the Impact of Disease-Associated Mutations on the Intermolecular Interaction Between DNMT1 and Histone H3

DNA methylation is a form of gene regulation, with high levels of methylation resulting in gene silencing. DNA methyltransferase 1 (DNMT1) is the enzyme responsible for copying DNA methylation patterns to newly synthesized DNA strands following replication. DNMT1 activity is regulated in cells by a variety of intra- and intermolecular interactions. Binding between DNMT1 and Histone H3 is one such interaction that is crucial for proper targeting of DNA methylation. Specifically, this interaction occurs between the RFTS domain of DNMT1, a key regulatory domain, and Histone H3 tails, the N-terminal region that protrudes out from the histone core. Mutations in the RFTS domain of DNMT1 are associated with development of adult onset neurodegenerative disorders. Changes to the normal DNA methylation pattern have been observed in patients harboring these mutations. I am exploring the effect of disease-associated RFTS mutations on this critical regulatory binding interaction. Wild-type and mutant RFTS domains (residues 351-600) have been expressed in bacteria and purified to homogeneity. Histone H3 peptides (residues 1-37) were synthesized commercially. I am utilizing electrophoretic mobility shift assays (EMSAs) and fluorescence polarization assays to examine binding. With unmodified H3 peptides, the binding interaction is not significantly impacted by the mutations. Previous work has shown that DNMT1 binds significantly tighter to ubiquitinated histone H3 tails. Future work includes generating ubiquitinated H3 peptides for use in these binding studies. I also plan to examine H3 peptide binding to full-length DNMT1 rather than just the isolated RFTS domain.

Meghan Catherwood '25; Natalie Dyer '25; Lauren Shaffer '26; Edith Simpson (Graduate Student); Sarah Lower; Moria Chambers

Faculty Mentor(s): Professors Moria Chambers and Sarah Lower, BIOLOGY
Funding Source: Pittsburgh Foundation

P. Scintillans: Small Fireflies with Strong Immune Responses

Catching fireflies is a memory that many share, but fireflies are not as prevalent today as they once were. Light pollution, loss or degradation of habitat, and climate change are a few potential factors contributing to their decline. These changes may cause fireflies to be more susceptible to infection since pathogen infections are energetically costly for host organisms, particularly those coping with other environmental stressors. The Chambers and Lower labs recently discovered that infection susceptibility of the common eastern firefly, Photinus pyralis, depends on pathogen species, initial host body condition, and date of host capture. However, it is unclear whether other local firefly species will be similarly affected. My work focused on

Photinus scintillans, which occupies habitats adjacent to those of P. pyralis but emerges earlier in the summer. We infected P. scintillans with Serratia marcescens and Providencia rettgeri, bacterial species causing mortality in P. pyralis. I hypothesized that P. scintillans would better survive infection due to a less energetically costly mating behavior. Female P. scintillans have shortened wings which is often evolutionarily linked with loss of male nuptial gift production. Supporting my hypothesis, infection with P. rettgeri did not significantly affect P. scintillans survival, but high and low doses of S. marcescens both affected mortality. P. scintillans, like P. Pyralis, had decreased physiological condition and became more susceptible to infection as the season progressed. This underscores the importance of studying multiple species, even if closely related, as they may respond differently to environmental challenges like infection or climate change.

Sarah Chapman '25; Jess L. Fenners '25; Jennifer L. Houtz; Maren N. Vitousek; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology

Telomere Dynamics in Tree Swallows: Exploring the Effects of Temperature and Microbiome

As the climate is rapidly changing, many species are facing a more unpredictable and thus challenging environment. Particularly, frequent cold weather swells, known as cold snaps, have posed a significant thermoregulatory challenge that is suspected to shorten telomeres–the non-coding, protective, terminal caps on chromosomes–and ultimately reduce organismal lifespan. However, it is unknown how the composition of the gut microbiome affects an organism's ability to face these thermoregulatory challenges. Here, we investigated the effect of temperature and antibiotics on telomere length in the widely distributed and tractable Tree Swallow (Tachycineta bicolor). Wild nestlings were reared in captivity from days five to twelve post-hatch under both cold (31°C) and control (35°C) conditions and further divided into two groups: antibiotic treated and non-antibiotic treated. Blood samples from twelve days post-treatment were analyzed using the telomere restriction fragment assay. While there was no significant temperature by antibiotic interaction, both warmer temperatures and antibiotic treatment resulted in individuals with longer telomeres. These findings suggest that more variable and colder climates early in the breeding season are likely to have a detrimental impact at the cellular level. Though we predicted that the administration of antibiotics may result in more telomere loss, the longer telomere average for the antibiotic treated nestlings suggests the connection between temperature challenges and the gut microbiome is complex and deserving of further research.

Aura Chuck Hernandez '27

Faculty Mentor(s): Professor Anne Ross, COMPUTER SCIENCE
Funding Source: Mozilla Just Computing Fellow Research

Long-Term Web Accessibility Evaluation for Small Businesses in Union, Snyder, and Northumberland Counties

The purpose of this study is to evaluate the long term sustainability of web accessibility initiatives for small businesses in Union County, Snyder, and Northumberland counties. By implementing a series of web accessibility workshops, this research focuses on instilling fundamental accessibility features such as color contrast and alternative text among participating businesses. These interventions are designed to enhance the digital inclusivity of small enterprises by equipping them with the necessary tools and knowledge to implement and maintain accessible web practices. The evaluation of these businesses will occur longitudinally, providing insights into their ongoing capacity to uphold accessibility standards. This study addresses the critical need to reduce accessibility barriers for small businesses, contributing to the broader goal of creating an inclusive digital environment for all users.

Brooke Corpuz '26

Faculty Mentor(s): Professor Chase Gregory, ENGLISH
Funding Source: James L.D. and Rebecca Roser Research Fund

Writing Across Difference in Creative Writing

My goal was to understand the successes and failures of writing across difference in order to improve my creative writing abilities. I read opinion pieces and fiction pieces by authors surrounding this topic in order to create an annotated bibliography. With this information, I've created a website of best practices to help myself and fellow Bucknell writers. Simultaneously, I wrote a page every day, five days a week for my novel in which the main character is a transgender man. I drafted 52 pages.

Through my reading, I've learned that writing across difference is not in itself disrespectful. Historically, white, straight, cis-gendered men have used marginalized identities as literary tools to further white supremacy. Marginalized people were not viewed as fully human, and therefore rendered harmfully and without complexity. This phenomenon continues to this day. In order to better one's craft, authors should reflect on their intention to write across difference and do thorough research. Most importantly, authors should gracefully receive and implement criticism from the community they are writing about.

I wrote 52 pages throughout the summer toward my novel. I've learned about my creative process and ways that I can overcome writer's block. I've learned that I prefer writing on physical paper rather than on the computer. I've also made up some writing exercises, such as going on a walk and imagining the character is beside you. Giving myself the time to be creative without a deadline or workshop pressuring me has been very helpful.

Ally Cruz-Flores ’26; Rachel Gamburg; Jayne C. McDevitt; David Rovnyak

Faculty Mentor(s): Professor David Rovnyak, CHEMISTRY
Funding Source: Harold W. Heine Undergraduate Research Fund in Chemistry

Naproxen: Unexpected Aggregation by a Common Analgesic and Occurrence in Human Sera

Naproxen is a non-steroidal anti-inflammatory drug (NSAID) that about 10-15% of the population are likely to find in their medicine cabinet. It is most commonly known under the brand name AleveTM. This pharmaceutical drug, from what we are aware of, does not have Nuclear Magnetic Resonance (NMR) data in water that is available to the public. The limited data that are available in other solvents do not match spectra in human sera. There is a need for data transparency to verify the identities of pharmaceutical drugs such as Naproxen in humans. In order to understand and compare the different Naproxen NMR data in water and those found in human sera, 30 samples of naproxen at different concentrations were prepared and 1H NMR spectra were obtained. By comparing the 30 samples, Naproxen showed changes in chemical shifts as the concentrations increased. We hypothesize that the changes were a result of concentration dependent aggregation. This work aims to resolve and explain inconsistencies among Naproxen NMR spectra and hypothesizes that concentration dependent self-aggregation may be partly responsible for observed differences in NMR spectra.

Aleksandr Davtyan ’25; Jordan Polvere; Karen Castle

Faculty Mentor(s): Professor Karen Castle, CHEMISTRY
Funding Source: NASA Solar System Workings

Titian’s CO Vibrational Energy Transfer: Experimental Insights with Helium Bath Gas

My project endeavors to investigate the vibrational energy transfer processes involving CO in planetary atmospheres, with a specific focus on Titan’s upper atmosphere. The vibrational states of CO in Titan’s upper atmosphere play critical roles in the energy balance of that environment. To enhance our general understanding of Titan’s atmosphere, we are conducting experimental measurements of rate coefficients using transient diode laser spectroscopy in the presence of helium as the bath gas. Our methodology involves a classic perturbation-relaxation technique combined with transient diode laser spectroscopy to measure relaxation rates. For Titan, we are examining the room-temperature quenching of CO(v) by CO in the presence of He. We use ozone photodissociation for generating a temperature-jump and shifting population into the desired CO(v) state of interest. We then measure the overall rate of collisional quenching by infrared absorption in the presence of varying amounts of bath gas. By improving the accuracy of rate coefficients for these energy transfer mechanisms, our research aims to refine non-LTE models of Titan’s atmosphere, contributing to a better understanding of its past and present climates. ur research aims to refine non-LTE models of Titan’s atmosphere, contributing to a better understanding of its past and present climates.

Susan Deering ’26; Dr. Sarah Lower

Faculty Mentor(s): Professor Sarah Lower, BIOLOGY
Funding Source: Department of Biology; National Science Foundation

Manual Curation of Firefly Genomes Reveals Odorant Receptor Diversification in Lampyridae

Odorant receptors (ORs) allow insects to sense airborne chemicals, and therefore play a crucial role in insect behaviors such as mating, finding food, and social communication. ORs are an excellent model to study gene family evolution, as they represent among the largest gene families in insects. Although thousands of ORs genes have been identified for species across the class Insecta, their rapid sequence divergence necessitates analyses of more recently diverged clades to provide insight into their evolutionary patterns in different insect groups and potential relationships to ecology and behavior. To advance the understanding of the diversity and evolution of ORs in one of the most speciose insect groups, the beetles, we annotated putative odorant receptor encoding genes in multiple firefly species (Coleoptera: Lampyridae) with publicly available high-quality genome assemblies. Iterative BLAST followed by manual curation of OR intron/exon boundaries found substantial variation in the number of ORs between species, with A. terminalis having around 100 ORs, similar to other fireflies, and L. yunnana having only 36 ORs, despite its larger genome size. Further, the adjacent positioning of many A. terminalis, but not L. yunnana, ORs in close proximity in the genome suggests that tandem duplication plays a role in OR diversification in this group. Continued genome sequencing efforts in this charismatic beetle group will enable future testing of potential relationships between OR diversification and ecology, specifically reliance on pheromones or bioluminescence to find mates, in fireflies.

Nick DeVita ’24

Faculty Mentor(s): Professor Kenny Mineart, CHEMICAL ENGINEERING
Funding Source: College of Engineering

Diffusion in Macroscopically Layered Polymer Gels

Transdermal drug delivery is a vital mechanism for skincare, hormone replacement, and other biomedical applications. Organic polymer gels have been recently identified as candidates for this drug delivery mechanism. Our present work focuses on controlling model drug release rate in a layered polymer gel system consisting of multiple organogels and a polystyrene backing. Typically, one organogel contains a diffusion probe [AOT (sodium bis(2-ethylhexyl)sulfosuccinate)], tri-block copolymer, and an organic solvent whereas the other contains only tri-block copolymer and organic solvent. The tri-block copolymer forms a physically crosslinked network within the gels that consists of spherical polystyrene domains and a plasticized rubbery matrix consisting of ethylene-co-butylene and aliphatic mineral oil (organic solvent). The matrix phase is fluid-like and amenable to mass transport, which allows for probe diffusion. Using Fourier Transform Infrared (FTIR) spectroscopy, the overall probe release rate, which stems from this diffusion, can be tracked. In particular, we are interested in the comparison between the aforementioned layered systems and a ‘traditional’ system with a single

organogel containing the AOT diffusion probe. We also seek to investigate how changing the tri-block copolymer concentration of the barrier organogel layer - that which contains no AOT - changes the overall diffusion probe release rate. Our measurements show that the release rate of layered systems exhibits a time-delay phenomenon. Furthermore, systems with higher tri-block copolymer concentration in the barrier layer exhibit a longer time delay.

Carolyn DiPietro '24; M.B. Gray; K.J. Castle; J.J. Dong; J. VanLone

Faculty Mentor(s): Professor Janet VanLone, EDUCATION
Funding Source: National Science Foundation Grant (NSF)

Developing Scientist Identity and Building Community: Recruiting and Retaining Low-Income Students in the Physical Sciences at Bucknell University

This project is an investigation into the lived experiences of high-achieving, high-financial need students selected for Bucknell University's Physical Science Scholars (PSS) program. Funded by the National Science Foundation, PSS seeks to strengthen low-income and underrepresented students' persistence in physical science majors through financial support, faculty and peer mentorship, cohort-building activities, and career counseling.

This project utilizes the qualitative analysis of eleven interview transcripts in an effort to better understand PSS students' perspectives on the development of their self-identification as scientists and their motivation to pursue STEM-related careers. Employing Ryan and Deci's self-determination theory and Tinto's theory of student persistence, it was anticipated that the features of the program would strengthen students' needs for autonomy, competence, and relatedness, leading to greater academic and social involvement, increased motivation, and higher graduation rates.

As a result of their involvement in the program, students developed a stronger sense of self-efficacy and confidently identified themselves as professional scientists by the end of their senior year. Students' sense of academic belonging generated through their participation in a science-themed living-learning community generally facilitated the development of a meaningful social network. Students expressed feeling well prepared and eager to take the next step in their STEM journeys, emphasizing the value of support from peers with similar socioeconomic backgrounds, genuine relationships with faculty, and transformative research experiences.

Andy Dorsel '25; Tanisha Williams; Scott Schuette; Chris Martine

Faculty Mentor(s): Professor Chris Martine, BIOLOGY; Tanisha Williams
Funding Source: David Burpee Endowment; Manning Intern Botanical Science; PA Wild Resource Conservation Program

Assessing Climate Vulnerability of and Genetic Threats to the Rare Bog Jacob's Ladder

Polemonium vanbruntiae (bog Jacob's ladder), an erect perennial herb in the Polemoniaceae (phlox) family with only a few remaining extant populations across its range in northeastern North America that are threatened with localized extinction. Such losses can have cascading impacts on our ecosystems, how species interact with their environment and each other, and might have unforeseen consequences that are yet to be uncovered. In Pennsylvania, the populations are at the southern edge of the species' range. Because P. vanbruntiae is rare in PA, at the edge of its range, and the populations are disjunct, it is listed as a species of conservation concern. This project uses Natural Heritage protocols, along with population genetics and climate change vulnerability modeling to develop an adequate recovery plan for P. vanbruntiae in Pennsylvania. We sampled all seven extant populations over the summer and received additional range-wide samples from our collaborators in other states. Findings from these samples will determine the vulnerability of each population, so decisions can be made for conservation efforts. If the populations are found to be clonal and lack genetic diversity it will require more effort to ensure they are not lost. We are also employing climate models to assess habitat suitability and to forecast potential climate change impacts on P. vanbruntiae. We used different predictions of future precipitation and temperature to create maps of suitable habitats over the next century. The areas of suitable habitat shrink drastically, especially in models that predict no change or an increase in human emissions.

Abigail Doss '24; Matthew Fedrovich '24; Christian Cadmus '24

Faculty Mentor(s): Professor John Ptacek, PSYCHOLOGY
Funding Source: Kimberly Jo McClymont '90 Fund; James L.D. and Rebecca Roser Research Fund; Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities

Self-Compassion as it Relates to Social Support, Coping, and Emotional Experiences in Recovering Injured Athletes

Athletic injury is a stressor that is hard not only on the body, but the mind as well. The goal of this present investigation was to analyze the extent to which self-compassion in injured athletes is related to their rehabilitation process, while keeping focus on social support, coping and expressed mood states. A handful of Bucknell University Student Athletes were gathered for data collection and each of them completed a retrospective self-report survey consisting of the Self-Compassion Scale (SCS), Social Support Scale (SPS), Coping Orientation of Problems Experienced (COPE), and Profile of Mood States Scale (POMS). Through means of correlational analysis, we found that self-compassion did predict a significant decrease in negative mood states in injured athletes. Self-compassion also acted as strong predictors for three of the six social support subscales, as well as four of the 14 coping subscales. Given these results, it would be wise for interventions to be implemented into athlete's daily training regimes to keep their mood state more positive, and treat themselves more kindly. Given the nature of this study, future research studying athletes of various size schools and competing levels should be considered. Additionally, research focusing on self-compassion interventions and their effectiveness over time could be a future direction of interest.

Jake Douglas ’25

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: College of Engineering

Electroencephalography Signal Processing Workflow for Analysis of Cortical Sensorimotor Oscillations Induced by Deep Brain Stimulation

Essential tremor (ET) is a neurological movement disorder characterized by debilitating tremors, significantly impacting patients’ quality of life. Deep brain stimulation (DBS) has emerged as a promising therapeutic approach, but optimizing its efficacy remains a challenge. This study presents a comprehensive workflow for electroencephalography (EEG) signal processing using EEGLAB in MATLAB, designed to identify biomarkers indicative of tremor that can ultimately be used to create a closed-loop DBS system. The workflow begins with data acquisition, where EEG signals are recorded from ET patients during rest and tremor-inducing tasks. Preprocessing steps include noise reduction, artifact removal, referencing the data around the most optimal channel, and data segmentation to isolate relevant signal epochs. Our method then incorporates an independent component analysis, an advanced signal processing technique in which channel data is transformed into the component domain, displaying the electrical power only acquired by an individual channel, as opposed to being affected by surrounding channel readings. Phase amplitude coupling analysis was then run to determine how different EEG bands affect one another during tremor. Ultimately, using this workflow, a closed-loop DBS system will be more achievable, greatly enhancing the quality of life for both ET patients and others who suffer from similar neurological movement disorders.

Marion Duval ’25

Faculty Mentor(s): Professor Moria Chambers, BIOCHEMISTRY/CELL BIOLOGY, BIOLOGY; Professor Sarah Smith, CHEMISTRY
Funding Source: Presidential Fellowship; Cell Biology and Biochemistry Undergraduate Research Fund

The Effect of Sequence on Structure and Microbial Properties of Insect Antimicrobial Peptides

The rising prevalence of antibiotic-resistant bacteria accompanied by the declining approval of new antibiotics is creating a global crisis of infections unable to be treated by antibiotics. Antimicrobial peptides (AMPs) are short proteins that act as a part of the innate immune system in many organisms and are under development as new therapeutics. My work focuses on cecropins, a family of AMPs found in many insect species that have low toxicity to mammalian cells and diverse amino acid sequences. Cecropins typically contain a “hinge” region connecting two α-helical regions of the peptide. In some insect species, changes in this hinge region impact both structure flexibility and the antimicrobial properties of the peptide. To further study the relationship between structure and antimicrobial activity, I categorized 250 peptide sequences based on their biochemical properties and then synthesized four of these peptides with varying predicted secondary structures. To gauge the antimicrobial activity of the peptides, we determine the minimum concentration of peptide necessary to inhibit bacterial growth. The synthesized peptides exhibited varied effectiveness against different bacterial species, suggesting the sensitivity of bacterial membranes to peptide sequence changes. Analysis of secondary structure and stability is ongoing, and preliminary data shows that tested peptides adopt an α-helical structure in conditions mimicking the cell membrane environment. A better understanding of the relationship between the structure and antimicrobial potency of AMPs will facilitate the design of more effective therapeutics inspired by the natural world.

Natalie Dyer ’25; Lauren Shaffer ’26; Meghan Catherwood ’25; Edith Simpson; Dr. Moria Chambers; Dr. Sarah Lower

Faculty Mentor(s): Professors Moria Chambers & Sarah Lower, BIOLOGY
Funding Source: Pittsburgh Foundation

Unintended Consequences? Impact of a Bacterial Insecticide on Your Neighborhood Firefly

Fireflies are a large part of many childhood memories of the summertime but their numbers are declining. While many factors may contribute, one possible cause could be insecticide use. Bacillus thuringiensis (Bt) is a bacterial insecticide that kills pest beetles that belong to the same order as fireflies Coleoptera. However, it is unknown if it negatively affects fireflies. To assess how Bt could impact local fireflies, we focused our study on the common eastern firefly, Photinus pyralis, which is abundant in eastern areas of the US such as Pennsylvania. To determine their susceptibility to Bt, adult fireflies were caught at three local sites that vary in level of human disturbance, injected with various doses of Bt and subsequently tracked daily to assess survival. While pest beetles typically ingest Bt, Bt is typically more lethal when injected and so we anticipated that this method of infection would reveal even very low level susceptibility of fireflies to Bt. Bt had no significant impact on firefly survival which suggests this insecticide is not a factor in their decreased population. In the future, it will be important to test other commonly used insecticides or different firefly species, which could be more susceptible. Learning more about factors that influence firefly survival and fitness is essential for preserving childhood memories of capturing fireflies for generations to come.

Jack Dziubek ’25; Eva C. Lindner ’24; Madeline P. Roth ’24; Jennie R. Stevenson; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology

How Social Stress Affects the Gut in the Socially Monogamous Prairie Vole

The bi-directional communication that occurs between the gut and the brain, termed the gut-brain axis, plays important physiological roles in digestion, metabolism, immunity, and cognition. Stress can have wide-ranging effects on the gut-brain axis. Socially living animals, like the prairie vole (Microtus ochrogaster), are greatly impacted by social stressors. Here we explore how social stress in prairie voles affects the gut-brain axis. To explore the relationship between social isolation stress and the gut-brain axis, we measured corticosterone,

triglycerides, and gastrointestinal transit time in paired and isolated prairie voles throughout a five-week period. We found that while there was not a significant difference between gastrointestinal transit times in the paired and isolated groups, corticosterone concentrations were significantly greater for the isolated voles. Additionally, regarding nutrient metabolism, there was a significant sex-by-time difference in triglyceride concentrations for the isolated voles. Current ecological factors including climate change, habitat destruction, and even pandemics can create social stressors for socially living animals, including humans. Our work provides insight into how social stress alters aspects of gut functioning that can affect organismal performance and health.

Bayasgalan Erdene-Ochir '24; Lorelei Curtin

Faculty Mentor(s): Professor Lorelei Curtin, GEOLOGY & ENVIRONMENTAL GEOSCIENCES
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Late-Holocene Sediment Record from Lake Pleasant, North Western Pennsylvania

Lake sediments consist of biological and clastic materials drained from the watershed, as well as endogenic minerals that precipitate within the lake. Quantitative analysis of lake sediments across various depths in a sediment core allows us to reconstruct a variety of environmental factors over time which is of great importance in understanding the lake environment's response to natural climate variability and modern climate change. We present a 231 cm long continuous sediment core data from Lake Pleasant, Northwestern Pennsylvania. An age model ranging over the last 5,600 cal BP was developed using 14C ages of terrestrial plant macrofossils (n=3). X-ray Fluorescence measurements and Loss on Ignition followed, which characterize climate shifts the lake has experienced in the past. Mid-holocene sedimentation rates are high at 1.6 mm/year while starting from 4,000 cal BP, it abruptly decreases to 0.14 mm/year. Principal Component Analysis (PCA) of the elemental concentrations explains 81% of the total variance in the dataset (n=3,927), as PCA-1 (Ti, Mn, Fe, Rb, Sr) indicates detrital clay mineral input from the watershed. PCA-2 (Ca, S, Ca/Al) consists of authigenic precipitate minerals and PCA-3 (Al, Si, Ca, S) is interpreted as sand depositions during dry periods. Based on these variations, we found 5 significant periodic droughts during the last 5,600 years, however, ~4,100-year BP drought event coincides with the decrease in sedimentation, which could be explained by changes in North American Monsoon and more intense El Nino-Southern Oscillation.

Krystell Ewing '24; Aya Tarist '25; Farhaj Shahid '26; Alexa Horvath '25

Faculty Mentor(s): Professor Anne Ross, COMPUTER SCIENCE
Funding Source: Clare Boothe Luce Research Scholarship; Dean's Fund for Summer Undergraduate Research in STEM

Advancing Accessibility in the Digital Age through Assistive Technologies

Technology plays a large role in our lives today, from the ability to shop online and have your items here the next day to being able to participate in online classes being miles away from your institution. Although various technological advancements have the benefit of high efficiency and productivity, some of these advancements fail to recognize the concern of accessibility in technology. Innovations such as screen readers, switches, and assistive keyboards help with improving accessibility while also changing the way people with disabilities engage with technology.

Our team examined various types of assistive technologies from plug-ins, screen readers, and familiarization of the Web Content Accessibility Guidelines (WCAG). Our research examined how these technologies allowed people with disabilities to access and interact with digital platforms, which consisted of performing web accessibility audits on various websites and checking if certain design and development tools were accessible themselves.

Results from our web and application audits proved that more awareness surrounding accessibility can be improved, as our team witnessed websites with poor color contrast, lack of heading usage, and absence of alternative text for images. Our research seeks to not only enhance our understanding of accessibility but hopes to raise awareness about accessibility in various workspaces and environments.

Timmy Facey '25; Amina Reyes '25; Ibrahim Tahir '26

Faculty Mentor(s): Professor David Rojas, LATIN AMERICAN STUDIES
Funding Source: Program for Undergraduate Research

The Non-White Experience at Bucknell

Black student's experience and the challenges it entails can be seen in quantitative data generated by students and faculty of color at Bucknell which shows that, if Bucknell keeps diversifying at the current rate (every academic year the institution enrolls a few more students of color than it did on previous years), the institution would only be as diverse as the average higher education institution in the United States in 2065. In order to mitigate this situation of acute lack of diversity at Bucknell, our institution has put in place safe spaces for marginalized groups to feel at home. However, as Thomas argues, by concentrating solely on the outcomes of diversity, there is a tendency to overlook the underlying processes that contribute to marginalization, including the discursive, structural, and interactive mechanisms that play a pivotal role in shaping the results (Thomas, 2020). In other words, diversity efforts at Bucknell are important, but they may be deeply insufficient to help students deal with life at this PWI. In this paper I offer an understanding the significance and limits of diversity efforts based on qualitative methodologies.

Ellie Fallon '24

Faculty Mentor(s): Professor Christina Xydias, POLITICAL SCIENCE

The Populist Wave: Unpacking the Global Drivers of 21st Century Right-Wing Populist Support

This thesis investigates the underlying causes of the global rise in right-wing populism support in the 21st century. I will examine both the origins of these shifts in public opinion and their consequences for political systems and global interactions. My analyses will take two forms: (1) a cross-national analysis of the rise in right-wing populism in 34 of the 38 member states of the Organization for Economic Cooperation and Development (OECD) to explore the demographic factors that exhibit a relationship with populist attitudes and (2) case studies of right-wing populism in the contemporary United States (with particular attention to former president Donald Trump and his supporters) and contemporary France (with particular attention to Éric Zemmour and Marine Le Pen and their supporters) to understand specific examples of the causes and manifestations in countries strongly impacted by the effects of globalization. Understanding this phenomenon through its roots and dynamics can provide a crucial view into mitigating its adverse effects on countries and their political systems, particularly towards movements aiming to undermine democracies, by directing more effective campaigns and policies, illuminating the future of politics, and understanding what interactions in international organizations, and borders may look like as globalization develops.

Will Feldscher '26; Julia Reynolds '25; Julia Silvia '27

Faculty Mentor(s): Professors Dabrina Dutcher, Tim Raymond & Ryan Snyder, CHEMICAL ENGINEERING
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Impact of Morphology and Polymorph on Behavior of Succinic Acid Aerosols in Mixtures with Ammonium Sulfate

Particles on the scale of nanometers are incredibly important in atmospheric chemistry due to their complex role as aerosols in the atmosphere. Atmospheric aerosols and their morphologies directly impact cloud formation, which in turn affects global warming and climate change modeling. In this project, a system of succinic acid, a dicarboxylic acid, and ammonium sulfate, an inorganic salt, was studied as both are commonly found in atmospheric aerosols. Aerosol systems are commonly studied by analyzing their size distributions, and it is expected that most systems produce a Gaussian (normal) size distribution. However, the succinic acid/ammonium sulfate system is noteworthy for containing aerosols with a bimodal size distribution. One plausible explanation for the observed bimodal size distribution is related to the polymorphism of succinic acid, as different crystal structures could produce different particle sizes.

This project utilized a syringe pump to feed aqueous solutions of varying concentrations and mixing ratios of succinic acid and ammonium sulfate into an atomizer to produce nanoscale particles. These particles were then dried and analyzed in a Scanning Mobility Particle Sizer (SMPS) system to obtain size distribution data. To test for the presence of different polymorphs in solutions of succinic acid and ammonium sulfate, particles were collected using a cascade impactor to then be analyzed with powder x-ray diffraction (PXRD) and scanning electron microscopy (SEM). The collected data allowed for the characterization of the succinic acid/ammonium sulfate system at different concentrations and mixtures of solution.

Melanie Gamboa '24; Dr. Carley Gwin; Dr. Deborah Sills; Fi Karamitros '25; Demi Gonzalez '26; Omuhle Ndhlovu '26

Faculty Mentor(s): Professors Carley Gwin & Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

What is Contaminating Streams in Buffalo Creek?

Many of Pennsylvania's waterways are, and have been, unfit for drinking, recreation, fishing, and aquatic life due to bacterial impairment. The main goal of this project was to conduct microbial source tracking (MST) to determine the source(s) of bacterial pollution at different locations within the Buffalo Creek watershed. During the summer of 2023,we monitored 13 sites along Buffalo Creek for standard water quality parameters, specifically E.coli. Bacterial results show that all 13 sites sampled were impaired for recreational use, based on levels of E. coli and DEP recommendations. MST can be used to identify the source of fecal bacteria. MST uses the detection of host specific intestinal bacterial species using endpoint or quantitative polymerase chain reaction (PCR). We tested 9 sets of primers on DNA extracted from animal manures (e.g., bovine, swine, and poultry) for specificity to ensure that our primers identify the DNA sequences from the appropriate gut bacteria based on animal source. However, all primers except for avian, deer, and horse hit on other animals, indicating poor specificity for the following primer sets: cow, pig, dog, goose, and human. Future work will include adding a probe to each primer pair with the hope of improving specificity of the assays. Preliminary MST is underway and potentially will reveal the animal source(s) of the fecal coliform contamination from these same locations, which will aid in the Buffalo Creek Watershed Alliance's efforts to limit the entrance of these pollutants into Buffalo Creek.

Grace Ginder '25; Moria Chambers, PhD

Faculty Mentor(s): Professor Moria Chambers, BIOLOGY
Funding Source: Department of Biology

The Impact of Timing on the Protective Effect of Chronic Infection in Drosophila Melanogaster

One influential category of microbes are ones that cause an acute infection and persist as a chronic infection if they don't kill their host. These chronic infections can influence many elements of host biology including immunity to future infection. In the fruit fly, Drosophila melanogaster, chronic bacterial infection protects against more lethal bacterial infections given a week later. It is hypothesized that protection is due to increased ability to kill or constrain bacterial pathogens, also called resistance. However, it is unclear how length of time between infections impacts this protective effect. We hypothesized that there is an optimal

window for protection, as longer times between infections may allow the host to recover from the first infection but may also result in lowered immune gene expression as well. To test how length of time between infection impacts protection, three commonly used fly lines were injected with a sub-lethal dose of a bacteria that causes chronic infection. Then, 3, 7, or 14 days later, the flies were injected again with a more lethal bacterial infection. Protection and resistance were assessed by tracking survival for 8 days and bacterial load at 12 hours post-infection. The protective effect and resistance were incredibly strong in one fly line across all time-points, suggesting that this line might have an altered immune response that allows it to uniquely benefit from chronic infection. We are currently testing how the strength of protection correlates with both antimicrobial peptide gene expression and immune cell proliferation.

Jack Glassman '25; Professor Kris Trego

Faculty Mentor(s): Professor Kris Trego, CLASSICS & ANCIENT MEDITERRANEAN STUDIES
Funding Source: Program for Undergraduate Research

3D Cataloging of Greco-Roman Lamps in the Turnure Collection

In this summer research project Professor Kris Trego and I worked with the Turnure collection from the Bucknell Samek Art Museum. This collection, donated in 2019 by Emeritus James Turnure, a Samuel H. Kress Professor of Art History at Bucknell, consists of over one hundred artifacts from Greece, Rome, and Egypt. Our goal for this project was to produce 3D models of ancient oil lamps in the Turnure collection. We saw this as an opportunity to bridge the gap between classics and computer science, bringing the ancient world and the modern world closer together. With the use of the Einscan-SE 3D Scanner we were able to create detailed 3D models of seventeen Greco-Roman oil lamps from the collection. This scanner takes twenty-four images from different perspectives and uses that data to compile a 3D model. Each of these models can be manipulated and viewed at any angle giving a better way for outside researchers to study the collection as opposed to flat images, which don't allow for detailed study. We were also able to create 3D prints of some of the lamps for in person study that does not incur the risk of damaging the artifacts. These artifact replicas can be used for classroom study, and can also be enlarged to study fine details on the lamps themselves. With this we hope to show how modern technology can be used to supplement the study of the Classics.

Jordana Groveman '24; Brie LaPree-Chavez '25

Faculty Mentor(s): Professor Reggie Gazes, ANIMAL BEHAVIOR, PSYCHOLOGY
Funding Source: Douglas K. Candland Undergraduate Research Fund

Epistemology of Primatology in Japan and the U.S.

Primatology, the study of nonhuman primates, developed independently in the West and in Japan in the early and mid 1900s. While Western practices were informed by ideas of individualism and human dominance over nature, the Japanese embraced the importance of community and human's connection with nature. As student members of the Bucknell primate lab, we have experience with scientific practices in the U.S. We visited Japan in the summer of 2023 to gain first hand experience with modern practices of Japanese primatology. Our goal was to explore the epistemological differences between Western and Japanese primatology. We investigated modern scientific practices in Japan by collaborating with researchers at Kyoto University's Center for the Evolutionary Origins of Human Behavior (EHUB). There, we observed chimpanzee testing sessions, participated in weekly lab meetings, and attended research presentations. In addition, we investigated the cultural and historical contexts of primatology by navigating religious sites, such as Buddhist temples and Shinto shrines, natural spaces, such as parks and forests, and animal centers, such as zoos and aquariums. We found that while traditional Japanese values continue to permeate the scientific approach through emphasis on social engagement, respect, and commonality, increased globalization has led to increased homogenization of modern primatological epistemology across the two countries.

Changkun Guan '24; Hunter Gehman '26; Thiago Serra

Faculty Mentor(s): Professor Thiago Serra, ANALYTICS & OPERATIONS MANAGEMENT
Funding Source: Program for Undergraduate Research

Structure of Optimal Covering Arrays and Constraint Handling

Finding flaws resulting from component interaction is a common task for safety checks in software and other devices. Even if every component were an on-off switch, evaluating every potential configuration would be impracticable; nevertheless, in actuality, most failures can be traced back to the configuration of relatively small subsets of components. As a result, we can fully cover tiny subgroup interactions with a significantly less number of tests by covering several potential interactions with a single test. But for unconstrained pairwise interactions among binary parameters, we only know of algorithms to provably minimize the total number of tests; constraints on individual tests or pairwise interactions are often handled ad hoc, by modifying the unconstrained case solutions. Here, we extend the analysis of the structure of optimal solutions of combinatorial testing problems involving pairwise interactions and binary parameters. We demonstrate that: (i) on binary parameters, we can efficiently avoid a wide range of families of forbidden tests while minimizing the total number of tests; (ii) forbidden interactions in subsets fundamentally alter the structure of optimal testing plans; and (iii) constrained testing may, on occasion, result in paradoxically fewer tests than optimal unconstrained testing. Our results allow us to acquire optimal answers, which in many cases need less tests than the ones produced in a comparable amount of time using state-of-the-art approaches.

Sofia Guerra-Torres '26

Faculty Mentor(s): Professor Ryan Snyder, CHEMICAL ENGINEERING
Funding Source: Program for Undergraduate Research

Electrospaying Coatings for Model Drug Delivery

Over the past summer, I had the opportunity to engage in research alongside Professor Ryan Snyder in the Chemical Engineering department. This research focused on the development of model drug infused coatings on 12 mm steel disks via a process called electrospraying. This process involves a positively charged polymeric solution being consistently ejected from the tip needle from the syringe towards a conductive plate. The components of the polymeric solution contributed to the properties of the coatings and the interaction with the charged plate during the electrospraying process. After refining the process of creating the electrosprayed coatings, we conducted various release experiments which involve placing a drug-loaded disk in a plastic holder in a small vial of 10 mL Phosphate Buffered Saline. Over the course of the release experiment we would take a 3 mL sample to test in the environment lab using a UV-visible spectrophotometer.

However, at the end of spring semester our lab conducted a release experiment and we received unexpected results. Therefore, before we could continue with anymore release experiments we would need to test various theories to explain our previous results. We embarked on an experiment to assess this, and no concrete evidence indicated photodegradation as the cause of the unexpected results in our prior experiment. Thus, the next step is to cross examine a release experiment using additional equipment such as the High-Performance Liquid Chromatography (HPLC). This new approach will be further tested in the upcoming semester alongside Professor Snyder.

Victoria Hall '24

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Program for Undergraduate Research (Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences)

Effect of Subthalamic Nucleus Deep Brain Stimulation on Levodopa and Dyskinesia Reduction in Parkinson Disease

Parkinson disease (PD) is neurodegenerative movement disorder. Levodopa is the most common medication for PD treatment but it has side effects such as dyskinesia. Deep brain stimulation (DBS) is an option for patients when levodopa does not mask PD symptoms. DBS is a surgical procedure in which electrodes are implanted in the brain delivering electrical pulses, with the main target as the subthalamic nucleus (STN) for movement improvement. VTA modeling is used to quantify the amount of spread in stimulation. The purpose of this project was to use VTA modeling techniques to create a model of patient specific anatomy and spread of stimulation to use for clinical assessment. Magnetic resonance imaging (MRI) and computed tomography (CT) were taken pre- and post-operatively, respectively. Both imaging modalities were imported into Analyze where resampling and registration occurred. Using MRI, the STN and the thalamus were extracted from both hemispheres. CT imaging was used to extract electrode coordinate position. VTA models were constructed in COMSOL using lead properties and patient specific properties such as anisotropic tissue conductivity, brain size, and lead location. Finite element analysis was performed to extract the electric field for each patient's brain. In MATLAB, therapeutic stimulation voltage [V] was used as a threshold hold to extract the VTA. Object maps from Analyze containing the segmented structures were imported into MATLAB and converted to point clouds. Overlap between the VTA and STN point clouds was determined by using the percentage of VTA point clouds inside of the STN.

Morgan Haros '25

Faculty Mentor(s): Professor Kris Trego, CLASSICS & ANCIENT MEDITERRANEAN STUDIES
Funding Source: Douglas K. Candland Undergraduate Research Fund; James L.D. and Rebecca Roser Research Fund

Following the Light

For the first time, I am cataloging and studying ancient lamps that were recently donated as part of the Turnure Collection to the Samek Art Museum. This year I began by focusing on one mold-made style of lamp, lamp TD2020.12.29, which style I determined came from the Eastern Mediterranean. However, through my research, it became clear that this specific lamp did not originate from that location. I started to look at similar later lamps in Italy, which then led me to start considering North African red-glaze pottery. This expanded my investigation to two similar lamps in the Turnure collection, TD2020.12.38, and TD2020.12.28, which may represent two different periods of the lamp's development. I am now investigating if the lamp may have come from or have been influenced by North African red slip pottery.

Laura Hart '24; Meghan Quinn '24; Olivia Tzefronis '24; Lexi Handy '24; Cory Sanderson '25; Katie Schadler '26; Briana Perea '26; Erica Delsandro; William Flack

Faculty Mentor(s): Professor Erica Delsandro, WOMEN'S & GENDER STUDIES; Professor Bill Flack, PSYCHOLOGY
Funding Source: Kalman Fund for Undergraduate Research in the Sciences; Program for Undergraduate Research

Campus Sexual Assault: Gender Based Violence and Sexual Harassment Against Women in STEM

Gender based violence, including gender harassment and sexual harassment, continue to be a problem in higher education throughout the world. Despite research conducted on sexual harassment on college campuses, inadequate progress has been made to improve this issue. Particularly, gender based violence and harassment in the fields of Science, Technology, Engineering, and Mathematics (STEM) is a critical problem on college campuses and in the workforce, especially for women. This CSA research project examines the types of gender based violence women in STEM face, which groups are most commonly perpetrators of gender based violence against women in STEM, and victim perspectives of Title IX reporting.

Both quantitative and qualitative research were used to conduct this research. The literature review includes an extensive look at research relating to gender based violence and discrimination against women in STEM. Interviews with Title IX Coordinator,

Samantha Hart, Interpersonal Violence Prevention and Advocacy Coordinator, Kristin Gibson, Associate Director for Gender and Sexuality Resources, Abby Fite, and Dr. Lilia Cortina from The University of Michigan were conducted and informed the research project. This senior project includes quantitative data from the Fall 2023 CSA survey and qualitative data from participant interviews.

Teagan Hawes '26

Faculty Mentor(s): Professor Gulay Guzel, MARKETS, INNOVATION & DESIGN
Funding Source: Helen E. Royer Undergraduate Research Fund

Are Bystanders More Persuasive than Victims? The Impact of Social Media Backlash Toward Brand Transgressions

In the digital age, brands face increasing scrutiny for their perceived transgressions. Influencers and social media commentators play pivotal roles in raising awareness and mobilizing collective action against such brands. Our research question delves into the comparative persuasiveness of bystanders versus victims in social media backlash toward brand transgressions: ""Are bystanders more persuasive than victims? The impact of social media backlash toward brand transgressions."" We collected data through interviews and archival research to inform a study on consumer perceptions of brands and their marketing materials, particularly focusing on diversity efforts. Our goal is to gain insights into how consumers perceive brand diversity initiatives.

We conducted interviews with a diverse group of participants, varying in age, gender, interests, and knowledge on the subject. Participants were asked a series of questions regarding their perceptions of brand diversity efforts. Additionally, they engaged in a projective exercise where they designed an inclusive advertisement for a fictional brand in a category they felt connected to. These interviews, alongside relevant literature, underwent coding and analysis.

Our findings suggest that social media users are directly affected by potentially unethical marketing practices highlighted by influencers; and they form attitudes towards the social issues based on how relatable they found the influencer. This research holds significance as it could enhance societal understanding of the impact of social media backlash on marketing activities. Furthermore, it aims to ascertain whether the source of the backlash and how it's communicated further shapes consumer perceptions of brands and their marketing endeavors.

Kaitlin Henry '25; Melody P. Sain; Morgan R. Olsen; Christopher T. Martine

Faculty Mentor(s): Professor Chris Martine, BIOLOGY
Funding Source: David Burpee Endowment; Manning Intern Botanical Science; Presidential Fellowship

Chemical Analysis of Extrafloral Nectar in Western Australian Solanum Tudununggae (Solanaceae) to Explore Possible Ant-Plant Relationships

Solanum tudununggae Symon (Solanaceae) is a narrowly-endemic dioecious bush tomato species of the remote Kimberley Region of Western Australia. One uncommon trait that sets it apart from most other species of Solanum is its secretion of extrafloral nectar. In fact, structurally complex extrafloral nectaries (EFNs) are currently known to occur on the back of the corollas in only three species of Australian dioecious Solanum. Consequently, little is known about the characteristics of its nectar - although botanists have noted abundant ant activity around these nectaries. However, the relative lack of research on Solanum EFNs leaves a gap in knowledge regarding the nature of the relationship between these plants and ants. Previous literature has shown that the composition of extrafloral nectar, specifically the presence of essential nutritional amino acids, can cause ant populations to prefer certain nectars to others in other species of plants. This ex-situ project uses high-performance liquid chromatography (HPLC) to analyze the composition of extrafloral nectar, specifically the presence of amino acids and sugars. Through HPLC, we hope to infer a possible correspondence between ant behavior and nectar content. We hypothesize that the presence of essential amino acids could suggest a mutualistic relationship between S. tudununggae and local ants, with the plant providing essential nutrients to the ant population and, in return, the ants offering protection against herbivores.

Maya Hernandez '25

Faculty Mentor(s): Professor Ramona Fruja, EDUCATION
Funding Source: Douglas K. Candland Undergraduate Research Fund; Program for Undergraduate Research

Benefits and Sacrifices: The METCO Program

I examined how alumni who have graduated within the timeframe of 2019-2023 of K-12 institutions in the Boston area experienced DEI efforts advanced within the METCO Program. My main research question was: How much should be sacrificed in order to pursue a "better education"? After completing a bibliographic study on racial discrimination in Boston schools and carrying out archival research on METCO, I focused on a group of 5 alumni who attended institutions as part of the METCO program in order to understand how it helped or hindered students of color. I employed qualitative research methods through in-depth, semi-structured interviews and focus group observation in the current lives of the study participants. The research will also shed light on whether the benefits that white students accrue from more diverse educational spaces also means more opportunities for METCO students of color. This project also takes on a psychological approach as I use the cultural ecological model to examine where individuals' connections relate to their experiences. Exploring identity formation and resiliency is integral to understanding the educational experiences of students of color within predominantly white institutions.

Ryan Hill '24

Faculty Mentor(s): Professor Nicholas Roseth, MUSIC
Funding Source: Bobko-Dennis Fund for Undergraduate Student Research

Life After a Secondary Music Ensemble: An Instrumental Case Study of Former Ensemble Musicians

The purpose of this instrumental case study was to investigate the experiences of former ensemble musicians and their views on collaboration during their secondary education experience. The analysis of collaboration was done through the framework of Collaboration Theory, with six components including building group cohesion, influencing others, observing and doing, organizing work, status-seeking, and turn-taking. Semi-structured interviews were conducted, coded and analyzed, then organized into themes. The participants' responses indicated a thoughtful reflection of their past experiences in middle and high school. The participants discussed and responded to questions about the individual components of Collaboration Theory and found it relevant in the secondary music classroom. They listed multiple ways their directors and peers facilitated those communal experiences, with students generally appreciating their smaller group time and an organized rehearsal space. Collaboration Theory was found to be an effective framework for discussing and implementing collaborative practices in secondary music education.

Libby Hoffman '24

Faculty Mentor(s): Professors Jonathan Scholnick, Edumund Searles, and Allen Tran, SOCIOLOGY & ANTHROPOLOGY
Funding Source: The Tom Greaves Fund for Research and Curricular Development; Program for Undergraduate Research

Community in a Cup – An Ethnographic Analysis of the Coffee Culture in Lewisburg

The "three waves" of coffee describe the growing importance of unique flavors and sourcing in order to best satisfy an increasingly sophisticated palate in coffee consumption. These allude to people's preferences for different kinds of coffee: third wave roasters emphasize the importance of traceability with their coffee beans, which in turn adds a level of education that is often referred to as the "coffee geek subculture". Conversely, the first wave does not rely on quality in order to sell, but rather on coffee as a mass product that delivers caffeine to its consumers. The second wave, then, intersects these two extremes, and relies on chain coffee houses to create more individualized coffee drinks, though they do not focus on value orientation of the product as heavily as third wave enthusiasts. My project examines the manifestation of these three waves in Lewisburg's coffee scene. I conducted interviews with both producers and consumers who live in our town to learn about whether or not their own coffee consumption intersects the three waves. Through this, I discovered a similar value-oriented system that distinguishes coffee consumers from one another: in Lewisburg, a person's consumption habits are driven by either a social, ethical, or economic value orientation. In this thesis, I analyze the three wave typology to challenge current understandings of coffee culture in the United States.

Devin Johnson '24; Dr. Ellen Chamberlin; Dr. Allison Pfeiffer

Faculty Mentor(s): Professor Ellen Chamberlin, GEOLOGY & ENVIRONMENTAL SCIENCES
Funding Source: Department of Geology & Environmental Geosciences Marchand Fund; James L.D. and Rebecca Roser Research Fund

Evaluating Field Evidence of Fine-grained Sediment Abrasion in Gravel-Bedded Rivers: A Case Study of the Lillooet and Suiattle Rivers in the Cascade Volcanic Arc (British Columbia, Canada, and Washington, USA)

Steep, gravel-bedded rivers are important sites for studying gravel abrasion, where material transported as bed load experiences size reduction and rounding due to grain-to-grain collisions. Studying fine sediment (<2mm diameter) abrasion and shape changes in fluvial systems is more challenging due to difficulties in quantifying sediment shape at this scale, but it is assumed that fine particles traveling in suspension do not experience abrasion. Here we use the Camsizer X2 to test the null hypothesis that fine-grained sediments have the same grain shapes along the length of a steep fluvial system. Our study sites are the Lillooet River (British Columbia, Canada) and the Suiattle River (Washington, USA) in the Cascade Volcanic Arc. Longitudinal sampling from point sources of fine-grained sediments to the downstream river mouths was completed through collection of sediment on the downstream tail of gravel bars.

Results show remarkable consistency across average values of shape parameters from all sample sites. Shape data analysis showed no significant relationship between fine sediment longitudinal location and shape parameters in either river system. Fine sand was found to consistently have a higher average roundness than medium sand, which in turn has a higher average roundness than coarse sand. Overall, linear trends and consistencies across shape parameters suggests that sediment transported as suspended load does not experience abrasion in steep, gravel-bedded rivers. This result supports the assumption that shape changes in sediment <2mm occurs predominantly in wind- or wave-driven environments.

Nicole Joseph '25; Kayla E. Lichtner '24; Redeit N. Woldebirhan '24; Benjamin D. Haussmann; Tiffany R. Hegdahl; Travis R. Robbins; Mark F. Haussmann

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology

The Effect of Temperature on Metabolism and Oxidative Damage in a Lizard, Sceloporus Consobrinus

Ectotherm metabolic rates positively scale with temperature. As metabolism increases, mitochondria produce more reactive oxygen species, consequently increasing oxidative damage to biomolecules such as DNA. While a recent study in ectotherms produced the expected positive relationship between temperature and metabolism, it also revealed a surprising inverse relationship between metabolic rate and oxidative damage. Our study investigates the effect of temperature manipulation on metabolism and oxidative damage in three geographically distinct populations of Sceloporus consobrinus across a latitudinal thermal gradient. Adult female lizards

from each population were collected and exposed to two separate 23.5 hour temperature treatments in the lab: 18°C and 37°C. Metabolic rates were measured at each temperature, and blood samples were collected before and after each temperature exposure. Following DNA extraction and digestion, the oxidative damage biomarker 8-hydroxy-2'-deoxyguanosine (8-OHdG) was quantified for each individual using liquid chromatography with tandem mass spectrometry. As expected, our findings show that metabolic rates are higher at warmer temperatures. Further, while we did not see a change in 8-OHdG levels after the 37°C treatment, the 18°C challenge resulted in an increase in 8-OHdG levels in two of the three populations. Interestingly, lizards from the northernmost population showed resistance to oxidative damage during the cold thermal challenge. This may be due to an altered thermoregulatory strategy or a mechanism to reduce temperature-related oxidative damage. As climate change continues to amplify temperature extremes and may disproportionately impact ectotherms, it is important to understand the influence that temperature has on organismal performance.

Maddy Kalaigian '26

Faculty Mentor(s): Professors Robert Nickel & Stu Thompson, ELECTRICAL ENGINEERING; Professor Janet VanLone, EDUCATION
Funding Source: Helen E. Royer Undergraduate Research Fund

Using AI to Implement UDL Principles in Traditional STEM Classrooms

In the ever-evolving landscape of engineering education, we are at a point where traditional instruction can be supplemented by AI to bridge the gap between current and best practices in the area of universal access. We have analyzed the Explicit Instruction Model, which matches well with STEM teaching approaches in higher education, with a Universal Design for Learning (UDL) lens to identify points in the instruction process where AI could support learning. From this activity, we determined that AI can facilitate learning through summarizing lecture content, identifying main ideas, developing checks for understanding, and providing supplementary resources for students. Once these features were identified, their efficacy was tested on three prominent generative AI platforms: ChatGPT 3.5, Gemini, and Bing AI. We created a prototype that analyzes a video of a STEM lecture and extracts a text transcript. The transcript data is then sent to the AI platform, which returns summaries, main ideas, checks for understanding, and supplementary resources pertaining to the lecture

We are investigating more AI-powered tools, focusing on their ability to provide real-time feedback and adapt to individual student needs. Additionally, various metrics and assessment strategies are under consideration to allow educators to quantify the impact of AI on student engagement and learning. In the future, we plan to deploy the AI prototype to collect Bucknell student feedback. By drawing a clear connection between explicit instruction models, UDL, and AI, engineering instructors can create more effective learning experiences for their students.

Filareti Karamitros '25; Melanie Gamboa '24; Demi Gonzalez '26; Omuhle Ndhlovu '26

Faculty Mentor(s): Professors Carley Gwin & Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Coupling Manure Management Plans with Microbial Source Tracking to Identify Sources of Pollution in Union County's Waterways

Most streams in Union County are impaired for recreation because of bacterial pollution, as reported by the PA Department of Environmental Protection (PA-DEP). In the summer of 2023 we collaborated with the Buffalo Creek Watershed Alliance to enumerate fecal bacteria (e.g., coliforms and E. coli) in samples collected from 13 locations in Union County. In addition, we worked on developing a molecular biology method—microbial source tracking (MST)— to identify sources of fecal coliforms found in local waterways. MST can be used to identify the animal source (e.g., poultry or swine) of fecal bacterial pollution. To complement MST, we scanned copies of all the nutrient management plans (NMPs) filed at Union County's Conservation District office. We then extracted data on animals and manure produced, as well as manure applied to fields and exported in and out of the county. We began creating maps using GIS with data from NMPs that report the manure produced and applied to fields. Our laboratory results show that coliform and E.coli concentrations exceed PA–DEP recommendations, and all of the sites we monitored are impaired for recreation. In addition, data extracted from NMPs showed that most of the manure produced in Union county comes from poultry, then swine, and then cow. This data will be used to identify the type and quantity of manure application in the parcels bordering our water testing sites, and we will determine if manure type and fecal bacteria type (as determined by MST) are correlated.

Brennah Kennedy '26

Faculty Mentor(s): Professor Alan Cheville, ELECTRICAL & COMPUTER ENGINEERING
Funding Source: William Corrington Renewable Energy Fund

Integrating Technical Sustainability into an Introductory Circuits Course

This research project, conducted during the summer of 2023 under the mentorship of Alan Cheville, explores the integration of technical sustainability concepts into an introductory circuits course within the Electrical and Computer Engineering (ECE) curriculum at Bucknell University. With the growing demand for engineers skilled in sustainability, the project aims to develop two laboratory experiments focusing on power factor and Thevenin Equivalent Circuit (TEC) while incorporating aspects of technical sustainability. These experiments allow students to engage with principles of energy efficiency and sustainability, aligning with their major coursework and preparing them for careers in a changing job market. Methodologically, the research involves the creation of pre-laboratory assignments to introduce sustainability concepts, followed by hands-on application in the labs themselves. The discussion emphasizes

the importance of sustainability integration in ECE coursework, promoting real-world applications and contributing to organizational cost savings and efficiency. Though yet to be implemented, the labs are scheduled for piloting in the 2023-2024 academic year, with ongoing evaluation and refinement anticipated during the 2024-2025 course redesign.

Holiness Kerandi '26

Faculty Mentor(s): Professor Darakhshan Mir, COMPUTER SCIENCE
Funding Source: College of Engineering

Disparities in Prison Punishment: Pennsylvania Department of Corrections

During the summer, I conducted an investigation into racial disparities in prison punishment within the Pennsylvania Department of Corrections, focusing primarily on incidents of prison misconduct. Specifically, my analysis spanned the years 2000 to 2019, following a revision in the department's categorization of misconducts within correctional facilities.

My findings reveal a notable racial disparity in the occurrence of misconducts, particularly among those categorized as "Category B" offenses, which often lack tangible evidence requirements. In my presentation at the symposium, I will delve into these findings and their implications.

Moving forward, the next phase of my research will involve an examination of custody numbers in relation to the incidence rates of misconducts. Throughout this investigation, I meticulously maintained a journal and developed various graphs to illustrate and support my findings.

Ben Khant '27

Faculty Mentor(s): Professor Joe Wilck, ANALYTICS & OPERATIONS MANAGEMENT
Funding Source: Presidential Fellowship

Building Large Language Models

ChatGPT became available in November 2022. It is the most widely used large language model. This research explores uses of ChatGPT in a variety of industries. We also explore building our own large language model using nanoGPT. NanoGPT offers the opportunity to create a small scale large language model on a single computer. Research questions would be 'How are industries using ChatGPT?' and 'How can we create our own large language model outside of ChatGPT?'

Chris Kopac '25

Faculty Mentor(s): Professor Samuel Gutekunst, COMPUTER SCIENCE
Funding Source: James L.D. and Rebecca Roser Research Fund

Broadway Analytics

Broadway musicals can amass millions of dollars a week, but can also hemorrhage money. Spider Man: Turn Off the Dark lost nearly $60 million throughout its Broadway stint. A common rule of thumb for musicals is that only one in five shows recoup their investment. However, this statistic is usually attributed to "insider sources" and no real data is ever given. This research project explores public data surrounding Broadway musicals to better understand their finances and recoupment rates. We studied all musicals that opened from 2007-2017, comprising 129 musicals, and found that approximately 27% of productions recoup their investments. To find this number, we found two preliminary datasets and scoured online databases for information regarding show recoupment. We were also able to estimate missing values for cost metrics using other related variables. Additionally, this research project looks into the distribution of show profits, revealing that such few shows sustain considerable profits in their productions. For instance, only 8 of the 129 musicals we studied could reasonably have doubled their profits. We also produced a master spreadsheet consisting of every Broadway musical in our studied time period, along with information regarding recoupment, running costs, and other metrics important to our analyses for each show. The findings of this project underscore the inherent difficulty in achieving financial success on Broadway, and provide concrete data to understand what proportion of shows recoup their investment.

Connor Kozick '26; Dr. Olivia Boerman

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 Intensity Pulsed Ultrasound (LIPUS) and Recombinant TGF-β1 on VEGF Secretion from Endothelial Cells

Chronic wounds last on average 12-13 months and affect roughly 1-2% of the worldwide adult population. Low intensity pulsed ultrasound (LIPUS) has been demonstrated to clinically advance the healing of chronic wounds by significantly advancing chronic wound healing. However, the biological mechanisms of this ultrasound-assisted healing is not yet understood. Angiogenesis, the creation of blood vessels, is an essential process to progress the healing of chronic wounds. It is hypothesized that the LIPUS may induce angiogenesis. Vascular Endothelial Growth Factor (VEGF) is an established protein that has been shown to be increased in secretion by endothelial cells during angiogenesis, making VEGF a reliable indicator of angiogenesis. Transforming growth factor beta 1 (TGF-B1) is another protein associated with angiogenesis of endothelial cells. The combination of TGF-B1 and LIPUS may be a promising dual-prong therapy. Therefore, the purpose of this study was to investigate the effect of TGF-B1 alone, LIPUS alone, and TGF-B1 and LIPUS on endothelial cell secretion of VEGF

Human Umbilical Vein Endothelial Cells (HUVECs) were used in this study. HUVECs were cultured then specifically seeded and treated with corresponding amounts of LIPUS ultrasound and TGF-B1. A human VEGF was then used to determine the amount of VEGF secreted by the cells.

Trends from the experiment show that the application of 150 mW/cm2 of LIPUS and 10 ng of TGF-B1 on HUVECs separately increases the secretion of VEGF, suggesting an increase in angiogenesis. However, when LIPUS and TGF-B1 are used together at the same intensity and concentration respectively, the secretion of VEGF by HUVECs decreases.

Alexander Kremer ’24; Timothy Raymond; Dabrina Dutcher

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

Hygroscopicity Study of Aerosolized Amino Acid

When particles are suspended in the air they become what is called an aerosol. When aerosols move high into the atmosphere, water can condense and form clouds around them. Depending on the particle, clouds may or may not form depending on its tendency to take up water, which is called hygroscopicity. The goal of this experiment was to determine if mixing different particles together affected the behavior of the aerosol that was formed and if different mixing mechanisms also had an effect.

Emma Lamberti ’24

Faculty Mentor(s): Professor Nicholas Roseth, MUSIC

Music Education within an Autism Support Classroom: Building Community and Educational Skills

The purpose of this action research study was to explore how music education might provide a sense of community, develop educational skills, and discuss general best practices for teaching students with Autism Spectrum Disorder (ASD) in a middle school autism support classroom. This study completed two action research cycles to examine community, educational skills, and best practices. The curriculum in Cycle 1 consisted of typical music lessons for a general music classroom. Interviews with teachers and students, video observations, and researcher reflections after each lesson were used to inform the development of Cycle 2. Cycle 2 retained the overall structure of Cycle 1 but with alterations to better support community and educational skills. Lessons included repetitive aspects such as ending and closing with a hello/goodbye song, but new elements were added as appropriate for the class to enhance engagement. For example, partner work was emphasized through instrument playing and folk dancing, and more physical movement was added throughout the lesson. Suggestions for a hypothetical third cycle are also discussed. Overall, it is imperative that teachers communicate with the student, special education teachers, parents, and paraprofessionals to understand the student best. When teaching students with ASD, it is good practice to include repetition with appropriate variation, multiple modes of engagement within activities, incorporate student interests, provide opportunities for partner work without teacher oversight, and maintain positive and excited enthusiasm throughout the lessons.

Emma Lamberti ’24

Faculty Mentor(s): Professor Sezi Seskir, MUSIC
Funding Source: Program for Undergraduate Research

Exploration of Collaborative Teacher-Student Relationships in Chamber Music Summer Programs

This project examines how chamber music promotes aspects of collaboration between teachers and students. Chamber music is a form of classical music composed for small ensembles, like quartets or duos. It is a case study of a chamber music summer program, Chamber Music Collective, with observational data from daily rehearsals and interviews with the teachers and students in the program. The results indicate that unlike other music teaching contexts such as private lessons, chamber music can allow for more room to explore ideas among the members of the ensemble, along with their teachers in the rehearsals. Overall, when the teacher allowed students to either run the rehearsal or provide equal or more feedback as the teacher, students felt more heard and valued in the rehearsals. According to the students, chamber music because of the teacher’s guidance approach, allowed them to learn the important musical concept of listening, meaning they were actively engaged in what the other members played as well as their own, allowing for more discussion amongst members. The paper concludes with suggestions for teachers on how to promote this collaborative environment within their teaching environments and what other work is needed in this area.

Sam Lasher ’25

Faculty Mentor(s): Professor Claire Campbell, HISTORY
Funding Source: Program for Undergraduate Research

“Forever Kept as Wild Forest Lands” A Story Behind the Making of the Adirondack Forest Preserve

In 1884, the new three-person Forestry Commission for the state of New York made various trips to the Adirondack Plateau “to report a system of forestry.” Within a year, the state legislature had passed various laws to create the forest preserve - including the remarkable language that promised the area “shall be forever kept as wild forest lands.” Over the course of the twentieth century, the Adirondack Forest Preserve became the largest publicly protected area in the lower forty-eight of the United States. What made this possible? My research in the summer of 2023, including fieldwork at the Adirondack Experience archives, sought to explain the particular intervention of the Forestry Commission in the larger landscapes of nineteenth-century American environmental thought, the history of competing uses in the Adirondack region, the concept of “second nature,” and emergent ideas of environmental protection like “forever wild.

Skyler Le ’27; Shaan Sekhon ’27

Faculty Mentor(s): Professor Sally Koutsoliotas, PHYSICS & ASTRONOMY; Dr. David Farmer
Funding Source: Presidential Fellowship

L-functions Out of Nothing

L-functions act as a bridge between many different areas of mathematics and physics. We found L-functions that no one has ever seen before. Using the BisonNet computing network, we generated more than 400 examples. Our data set reveals intriguing patterns.

Eddie Lee ’25

Faculty Mentor(s): Professor Aaron Mitchel, PSYCHOLOGY
Funding Source: Program for Undergraduate Research

The Impact of Cognitive Load on Multisensory Integration

Multisensory integration (MSI) is the process by which stimuli across different sensory modalities are integrated into a unified percept, enhancing an individual’s perception of the world around them. MSI is a core feature of our day-to-day experience, imparting perceptual enhancement to improve our understanding of the world across all sensory domains. Examples of situations where MSI is utilized include speech, where we rely on visual cues from a speaker’s lips in noisy environments to understand what they are saying, and driving. Given its relevance to daily life, understanding what processes underlie it and what factors may influence it has become a topic of interest.

Researchers have proposed and defended two main theoretical stances regarding what may contribute to MSI. The first theory is the early model of MSI, which stipulates that MSI is mental-resource independent, and does not require allocating available mental resources by a central executive in the brain. The second model is the late model of MSI, which stipulates that MSI is a mental resource-dependent task that requires allocating mental resources via a central executive in the brain to occur. Our research seeks to contribute to finding an answer to this question and determine whether MSI is mental resource-dependent or independent through an interleaved speech-in-noise and n-back task. Our results tentatively support an early model of MSI, lending credence to the theory that MSI is a mental-resource-independent process.

Hayden Linkerhof ’26

Faculty Mentor(s): Professors Dabrina Dutcher & Tim Raymond, CHEMICAL ENGINEERING
Funding Source: National Science Foundation Grant (NSF)

Aerosol Hygroscopic Effects and Automation

The physical structure and appearance in compounds changes drastically under different humidity levels. This can significantly affect chemical properties and reactivity. Our research plan was to record what humidity levels will cause this physical change in various compounds.

What exact humidity level will induce physical changes to certain chemicals, and can we create a system to calculate this for us?

This question was investigated throughout the course of research, and may be considered an ongoing question. The original lab setup was composed of a microscope, glass slides, an air chamber, bubblers, humidity meter, and a flowmeter. The flowmeter was used to control the amount of air entering the bubblers, which would create a certain concentration of wet air to mix with dry air entering the air chamber. This mixture would alter the humidity levels inside the air chamber to induce the physical changes on the compound being examined, and the microscope was then used to observe these changes.

To improve this process, the new lab setup includes a PID controller, a new humidity meter, and a solenoid valve. The humidity meter and solenoid valve are connected to the back of the PID controller. As the PID controller receives an input from the experimental user, it will observe the current humidity level and make the solenoid valve either open or close to control the air flow stream, which would consequently alter the humidity level. This new system increases autonomy while being able to reduce time for experiments and increasing accuracy.

Tyler Luong (Graduate Student)

Faculty Mentor(s): Professor Peter Jansson, ELECTRICAL & COMPUTER ENGINEERING
Funding Source: Graduate Summer Research Fellowship

Development of Data Sensing Module for Microbial Fuel Cell

This research presents early stage development and design of a data collection and energy harvesting device for Microbial Fuel Cell applications. Basing off a pre-existing current sensing design from researchers at University of California San Diego, time was taken to understand the functionality of the boards and areas of improvement were then identified. Alternative Current Sensing Amplifiers were selected with intentions of improving upon the current component and KiCad design was done to prepared for PCB manufacturing.

Damien Mahanama ’24; Dr. Olivia Boerman

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING
Funding Source: Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Low-Intensity Pulsed Ultrasound Increases FGF-2 Secretion in Human Endothelial Cells

Low-intensity pulsed ultrasound therapy (LIPUS) is a developing noninvasive method that is being tested for its efficacy in promoting wound healing. A previous study found LIPUS to increase cell proliferation and accelerate chronic wound closure.1 However, the biological mechanisms of how ultrasound promotes wound healing are not yet understood. Angiogenesis is a biological process that involves the formation of new blood vessels from pre-existing ones, making it a vital component of wound healing. Basic fibroblast growth factor (FGF-2) is a key angiogenic factor that stimulates endothelial cell proliferation and migration. Using an ELISA to quantify the amount of FGF-2 released by endothelial cells can serve as an indirect measure of angiogenic activity. The purpose of this study is to compare levels of FGF-2 secretion between LIPUS-treated and control groups to assess whether LIPUS has the potential to enhance angiogenesis. Further investigation into the effects of LIPUS on angiogenesis can provide a framework for the development of novel therapies in wound healing and tissue regeneration.

It was observed that higher LIPUS intensities resulted in more FGF-2 secretion, which is a critical indicator of angiogenesis. The significant difference observed in FGF-2 concentration between the control group and the 100 mW/cm2 and 150 mW/cm2 intensity groups indicates that 100 mW/cm2 may be the minimum therapeutic threshold. Further investigation is needed to determine the precise ultrasound parameters for optimal FGF-2 stimulation and angiogenesis promotion.

Ethan McNamara ’24; Isabella Diaz ’26; Ian Mawn ’22; Sarah J. Smith

Faculty Mentor(s): Professor Sarah Smith, BIOCHEMISTRY/CELL BIOLOGY, CHEMISTRY
Funding Source: Department of Chemistry; Culliton Family Fund for Undergraduate Research; Physical Science Scholars Program (NSF)

Optimization of a Hybrid Metal Coordination Motif in Cell-Penetrating Metallopeptides

A variety of strategies have been utilized to increase the capacity for peptides to cross cellular membranes and enter the cytoplasm. It is well established that structured, positively charged peptides, or peptides with positively charged termini, are best able to cross the cellular membrane. Recent work in the literature has demonstrated the binding of metal ions at designed sites on a peptide backbone greatly enhances the ability of the metallopeptide to enter a cell. Here, we present work to establish the principles that enable metal-ion enhanced permeation. We have designed a series of fluorescein-labeled peptides with natural and non-natural amino acids to bind transition metal ions across one-, two-, or three-turns of an alpha-helix.

For each set of metal binding ligands on a peptide backbone, the metal binding affinity and change in secondary structure upon metal binding is measured for the first-row transition metals Ni, Co, Cu, and Zn. After incubation with HeLa cells, we measure peptide incorporation via flow cytometry and confocal microscopy, and metal ion incorporation via inductively coupled plasma mass spectrometry (ICP-MS). We have demonstrated that peptide internalization correlates with the degree of alpha-helical structure induced upon peptide binding. Further, we conclude that metallopeptides are crossing cellular membranes as metal-peptide conjugates. We also demonstrate the first example of an engineered peptide with two non-natural metal-binding groups, creating a 4-coordiante metal-binding site across 3-turns of an alpha-helix.

Shane Monaghan ’26

Faculty Mentor(s): Professor Darakhshan Mir, COMPUTER SCIENCE
Funding Source: L&IT Digital Pedagogy and Scholarship Summer Research Grant

Disparities in Pennsylvania Parole Decisions

Conducted over the summer of 2023, this study sought to answer the question “What disparities between racial groups, if any, exist in decisions regarding an inmate’s parole? How might these differences be explained?” The motivation for this study comes from a New York Times investigation into New York state prisons. That investigation, which examined thousands of parole decisions and almost sixty-thousand disciplinary cases, revealed that black and Hispanic men were punished more frequently and severely than their white counterparts and that they were significantly less likely to be granted parole on their first attempt (Winerip). Similarly, research conducted by Massaro et al. revealed that racial bias exists in the algorithms of Pennsylvania state prisons (Massaro et al.). By examining hundreds of thousands of parole decisions, this study revealed that racial disparities do exist in parole decisions in Pennsylvania, with black incarcerated persons being granted parole at a lower rate than their white counterparts. These disparities are particularly pronounced in decisions involving younger people. However, this work does not assess whether or not race is a causal factor in these disparities.

Mark Mosier ’25

Faculty Mentor(s): Professor Indranil Brahma, MECHANICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences; Program for Undergraduate Research

Nanoparticle Characterization and Reduction by Air-Fuel Mixture Vaporization for Small Gasoline Engine Emissions

Small gasoline engines remain common in day-to-day life even with the rise in popularity of electric devices. For example, many lawnmowers, generators, and other handheld tools are powered by small gasoline engines. Inside small gasoline engines, air and fuel are mixed in the carburetor then sent to the cylinders for combustion. Incomplete mixing of air and fuel results in carcinogenic nanoparticles being released to the environment. However, there is a lack of empirical nanoparticle emissions data for small gasoline engine emissions relative to large gasoline engines. In this work, a HONDA GX160 engine was equipped with sensors to record engine speed, load, intake and exhaust temperatures, fuel and air flow, in-cylinder pressure, and crankshaft angle. A TSI Engine Exhaust Particle Sizer spectrometer was prepared to record nanoparticle emissions at various speed and load combinations. Data acquisition programs were developed in LabVIEW, and data processing programs were prepared in MATLAB to plot particle diameter vs. concentration. Future work will involve collecting data and characterizing nanoparticles based on size and number. A homogenizer device developed by a Bucknell senior design group will be installed on the engine to determine to what extent emissions are reduced. Additionally, collected data may be used to assist in future decisions of standards for safe levels of small gasoline engine emissions. Obtaining more data on small gasoline engine emissions is essential to develop nanoparticle mitigation technology.

Abigail Motter ’25

Faculty Mentor(s): Professor Chris Martine, BIOLOGY
Funding Source: David Burpee Endowment

Censer and Trample Burr Seed Dispersal Mechanisms in Australian Bush Tomatoes

Several major threats of climate change include increased wind intensity, altered wind direction, and the disappearance of species due to habitat loss. Australian bush tomatoes in northern Western Australia likely have seed dispersal mechanisms that depend on these processes, thus changes to them might jeopardize the success of the plants. Solanum tudununggae seeds are wind dispersed by the censer mechanism in which seeds fall from holes in the top of the fruit when the plant is moved. Therefore, changes in weather patterns could severely impact the effectiveness of this mechanism. Likewise, piles of abscised and burr-like fruits have been found strewn around the bases of S. ossicruentum, possibly due to the extinction of animals that may have been a means of dispersal via epizoochory. In this study, we attempt to provide support for the theorized dispersal mechanism for

these two species of Solanum. The S. tudununggae censer mechanism will be tested by shaking individual plants with mature fruit and recording the number of fallen seeds and the distance of each from the plant. To ascertain information about the seed disperser for S. ossicruentum, animal pelts with varying thickness, density, and hair length will be used to assess fruit adherence. The number of fruits that stick to each individual pelt will help narrow down the possible identity of the disperser of S. ossicruentum. The results from these experiments will likely confirm the mechanisms proposed in previous studies and suggest impacts of climate change on species with similar dispersal mechanisms.

Liam Moyer '24; Samuel Gutekunst; Andrew Daw; Jameson Railey '22

Faculty Mentor(s): Professor Samuel Gutekunst, COMPUTER SCIENCE
Funding Source: College of Engineering

NFL Score Simulation

American football has a scoring system that is unlike any other sport. Due to the variety of scoring methods and their set point values, as well as the constant changes to NFL rules, there continues to be final scores that have never happened before in NFL history; a term which has been named a Scorigami. Our research attempted to predict the next most likely Scorigamis as well as create a simulation algorithm that can accurately predict the scoring patterns of NFL scores in any era.

To achieve our goal, we analyzed every game in NFL history by extracting data from various databases. After creating a file with every final score and every scoring method, we created a Python simulation based on the Poisson distribution of scoring events. Essentially, it generates a final score based on the average number of scoring events per team per game. Further research into a "time-based" simulation has been started and is currently under development with play-by-play data. Theoretically, this will give a more accurate representation by simulating a score based on when certain scoring events are more likely to occur in game-time.

In addition to creating a file of every game in NFL history, our research has successfully produced a list of the next most likely Scorigamis, several of which have occurred this past season. Our Poisson simulation accurately reflects the average scoring events of each era and we are excited to continue to develop a simulation dependent on the game clock.

Omuhle Ndhlovu '26; Demi Gonzalez '26; Fi Karamitros '25; Melanie Gamboa '24

Faculty Mentor(s): Professors Carley Gwin & Deborah Sills, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Program for Undergraduate Research

Water Quality Assessment: Microbial Source Tracking of Coliform Contamination in Waters Impaired for Recreation in Union County

Pennsylvania is surrounded by numerous water bodies that serve as habitat for aquatic life, providing drinking water and recreational opportunities. However, several streams in Union County are impaired, and cannot not be used for recreational purposes, let alone consumed. We conducted research in the Buffalo Creek with the goal of determining the water quality through collaborating with Buffalo Creek Watershed Alliance (BCWA). We collected water samples at 13 locations along the Creek, five times over a period of 30 days. We measured standard water quality parameters such as temperature, pH, Total Suspended Solids, turbidity, conductivity, and dissolved oxygen (DO). We compiled the data sets and compared them to the standard values required by the Department of Environmental Protection (DEP). We also filtered water samples and stored them in the -80°C freezer until DNA extraction. This summer we extracted DNA from last year's water sample filters using Salmon Sperm as a positive control. This DNA will be used for PCR with various primers we have screened for accuracy in identifying fecal coliforms. Moreover, we used Microbial Source Tracking (MST), to determine the animal source of fecal coliform contamination. DNA sequences of particular bacteria from various animal sources are known, therefore we can use this information to screen water samples and identify the animal source. This is accomplished by isolating DNA from water samples and using Polymerase Chain Reaction (PCR) to make millions of copies of the DNA of interest, if it is present.

Siobhan Nerz '24; Dr. Elena Machado

Faculty Mentor(s): Professor Elena Machado, ENGLISH
Funding Source: Presidential Fellowship

Where is US Latinx Theatre happening?

This in-progress digital mapping project uses ArcGIS to feature information about the location, establishment dates, websites, and founders of over 120 Latinx theaters. The purpose of this interactive map is to give visibility to Latinx theatres and create a digital record of current and past organizations. Many theaters' work of holding community events and featuring works of Latinx playwrights lacks visibility. The map will give theaters a presence in digital records and bolster public awareness.

Hung Ngo '26; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE
Funding Source: James L.D. and Rebecca Roser Research Fund

A Touchless Typing Approach Using Apple Augmented Reality Kit & Sequence-to-Sequence Learning

Traditional input interfaces require fine motor skills, which may be challenging or impossible for some individuals with disabilities. Touchless typing interfaces that use head or face movements could help these individuals access the exciting computing world. Recent studies have shown promise in inferring text from head movements and gaze patterns while the user attempts to gaze through alphabets presented via an onscreen QWERTY keyboard. These studies, however, use external sensors, including the camera, gaze trackers, or virtual reality (VR) headsets. This study proposes an end-to-end touchless typing model that utilizes facial movements captured via a True Depth camera built into Apple devices. The True Depth camera projects thousands of visible dots onto users' faces and analyzes them to create a depth map. The proposed method translates the recorded face movements to a sequence of nine cluster ids that divide the onscreen QWERTY keyboard into nine regions. The sequence of cluster ids is then translated from a sequence of words using a Sequence-to-Sequence Model.

Rose Nyounway ’27; Omid Mohammadi ’25

Faculty Mentor(s): Professor Vanessa Massaro, GEOGRAPHY; Professor Darakhshan Mir, COMPUTER SCIENCE
Funding Source: Mozilla Foundation: Responsible Computing Challenge

US Carceral Data and Mental Health

Research Question:
Exploring the interconnections between data from the United States Carceral System, Mental Health Documents, and Reception and Classification Policies through a comprehensive and comparative lens.

Method:
Conducting an in-depth analysis of Carceral System data, Reception and Classification Policy Documents, and mental health documents. Employing interviews with individuals who were previously incarcerated and contractors associated with the Pennsylvania Department of Corrections to juxtapose official documents with real-life experiences. Investigating correlations between Carceral System data and mental health indicators among inmates.

Tobi Odusote ’25

Faculty Mentor(s): Professors Indranil Brahma & Constance Ziemian, MECHANICAL ENGINEERING
Funding Source: Program for Undergraduate Research

Exploring the Use of Machine Learning and Finite Element Analysis for Improvement in Fatigue Life Predictions of Additively Manufactured Specimen

This research investigates the potential integration of Long-Short-Term Memory (LSTM) in deep learning, specifically for predicting the Remaining Useful Life (RUL) and residual strength of additively manufactured ABS plastic components. The study explores the application of deep learning algorithms to enhance predictive capabilities by leveraging existing model characteristics. The methodology comprises a comprehensive literature review on deep learning forecasting, followed by utilizing collected data to construct a network predicting RUL and conduct extensive testing. Recognizing the need for additional specimen information, a SolidWorks model is designed to represent the tested component accurately. Finite Element Analysis (FEA) is then employed to simulate tensile testing of the model, using experimental data to validate FE models regarding tensile behavior. Preliminary findings are promising and indicate the potential of deep learning in predicting AM part failure, with the trained model demonstrating satisfactory accuracy in RUL prediction. However, recognizing the importance of additional specimen details, the goal is to generate additional computational results to also be integrated. Ongoing efforts involve refining the FE model characteristics, such as air voids and density, and altering it to represent different mesostructures and ultimately to simulate fatigue testing. The primary goal is to use the FE results to improve predictive accuracy in machine learning networks. This research signifies the promising synergy between machine learning and FEA in exploring the possibilities of predicting fatigue life in additively manufactured specimens.

Enzo Ottaviani ’25; Olivia Boerman

Faculty Mentor(s): Professor Olivia Boerman, BIOMEDICAL ENGINEERING
Funding Source: Kalman Fund for Biomedical Research Fellows

Effects of Low Intensity Pulsed Ultrasound Technology on Vascular Endothelial Growth Factor Secretion

I was looking to see how therapeutic ultrasound affected vascular endothelial growth factor (VEGF), to see if increased angiogenesis occurred.

Renee Palma ’26

Faculty Mentor(s): Professor David Del Testa, HISTORY
Funding Source: Bucknell Institute of Public Policy

International Virtual Exchange as a Microcosm of the Corporate University: Preliminary Reflections

This paper introduces a critical theoretical framework for analyzing the developing field of International Virtual Exchange. It situates its development within the current economic period of transnational capitalism and explores how its implementation across American universities might be motivated by the values of the corporate institutions that dominate the broader social structure. In offering this framework, this paper aims to stimulate critical discussion regarding how internationalization can be aided by technology without compromising its educational mission.

Lucy Park ’26; Jade Gregg ’25; Maddy Davis ’25; Elena Marchetti ’23

Faculty Mentor(s): Professor Brian Smith, CHEMISTRY
Funding Source: James L.D. and Rebecca Roser Research

Fund Flexibility and Functionalization of 3D Imine Covalent Organic Frameworks

Covalent Organic Frameworks (COFs) are highly crystalline, porous polymers that offer potential as a modular molecular scaffold attractive for any fields requiring advanced materials with programmable properties. Their exceptional surface area and chemical modularity enable applications in water purification, gas and energy storage, drug delivery, and catalysis. Three-dimensional (3D) COFs are particularly attractive due to their interconnectivity, although fundamental questions about their structure and flexibility remain. Using COF-300 as a model system, we explore the impact of reaction conditions, functional groups, and additives on the final crystal form of the framework. Certain additives lead to variable pore sizes of the final form, suggesting a “”breathability”” of the network in contrast to the traditionally expected rigid nature of crystals. Subsequent efforts explore how functional linkers impact (or inhibit) crystallization of the polymer network. Overall, these endeavors not only establish the stability of intermediate packing structures of the COF but also determine favorable synthesis conditions for next generation COF materials.

Hung Pham ’26; Rajesh Kumar

Faculty Mentor(s): Professor Rajesh Kumar, COMPUTER SCIENCE
Funding Source: Helen E. Royer Undergraduate Research Fund

Trustworthiness of EEG Emotion Recognition

Electroencephalography (EEG) has gained popularity as a non-invasive and cost-effective method for emotion recognition. In this research, we focused on the trustworthiness of EEG-based emotion recognition models by reproducing state-of-the-art results, improving their performance, and evaluating their effectiveness across different demographic groups.

Kasey Piper ’25; Kenneth Mineart

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

How Many Passes Does it Take?

An Investigation to Determine the Optimal Number of Liposome Extrusion Cycles

Liposomes are lipid-based nanoparticles commonly known for their drug carrying capacity and value in membrane and nanoreactor research. One commonly used method of fabricating liposomes of particular size is membrane extrusion in which liposomes are pushed through a porous membrane and break apart to form smaller liposomes. However, the details pertaining to liposome extrusion, such as the number of passes, membrane pore sizes, and pre-extrusion sample preparation, vary between different labs. The specific goal of this project is to establish a relationship between the number of passes through a track-etched, polycarbonate membrane, and the average diameter and diameter distribution of extruded liposomes. To investigate, we extrude samples to several different amounts varying from 1 to 1,000 passes and measure the average hydrodynamic diameter and diameter distribution of each using dynamic light scattering (DLS). In addition to cross-experiment comparison, we compare liposome size data to the size distribution of membrane pores, which is acquired using scanning electron microscopy (SEM) and subsequent image processing. Cases in which liposome and pore size distributions are similar suggest that extrusion has been completed, and further extruding would not change the liposome size. These results provide relevant researchers with the optimal number of passes for liposome extrusion that will allow them to form ideal distributions in the shortest amount of time.

Alejandro Plata ’25

Faculty Mentor(s): Professor Andrew Sloboda, MECHANICAL ENGINEERING
Funding Source: Program for Undergraduate Research

Machine Learning to Detect Damage in Nonlinear Systems

Structural and mechanical systems wear and fatigue over time and managing these effects has proven to be a critical challenge for engineers. Monitoring damage in systems allows time, resources, and money to be properly allocated to repair or replacement. Many methods exist for damage detection in linear systems, but nonlinear systems have few methods available. Sensitivity vector fields (SVFs) are one way of detecting damage in nonlinear systems. SVFs quantify how nearby dynamic paths in phase space, called trajectories, separate due to damage. The magnitude of a sensitivity vector is expected to correlate to the amount of damage while the direction of a sensitivity vector can indicate the type of damage. This research used machine learning to expand SVF damage detection into the multi-parameter domain and to test its effectiveness on experimental data sets. Experimental data from a Chua circuit was processed in MATLAB and then the damage was classified using a stacked meta-learning model. A mix of support vector machines and random tree ensembles provided the best classification and regression model. The model was able to predict changes in all three system parameters with an MSE of less than 0.01. Simulated data was created for a five-body mass-spring system driven by a chaotic signal. Accurate classification and regression results were obtained for limited damage scenarios, such as multi-level damage at one location or a fixed amount of damage at multiple locations.

Morgan Powell ’26; Dr. Shaunna Barnhart

Faculty Mentor(s): Dr. Shaunna Barnhart, CENTER FOR SUSTAINABILITY & THE ENVIRONMENT
Funding Source: William Corrington Renewable Energy Fund and Center for Sustainability & the Environment

Exploring Expansion of Biogas Energy Production on Homesteads, Small-Scale, and Large-Scale Farms

This project analyzes how the perception and implementation of biogas differs across large-scale farms, small-scale farms, and homesteading operations. Its end goal is to better understand the economic feasibility and practicality of biogas at different scales with the hope of establishing a more solid foundation for the sustainability community to operate on and more widespread use of biogas. Both a survey and in-person interviews were conducted during this research. The results of both indicate that existing literature does not accurately represent the state of biogas in Pennsylvania. While public perception and existing studies indicate that biogas is most effective on large-scale farms, this study finds that biogas on a micro scale is overall more affordable, accessible, and easy to maintain. With 17% of the large scale farms using biogas in Pennsylvania responding to the survey and on-site visits to two large scale farms, the results show that the cost to maintain a large biogas digester (all of which were over $1 million to build) are potentially prohibitive for the long term viability of large scale systems. In contrast, the small scale users who are building smaller household scale systems for on-site use for energy generation (all of which were under $1,000 to build) report minimum expenses necessary for maintenance.

Morgan Powell '26

Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Presidential Fellow Program

Exploration of Fabrication Methods for Origami-Inspired Systems to Address Crease Pattern Incompatibility

Origami-inspired structures are theoretically intriguing designs, but complications arise when they are constructed of more substantial mediums because the fold patterns are often incompatible with the material thickness. This project explores fabrication methods to create foldable structures that capitalize on the increased stiffness and flexibility of the system, while addressing the crease pattern incompatibility. Past work at Bucknell identified the Miura-Ori fold as a basis for experimentation. This project explores the feasibility of utilizing fiber reinforced polymers (FRP), a series of rigid plates bonded to a base material with flexible hinges between stiff areas. The materials used for construction experimentation are an epoxy resin and fiberglass cloth due to their inexpensive nature and adaptability. Initial testing involved perfecting the application method of the epoxy on the fiberglass. The critical issue here was ensuring a clean edge on the epoxy to control the location and angles of the hinge. The final application method selected for moving to design was using rubber-based adhesive as a seal on the fiberglass fabric to outline the geometric pattern. A double-sided, wet layup application method of both the rubber-based sealant and the epoxy resin was deemed most effective at ensuring consistent thickness and clean edges. Using this technique, a successful 3D model of the classic Miura-Ori fold has been constructed and analyzed for necessary improvements. Ongoing work focuses on improving the system's ability to maintain its form after folding and using the same materials and fabrication to scale-up designs and work towards real-world applications.

Meghan Quinn '24; Laura Hart '24; Olivia Tzefronis '24; Lexi Handy '24; Katie Schadler '26; Briana Perea '26; Bill Flack; Erica Delsandro

Faculty Mentor(s): Professor Erica Delsandro, WOMEN'S & GENDER STUDIES; Professor Bill Flack, PSYCHOLOGY
Funding Source: Program for Undergraduate Research

Campus Sexual Assault: Current Title IX Regulations and Mandatory Reporting Attitudes

Examining the role of Title IX on college campuses may open up an explanation as to why sexual assault has continued to rise. The fact is, many young people are being traumatized, harmed, or violated in what they thought was a safe community. Sadly, when sexual assault violations occur, many go unnoticed and unreported. The current study analyzes student's knowledge and attitudes regarding Title IX and mandatory reporting. Using a mixed-methods approach, data was collected quantitatively through sending out a campus-climate survey and qualitatively through conducting interviews with students about Title IX and mandatory reporting. Survey data was analyzed using SPSS statistical software and interview data was analyzed using qualitative coding methods. Preliminary quantitative results show that men had more positive perceptions of institutional response in handling campus sexual assault than did women. Additionally, non-victims of campus sexual assault reported more positive perceptions of institutional response in handling campus sexual assault than did victims. I expect to find that male students will minimize assault more than female students, that more female students than male students will be victims of sexual violence, and that female students will know more than male students about Title IX and mandatory reporting. This research will not only educate both administrators and students on Title IX policies at Bucknell but also emphasize the need for increased support of victims.

Christian Ragnacci '24

Faculty Mentor(s): Professor Jeffrey Trop, GEOLOGY & ENVIRONMENTAL GEOSCIENCES
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Provenance of Paleogene Fluvial Strata in the Eastern Talkeetna Mountains, South-Central Alaska (U.S.A.) Using Detrital Zircon Geochronology and Compositional Analyses

Paleogene sedimentary strata in the Matanuska Valley, Talkeetna Mountains and Chugach Mountains of south-central Alaska record continental forearc basin evolution. New data from previously unstudied strata (Nowhere Creek formation) in the eastern Talkeetna Mountains constrain depositional age, environment, and provenance. Measured sections document conglomerate and subordinate sandstone and siltstone interpreted as fluvial deposits. Palynomorphs and youngest U-Pb detrital zircon ages (55-52 Ma) demonstrate late Paleocene-earliest Eocene deposition. Clast counts (n=404) display dominantly igneous clasts (96%), including 64% mafic volcanic, 21% felsic plutonic, 10% felsic volcanic, and 1% mafic plutonic. U-Pb detrital zircon geochronologic analyses (n=440) document late Cretaceous-early Eocene (90%) and Jurassic (8%) ages, which build upon previously reported ages from the Arkose Ridge (n=1,686), Chickaloon (n=2,890), and Wishbone (n=505) Formations. Multidimensional scaling analysis and unmixing modeling of detrital ages reveal three provenance groups. Group 1 indicates Jurassic-Paleogene arc igneous sources in the Talkeetna Mountains. Group 2 displays mixing from Jurassic-Paleogene magmatic arc sources in the Talkeetna Mountains and Jurassic-Cretaceous metasedimentary accretionary complex sources from the Chugach Mountains. Group 3 indicates erosion of Chugach Mountains metasedimentary accretionary complex sources. Together, the datasets indicate Paleogene strata exposed north of the Castle Mountain Fault, including the Nowhere Creek formation, were sourced from arc sources, whereas strata exposed south of the fault were sourced from accretionary complex sources or a mixture of both arc and accretionary complex sources. Additionally, results from this study document a larger areal extent of Paleogene arc-derived fluvial sedimentation than previously recognized.

Eliza Ray ’24

Faculty Mentor(s): Professor Sue Ellen Henry, EDUCATION
Funding Source: Douglas K. Candland Undergraduate Research Fund

Curriculum, Knowledge, and Power: A Critical Race Approach to Content Analysis of Social Studies Textbooks

This study uses Critical Race Theory as a theoretical framework to examine the portrayal of the U.S. Revolutionary War and the origins of the nation in four 5th grade social studies textbooks approved by the state of Florida’s new curriculum standards. Literature shows that textbooks have been a largely political debate, most recently influenced more by politicians than by educators. This study dives into the politics of the K-12 curriculum and its reflection of ideological interests. A qualitative rubric was developed to evaluate four Florida textbooks, providing a scale that determines the primary orientation of the historical narrative. This scale ranges from the current master narrative rooted in American patriotism and pride, to a well-developed Critical Race Theory point of view on the nation’s founding, showing how systemic racism has, and continues to be, foundational to American life. This rubric was informed by the five tenets of Critical Race Theory in educational research as described by Solorzano and Yosso (2002) and McCoy & Rodricks (2015). A primary text used to determine the counter narrative to the current master-narrative of the Revolutionary War was Gerald Horne’s The Counter-Revolution of 1776: Slave Resistance and the Origins of the United States of America. Data collection on the four textbooks is currently in progress.

Amina Reyes ’25

Faculty Mentor(s): Professor David Rojas, LATIN AMERICAN STUDIES
Funding Source: Program for Undergraduate Research

Critical Research Laboratory

CREL focuses on the students of color experiences at institutions like Bucknell. Each researcher will present about different aspects of student lives at Bucknell. My specific section will touch on if Bucknell considers the dynamics of race and sports.

Brandon Rickett ’24; Haley E. Kragness

Faculty Mentor(s): Professor Haley Kragness, PSYCHOLOGY

Pitch and Volume Influence Children’s Gendered Judgments About Musical Instruments

From a young age, children incorporate gender and gender stereotypes into their understanding of the world. From around 8.5 years old, children report that some musical instruments are “for boys” and others “for girls”. Previous studies suggest that these judgments are largely influenced by past exposure to particular gender-instrument pairings (e.g., “My brother plays the trumpet, so trumpet is for boys). In the present study, we investigated whether physical (size) and musical (pitch, volume) attributes affected children’s gendered judgments of musical instruments. To avoid potential effects of children’s past experiences, we used fictional instruments. Participants were 60 children (31 girls, 29 boys), aged 8.5 to 11 years old (M = 9.36, SD = .73) from across the United States and Canada. On each trial, children saw (large or small) and heard (high or low, loud or soft) a fictional instrument onscreen. Their task was to select which of two characters (girl or boy) should play the instrument. Main effects were found for instrument volume ($p = .026$) and pitch ($p = .002$), with children being more likely to select boys for louder instruments and lower-pitched instruments. Results suggest that specific attributes of instruments impact children’s gender stereotyping, and that beliefs about which gender should play which instruments does not come solely from past exposure to instruments.

Mary Robinson ’25; Uijin Kang ’26

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Engineering Success Alliance Summer Research Scholarship

Comparison Between Two Image Analysis Softwares for Magnetic Resonance Imaging and Computed Tomography Registration in Deep Brain Stimulation

Deep brain stimulation (DBS) is used to treat the symptoms of patients with Parkinson disease. To reduce the side effects of DBS treatment, clinical precision of electrode localization is necessary. Identifying the target region is guided by developing an anatomical map using preoperative magnetic resonance imaging (MRI) and computed tomography (CT) scans. We can confirm that electrodes are implanted in the targeted region by assessing a merged postoperative CT and a preoperative MRI. Electrode localization from postoperative CT and preoperative MRI has been identified using the medical image analysis software Analyze. For this project, the goal was to compare the localization of DBS electrodes within the subthalamic nucleus between Analyze and MATLAB’s medical imaging toolbox. One preoperative MRI and one postoperative CT were used to reconstruct the DBS electrode localization. Such a process was performed in both Analyze and MATLAB softwares, following the same procedure to measure the location of the electrodes: resampling, transformation, and registration. The MRI voxels were upsampled to match that of the CT. Once resampled, the MRI was oriented according to the Talairach coordinate system. The CT was registered to the Talairach-oriented MRI to normalize the coordinate system between the two imaging data sets. After registration was complete, the electrode coordinates were then calculated and compared between the two softwares. The x, y, and z coordinates differed approximately 1 mm each. Overall, they are both comparable programs for registering MRI and CT scans.

Sophie Rocereta ’24; Sky Woodard ’24

Faculty Mentor(s): Professor Julie Gates, BIOLOGY
Funding Source: Kalman Fund for Biomedical Research Fellows

Exploring the Role of Garz During Dorsal Closure in Drosophila Melanogaster

Dorsal closure is a developmental process that occurs in the embryos of Drosophila melanogaster in which the outer epidermal layer of the embryo becomes one continuous structure. This closely mimics the process of wound healing in humans as there’s a gap in the epidermal layer on the dorsal side of the embryo, similar to a cut, that is sealed shut by several forces involving the actin cytoskeleton. Multiple proteins play a role in driving dorsal closure. In this project, we focus on the protein Garz, a guanine nucleotide exchange factor (GEF).

GEFs are components of signal transduction pathways that regulate cellular activity, and these components are specifically responsible for inactivating small GTPases that act as molecular switches. Garz inactivates the small GTPase Arf. To investigate the function of Garz during dorsal closure, genetic crosses are carried out to generate embryos with reduced levels of the Garz protein. We use immunofluorescence to stain the actin cytoskeleton of these embryos then image them using the confocal microscope. The structure of the actin cytoskeleton during dorsal closure in wild-type embryos and embryos with reduced Garz levels are compared to examine the function of Garz during this process. So far, this project has analyzed dorsal closure in wild-type embryos to obtain control images for comparison against embryos homozygous mutant for Garz.

Kaitlyn Ryan '24

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

Optimal Deep Brain Stimulation Targets in the Subthalamic Nucleus of Patients with Parkinson Disease

Deep brain stimulation (DBS) of the subthalamic nucleus (STN) is a widely used technique to treat patients with Parkinson disease (PD). PD has a range of motor symptoms including tremor and rigidity of motion, and there is high variability regarding motor improvement after DBS. The Unified Parkinson's Disease Rating Scale is used to evaluate various aspects of PD including motor and non-motor experiences to compare symptom improvement and side effects occurrence after DBS uniformly across patients. The goal of this research was to compare the midcommissural point (MCP) as an anatomical reference to the STN centroid and assess the relationship between stimulation location, which can be measured in various ways (electrode position and tissue activation overlap), and motor improvement in PD patients. This provides insight into the optimal location of DBS. Using the MCP as a reference does not consider the variability in brain structures across patients regarding individual STNs. Therefore, this research set out to compare stimulation location quantified using the MCP and STN centroid as a reference and its relationship with clinical outcome.

Katie Schadler '26

Faculty Mentor(s): Professor Michael Drexler, ENGLISH
Funding Source: College of Arts & Sciences

Reclaiming Repositories of Trauma in Alice Walker's Meridian and Toni Morrison's Beloved

Two prominent Black female authors Toni Morrison and Alice Walker have elicited much attention for their respective works on slavery, Beloved and The Color Purple. However, little scholarship has been written about Walker's lesser-known work Meridian, a novel about a young female freedom-fighter during the Civil Rights Movement. Beloved's Sethe is a former slave trying to bury the horrors of slavery that drive her to commit a paradoxical act of motherly love while Meridian is a community figure who must witness the structural violence within her town while grappling with the interpersonal violence of her past. Despite Meridian and Sethe being impacted by two distinctly different yet interconnected moments in history, both women are found in a state of incoherence by the end of the novels. Absorbing the anti-Black violence of their environments, Sethe and Meridian are forced to redefine what it means to love and be human when their lives are in a constant condition of disequilibrium. Meridian complicates the reading of Beloved by highlighting how the Black female body becomes a unifying site that physically and psychologically harbors the accumulation of trauma and violence. Utilizing the historical brutalization of the Black female form as a starting point for my research paper, I comparatively argue that Meridian and Beloved demonstrate the ways in which anti-Black dehumanization can destabilize seemingly "natural" perceptions of love, agency, and self-worth, leaving the Black female body to eventually cave in on itself.

Hannah Schultheis '24

Faculty Mentor(s): Professor Ellen Herman, GEOLOGY & ENVIRONMENTAL SCIENCES; Professor Molly McGuire, CHEMISTRY
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

An Analysis of Trace Metals in an Abandoned Mine Drainage Passive Treatment Site, PA

Abandoned mine drainage (AMD), defined by low pH and high concentrations of iron and toxic metals, is a contamination issue that impacts many watersheds across the country. To better understand the fate of trace metals in a passive treatment system designed to remove iron, water samples were collected at various points in both aerobic and anaerobic regions of the treatment site and analyzed for iron and trace metals in dissolved and colloidal phases. Iron precipitates occur primarily under aerobic conditions as iron oxyhydroxides, while aluminum precipitates in anaerobic conditions due to the increase in pH associated with limestone installed in the anaerobic portions of the treatment system. The trace metals generally follow a similar trend in precipitation as aluminum, most likely coprecipitating with the aluminum, with the exception of zinc, which could precipitate with sulfide instead. The iron precipitating in aerobic conditions drives the pH lower, inhibiting adsorption of the trace metals onto the iron. AMD is caused by water and air reacting with abandoned mines, transporting acid and toxic metals into waterways, harming the local environment. One way to mitigate these environmental impacts is with passive treatment. Passive treatment sites are implemented to remove iron and increase the pH. In Scarlift 15, a passive treatment site, AMD can react with oxygen to remove iron or travel through vertical flow wetlands (VFWs) made out of mushroom compost and limestone, which increase the pH and induce reducing conditions.

Jacob Severnak '25

Faculty Mentor(s): Professors M. Laura Beninati and Andrew Sloboda, MECHANICAL ENGINEERING
Funding Source: James L.D. and Rebecca Roser Research Fund

Flow-Induced Vibration of a Circular Cylinder Close to a Wall

Flexible bluff bodies exposed to a uniform fluid flow undergo vibration due to vortex-shedding from the body; this phenomenon is known as vortex-induced vibration. Cylindrical structures next to a planar surface can undergo strong vortex-induced vibrations. This includes structural members such as cables, conduits, and pipelines. These vibrations result in

structural stresses and can be a cause of failure. This research seeks to expand on current knowledge about the mechanism for the vibration of a cylinder in uniform fluid flow below a critical distance from a plane wall. A cylinder, mounted on two degree-of-freedom leaf springs, was placed in an open subsonic wind tunnel. Experiments were conducted with the cylinder at fixed distances from the wall, and acceleration data was collected from the two ends of the cylinder as it vibrated. This data was used to construct plots of the vibration frequency and cylinder displacement. The results of this study were consistent with theoretical expectations and earlier numerical models.

Lauren Shaffer '26; Olivia Schroeder-Positano '25; Skye Sunderhauff '25

Faculty Mentor(s): Professors Moria Chambers and Sarah Lower, BIOLOGY
Funding Source: Department of Biology

Challenges and Progress on Rearing the Common Eastern Firefly, Photinus Pyralis

During distinct life stages, an organism's immune system is expected to be regulated in different ways to optimize allocation of their energy and resources to important processes for that stage. For example, larvae may allocate more energy to growth and survival, while adults allocate more energy to reproduction. The common eastern firefly, Photinus pyralis, is an intriguing system to study stage-specific investment in immunity due to its relatively long-lived larval stage. P. pyralis spend 1-2 years in the larval stage, and only two weeks in the adult stage. However, P. pyralis larvae are difficult to find in the wild, and there has been limited success with rearing larvae in the lab. In this project, we collected male and female fireflies from two different locations near Lewisburg, Pennsylvania during summer 2023. We allowed them to mate in mating containers that contained one female firefly and two male fireflies, and then females laid eggs in the same containers. After the larvae had hatched, they were moved into petri dishes and ecoshoeboxes, which resembled their natural environment and included other organisms such as springtails, whiteworms, and isopods, to serve as a "clean up" crew by consuming any excess detritus and fungus in the box. Overall, we reared 196 larvae although none grew big enough for downstream immune studies suggesting further optimization of rearing is needed.Not only will these methods be able to inform immune investment studies, but also conservation efforts for these charismatic creatures.

Reva Sharma '25

Faculty Mentor(s): Professor Darakhshan Mir, COMPUTER SCIENCE
Funding Source: Program for Undergraduate Research

Assessing the Impacts of Algorithmic Relocations on the Mental Health of Incarcerated People

Driven by the belief that algorithmic decision-making possesses the potential to rectify flaws in human judgment, these technologies now undergird the very fabric of prison systems, influencing critical aspects, ranging from policing and bail decisions to sentencing and parole. However, entrusting individuals' fates to "black box" computer programs, which lack transparency, obscures whether these programs address such "flaws in human judgment." These algorithms exhibit concerning bias by disproportionately affecting people of color, especially Black individuals, leading to higher custody levels (with higher levels of security, less freedom, and privileges) and frequent transfers into solitary confinements. To gain deeper insights, our research examines data encompassing incarcerated individuals, provided by the Pennsylvania Department of Corrections (PADOC). The investigation aims to understand the impact of algorithmically-determined transfers on incarcerated individuals' experiences and mental health, taking into account potential disparities related to race, age, and gender.

Harry Shi '25

Faculty Mentor(s): Professor William Scott, MECHANICAL ENGINEERING
Funding Source: Helen E. Royer Undergraduate Research Fund

Gait Optimization and Steering Capable Design for Caterpillar-inspired Soft Robot

Soft crawling robots can potentially access locations that are unreachable by humans and traditional rigid robots. Due to their flexible body structures, they are less likely to cause damage to the environment or injure themselves when they fall. In this case, the soft crawling robots play a crucial role in conducting the missions like observing, monitoring, and even rescuing. Previously, our team developed a caterpillar-inspired soft robot with multiple segments that can crawl in one direction on a horizontal surface. This summer, we further optimized its crawling gait by increasing the thickness of its soft parts. In addition, we progressed on its structure and control architecture so that it has the ability to change the crawling direction actively. By the end of the project, the prototype with thicker 3D-printed soft bodies can store more elastic energy and allows the robot to lift its feet to better mimic the motion of the caterpillars. Furthermore, we developed a new segment structure, controlled by two separate motors, which can perform both bending and steering motion. When integrated into the improved caterpillar prototype, this steering segment enhances the robot's steering performance, enabling it to walk in multiple directions.

Nicholas Shopis '25; Craig Beal, PhD

Faculty Mentor(s): Professor Craig Beal, MECHANICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Vehicle Alignment Measured and Adjusted by Wheel Forces on Steer-by-Wire Systems

To optimize fuel efficiency and tire wear, all modern automotive vehicles have service intervals after which the front wheels are re-aligned. An offset alignment causes unwanted forces and moments on the wheels and steering system that reduce fuel efficiency and increase tire wear. An alignment procedure is normally done using a machine that can measure the angle of wheels, which are adjusted using mechanical linkages on the vehicle. New electronic steering systems, such as steer-by-wire, offer a new alternative to this angular alignment procedure. Since these steering systems can control the angle of wheels independent from the steering wheel position, the alignment

of the wheels can be done without adjusting mechanical links. By measuring forces on the wheels with onboard sensors, a relationship can be developed between them and the correct alignment angle of the wheel. A vehicle model was created and tested against an electric research vehicle equipped with a steer-by-wire system. The research vehicle was equipped with a set of wheel force transducers that were able to measure the forces and moments on the front wheels in all directions. It was found that adjusting the wheel angle to minimize both the rolling resistance and slip angle produced the highest increase in fuel efficiency and the largest decrease in tire wear. Additionally, this vehicle model serves as a bench block for an active alignment algorithm that can take real-time wheel force measurements and automatically adjust the steering systems based on these loads.

Edith Simpson (Graduate Student); Natalie Dyer '25; Lauren Shaffer '26; Meghan Catherwod '25

Faculty Mentor(s): Professors Moria Chambers and Sarah Lower, BIOLOGY
Funding Source: Department of Biology; Graduate Summer Research Fellowship

Interaction Between Diet and Bacterial Infection in the Common Eastern Firefly, Photinus Pyralis

Many people have fond memories of catching fireflies. However, climate change and human activity are disrupting their habitat. One of Pennsylvania's most abundant fireflies is the common eastern firefly, Photinus pyralis. Previously, the Chambers and Lower labs found that host body condition (mass/length), developmental location, and time of capture impact the ability of this firefly species to survive bacterial infection. These studies made the widely-held assumption that this species consumes no food as adults. In one study, P. pyralis was found on flowering plants, suggesting that the adult species may consume nectar. If adult P. pyralis eat, it could profoundly impact their immune response and influence which factors are important for fighting bacteria infection. To address these concerns, I assessed whether access to sugar water impacted firefly survival both with and without bacterial infection. We captured fireflies at three local sites and infected a subset with Serratia marcescens, a bacterial pathogen which causes significant mortality in this firefly species. Among the fireflies, half had access to 10% sucrose solution and half to water. We found that access to sugar water significantly increased survival in both controls and infected flies, with some fireflies in vials with sugar water living over eighty days while 55 days was the longest lived firefly housed with only water. This suggests that the fireflies are consuming the sugar water and benefiting. Future studies should assess whether factors that significantly impacted infection remain important when fireflies consume sugar water as this will help focus firefly conservation efforts.

Lauren Stettler (Graduate Student); Ryan Ziskin '26; Dr. Douglas Collins

Faculty Mentor(s): Professor Douglas Collins, CHEMISTRY
Funding Source: Department of Chemistry

Oxidation of Oleic Acid when Exposed to Gaseous Hypochlorous Acid and the Synergistic Influence of Added Benzo[a]pyrene

The functions and structures of fatty acids found on human skin are essential to the composition of the protective skin barrier. Skin diseases often result from structure disruption, which may be more likely due to the recent increase in use of bleach (HOCl) based disinfectants since COVID-19. To investigate the potential reactions between epidermal fatty acids and bleach, oleic acid was used to form thin films on glass surfaces, dried under N2 gas and placed in a glass flow tube reactor. Air was bubbled through a phosphate-buffered HOCl solution to liberate gaseous HOCl directed over the glass substrates for two hours. The resulting oxidation and chlorination products of oleic acid were investigated with a quadrupole time of flight mass spectrometer (Q-ToF) equipped with an atmospheric pressure chemical ionization source (APCI). All data collected was interpreted with the MassHunter Qualitative Analysis and Skyline software systems. As a chemical proxy for combustion-related air pollutants, benzo[a]pyrene (B[a]P) was added to the reaction mixture in a second set of sample films. The products resulting from the combined effects of HOCl and B[a]P on oleic acid were analyzed to understand the potential for different reaction pathways, with and without B[a]P. The chlorohydrin form of oleic acid was favored, specifically without B[a]P; in the presence of B[a]P the chlorohydrin of esterified oleic acid was favored. Further studies will look at reaction kinetics and the oxidized products of B[a]P.

Ian Straits '25; Lorelei Curtin; William J. D'Andrea; Nicholas L. Balascio; Martina Tingley; R. Scott Anderson; Stephen Wickler; Caitlin Walker; Gabe Westergren

Faculty Mentor(s): Professor Lorelei Curtin, GEOLOGY & ENVIRONMENTAL GEOSCIENCES
Funding Source: Program for Undergraduate Research

A Multi-Proxy Record of Climate Variability and Human Land-Use Impacts From the Lofoten Islands, Norway

The Lofoten Islands of northwest Norway, within the Arctic Circle, have a long history of Norse activity. The rapidly changing climate makes this an ideal location to better understand the interactions between natural climate variability and human activity. Lipid biomarker records derived from lake sediments of Lofoten, archive important environmental information, including expansion of Norse agriculture and an increase in fire frequency in the late Holocene (D'Anjou et al, 2012; Topness et al., 2023). Here, we present a 11.0 ky record of leaf wax n-alkane distributions from a sediment core from Ostadvatnet, a lake on the island of Vestvågøy. Leaf wax n-alkane distributions vary according to plant type; longer chain n-alkanes are sourced from terrestrial plants, shorter chains from aquatic plants. Leaf wax distributions in lake sediment can, therefore be used to understand variability in past vegetation. We compare these results to local pollen, PAH, and charcoal records from nearby lakes as well as an alkenone-based temperature reconstruction. We find a correlation between a n-C17 spike and an alkenone temperature spike in the early Holocene, meaning higher lake productivity and higher lake-surface temperatures. Evidence of human impact is found by looking at concentrations of n-C31 relative to n-C29 in the latest Holocene (3kya-present), which we attribute to a shift from woody to grassy taxa due to the influence of agriculture. This interval of greater inferred human land-use impact also correlates with an increase in regional fire activity documented by charcoal and PAH analyses (Topness et al., 2023).

Ibrahim Tahir '26; Amina Reyes '25; Timmy Facey '25

Faculty Mentor(s): Professor David Rojas, LATIN AMERICAN STUDIES
Funding Source: Program for Undergraduate Research

Race and Student Life @ Bucknell

My research report focuses on the racial and ethnic diversity at Bucknell University. It studies Bucknell's undergraduate student population numbers using statistics provided by the institutional research department and IPEDS (the Integrated Postsecondary Education Data System). The context of this research is the significant progress that higher education institutions in the United States have made in expanding access to populations that have been historically excluded from universities and colleges. In what follows I offer a quantitative analysis of race and ethnicity at Bucknell University that aims to provide a data-driven analysis of demographic changes at our institution. Bucknell's main contribution to society-wide efforts in higher education does not consist in increasing enrollment, but rather in making it possible for people of diverse backgrounds to become Bucknellian. Indeed, we often read and hear about Bucknell's ongoing commitment to diversity, especially after the dismantling of Affirmative Action in college admissions by the Supreme Court. My research elucidates the outcomes of Bucknell's diversity efforts by analyzing how the proportion of Black, Indigenous, and People of Color (BIPOC) within its student body has changed over the past decade. Moreover, I compare how BIPOC rates within Bucknell's student population compare with similar rates at peer institutions. Peer institutions are elite institutions that are less diverse than the national average higher education institution. Despite national diversification in higher education, Bucknell's BIPOC representation remains lower. While Bucknell is smaller and elite, it lags behind peer institutions. This study underscores the need for ongoing efforts to bridge diversity gaps, aligning with the broader national trend toward inclusivity in higher education.

Lea Tarzy '24

Faculty Mentor(s): Professor Brantley Gasaway, RELIGIOUS STUDIES

Is It Okay to Help Students Pray? A Constitutional Analysis of Chaplains in Public Schools

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof. Most analysts understand the First Amendment as requiring the separation of church and state while allowing for individual religious liberty. Though seemingly straightforward, the application of these principles is highly contested – especially in the context of public schools. The Supreme Court is often tasked with determining how to maintain a careful balance between avoiding religious establishments and protecting free exercise. The current posture of the Court and the convergence of recent rulings indicate an increasingly permissive attitude towards the commingling of religion and schools. The landmark cases of Kennedy v. Bremerton and Carson v. Makin in 2022 established a new era of the contemporary Court: protections for public school employees to exercise their religion on school grounds, and allowing the use of public funds for religious education. Since then, many states have proposed bills that allow religious symbols and practices in public schools, including requiring classrooms to display the Ten Commandments, mandating a daily moment of silence, and allowing teachers to pray during the school day. Perhaps most intriguing are policies permitting religious chaplains to serve as counselors in public schools. Already enacted in Texas, more than a dozen other states have recently proposed similar legislation. This presentation analyzes the constitutionality of these policies. I argue that allowing chaplains to work as counselors in public schools ultimately undermines the principles set forth in the Constitution.

Keeler Thomas '25

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Costa Healthcare Research & Design Fund

Role of White Matter Tissue Activation in Deep Brain Stimulation for Essential Tremor: A K-Means Clustering Approach

Essential tremor (ET) is a neurological movement disorder characterized by involuntary shaking of upper extremities. ET affects 1% of individuals worldwide and 5% of those older than 65. One treatment option for ET is deep brain stimulation (DBS), a surgical technique where implanted electrodes stimulate local brain tissue. The traditional implantation target for ET is the thalamus, a gray matter (GM) structure established to alleviate tremor when stimulated. Side effects associated with thalamic DBS include paresthesia (PAR) and motor contractions (MTR). Recent studies investigate a nearby white matter (WM) structure, the dentatorubrothalamic tract, as a more optimal stimulation target. The present study aimed to determine if increased WM tissue activation was associated with tremor reduction without side effects. 18 ET patients previously received thalamic DBS. Their therapeutic (THER) and side effect individualized volumes of tissue activation (VTA), previously modeled in COMSOL, were analyzed in MATLAB. Using diffusion tensor imaging data, k-means clustering was implemented to classify three main tissue types in the brain: cerebrospinal fluid, GM, and WM. Tissue activation was calculated for all clinical outcomes as the overlap with individualized VTAs. Percent of the VTA activating WM was compared across clinical outcomes using Wilcoxon rank sum tests. Activated WM tissue coordinates were compared using an ANOVA test across clinical outcomes. All clinical outcomes had similar percentages of WM activation. Comparing the coordinate location of activated WM tissue showed that all outcomes in x, y, and z-directions are significantly different, except between THER and MTR WM in the z-direction.

Ella Van Benschoten '24; Chris McFarlane; Jamey Jones; Christopher Daniel

Faculty Mentor(s): Professor Christopher Daniel, GEOLOGY & ENVIRONMENTAL SCIENCES
Funding Source: Clare Boothe Luce Research Scholarship

The Shaggy Peak Shear Zone: In-situ Rb/Sr LA-QQQ-ICP-MS Muscovite and Biotite Analyses Reveal Connection to Picuris Orogeny

The Shaggy Peak shear zone is a E-NE striking, moderately north-dipping, top-to-south, reverse-displacement ductile shear zone, located south of Glorieta Baldy peak, Santa Fe, New Mexico. The shear zone juxtaposes the Shaggy Peak granite in the footwall with supracrustal amphibolites and felsic schists

of the Thompson Peak metamorphic succession in the hanging wall. The Shaggy Peak granite yields a preliminary 207Pb/206Pb weighted mean crystallization age of 1687 ± 3 million years (Ma).

Near the contact between the granite and amphibolite, sheared granite displays an intense gneissic foliation with grain size reduction. Thin section observations reveal C-S and C′ foliation with top-to-south, reverse shear sense. The S-plane is defined by aligned quartz grains and the C-plane is defined by aligned muscovite grains. C′ is characterized as shear bands. Amphibolite near the contact preserves an intense foliation but no obvious shear sense. Felsic schist adjacent to amphibolite exhibits intense foliation. Thin section observations reveal C-S and C′ foliation with top-to-south, reverse shear sense. The C-plane is defined by alignments of muscovite grains and the S-plane is defined by aligned quartz grains. C′ is defined by kinked and sheared muscovite.

Muscovite and biotite rubidium-strontium analyses from in-situ LA-QQQ-ICP-MS yield ages between 1332 and 1362 Ma for muscovite and a maximum age of 1332 Ma for biotite. These dates are similar to U–Th-Pb monazite-xenotime chemical ages previously reported for the area. We interpret N-S to NNW-SSE contractional deformation in the Shaggy Peak shear zone to be associated with the 1430-1350 Ma Picuris Orogeny.

Matthew Van Bloem ’25

Faculty Mentor(s): Professor Haley Kragness, PSYCHOLOGY

Funding Source: Program for Undergraduate Research

Rhythmic Recall: Short-term Memory Recall of Sensorimotor Synchronization

The ability to move your body in time with a sensory input (such as music) develops substantially across the first 10 years of life. Previous research has demonstrated that children vary substantially in their ‘sensorimotor synchronization’ abilities, but no previous studies have examined the potential relationship with auditory memory (which also develops substantially in early childhood). In this study, we investigate 5- and 6-year-old children’s ability to align with, remember, and reproduce musical tempos. The project examines two questions: (1) does song familiarity influence children’s ability to align with and reproduce a tempo?, and (2) does children’s tempo alignment ability predict their tempo reproduction ability? Children are presented with a video game asking them to tap on their laptop to six Disney songs (3 likely to be familiar, 3 likely to be unfamiliar) under two conditions: first, along with the music, and second, in their head once the music stops. Each song falls under three tempo conditions (slow, medium, fast), totaling in six different tracks. Their tapping data is recorded and analyzed. We hypothesize that participants will tap along more accurately to familiar songs. Additionally, we expect that the more accurate participants are at tapping along to the song, the better they will be at reproducing that tempo without the music present. Results will clarify the role of familiarity and auditory memory in children’s developing sensorimotor abilities.

David Venuti ’25; Brian Heist; Jacquelyn Gerhart; Keith Mathers; Cathy Hatcher; Steven Morency; Joseph Richards, Jr.; Mindy George-Weinstein

Faculty Mentor(s): Jacquelyn Gerhart, LAB COORDINATOR, PHILADELPHIA COLLEGE OF OSTEOPATHIC MEDICINE

Funding Source: Thomas Spitzer Undergraduate Research Fund

The Role of MyoD in Myofibroblast Differentiation in Explants of Human Lens Tissue

Visual impairment in posterior capsule opacification (PCO) is primarily caused by myofibroblasts in lens tissue. Post-cataract surgery, myofibroblasts are derived from Myo/Nog cells expressing skeletal muscle specific transcription factor MyoD, bone morphogenetic protein inhibitor noggin and brain-specific angiogenesis inhibitor-1 (BAI1). We tested whether MyoD was required for Myo/Nog differentiation into myofibroblasts.

Anterior lens tissue obtained from cataract patients was incubated in MyoD1 siRNA. Double-label immunofluorescence localization was performed with MyoD antibodies, BAI1, noggin, alpha-smooth muscle actin (α-SMA), myosin and Ki67. Differential interference contrast microscopy quantified capsule wrinkles.

MyoD, α-SMA and myosin were present in most BAI1 and Noggin-positive Myo/Nog cells but absent from lens epithelial cells (LECs) in controls. MyoD was detected in <1% of siMyoD treated cells. MyoD knockdown increased number of Myo/Nog cells 3-fold parallel to a Ki67 labeling increase. MyoD siRNA effect on α-SMA was variable. Few Myo/Nog cells contained detectable myosin levels with MyoD knockdown. In controls, areas denuded of LECs were surrounded by myofibroblasts and contained capsule wrinkles. Myo/Nog cells lacking myosin surrounded epithelium holes in explants treated with MyoD siRNA; capsule wrinkles were significantly reduced. LECs were unaffected by MyoD siRNA.

Michelle Vovsha ’24; Dr. Moria Chambers; Dr. Sarah Smith

Faculty Mentor(s): Professor Moria Chambers, BIOLOGY; Professor Sarah Smith, CHEMISTRY

Funding Source: Cell Biology and Biochemistry Undergraduate Research Fund

Assessing the Anti-bacterial Activity of Photinus Pyralis CecX

Antibiotic resistance continues to be a worldwide concern with more than 2.8 million antibiotic-resistant infections occurring in the United States each year. Antimicrobial peptides (AMPs) are found in the innate immune system of various organisms and are a potential solution. Cecropins, a type of AMP found in insects, are promising for human therapeutics due to their anti-inflammatory activity and low toxicity against mammalian cells. A novel cecropin, CecX, was recently identified in the common eastern firefly, Photinus pyralis, and by assessing its antimicrobial activity we can learn more about its potential as a human therapeutic. To assess the relative potency of CecX, we determined the minimum concentration of peptide needed to inhibit the growth of multiple bacterial species in liquid culture. These species included Escherichia coli, a commonly tested bacteria in antimicrobial assays, Providencia species isolated from insects and species exhibiting concerning

levels of antibiotic resistance in clinical settings (subset of ESKAPE pathogens: Staphylococcus aureus, Pseudomonas aeruginosa, Enterococcus faecalis). We found that CecX is able to inhibit multiple bacterial species including some of the ESKAPE pathogens. We are currently assessing how quickly CecX kills bacteria, which will inform future studies using scanning electron microscopy (SEM) to visualize how CecX alters membrane architecture as cecropins are thought to kill through forming pores in bacterial membranes.

Ryan Walker '24; Edith Simpson; Aidan Sullivan '25; Sarah Townsend '24; Owais Gilani; Moria Chambers; Sarah Lower

Faculty Mentor(s): Professors Moria Chambers & Sarah Lower, BIOLOGY
Funding Source: Department of Biology; Pennsylvania Firefly Festival and the Pittsburgh Foundation

Illuminating Immunity: Analyzing Resistance to Serratia Marcescens Infection in the Common Eastern Firefly

Insect immunology studies are powerful tools to not only identify novel antimicrobial compounds for combating antibiotic resistant human infections, but also focus conservation efforts for certain threatened insect species. Despite this, some insect groups, including fireflies, are understudied. Our study investigated factors, such as resistance, time in the season, and body condition that influence how the common eastern firefly, Photinus pyralis, responds to pathogenic bacterial infection. Fireflies were captured at three sites and injected with Serratia marcescens, a bacterial strain found in the environments where fireflies spend most of their time. To assess resistance, fireflies were monitored for survival and a subset were sacrificed to determine bacterial load after infection. To determine how infection impacts body condition, each firefly was weighed and imaged both before infection and after death. We found that fireflies captured early in the season and with good body condition (high mass:length ratio) resisted infection better. This suggests that environmental changes that negatively affect body condition may make firefly populations more susceptible to new infections. While most fireflies lost mass between capture and death, the rate of decline was not impacted by infection suggesting depletion of energy stores is not the cause of early death during infection. Improved survival due to good body condition may instead be due to the ability to mount a stronger initial immune response. Future work can build on these findings by identifying native bacterial infections of fireflies and assessing whether these infections have a similar relationship with body condition and seasonality.

Kerong Wang '24; Professor Keegan Kang

Faculty Mentor(s): Professor Keegan Kang, MATHEMATICS
Funding Source: Startup fund for Professor Keegan Kang

Improving Hashing Algorithms with Linear Maximum Likelihood Estimators

Sign random projections (SRP) is an algorithm that allows the user to quickly estimate the angular similarity and inner products between data. SRP with Maximum Likelihood Estimation (MLE) is an improved algorithm based on MLE that is theoretically more accurate than SRP. However, it suffers numerical error when optimizing likelihood functions and it's time-consuming. We propose an improved algorithm, Linear MLE, that only involves linear calculation when optimizing likelihood functions so that the algorithm is computationally more efficient and accurate. Our proposed algorithm also gives users the freedom to choose the number of bits of information to store so that the computation time and the estimation accuracy are in control. We demonstrate the effectiveness of our method on the MNIST test dataset and the Arcene dataset. We discuss how our method can be generalized to weighted MLE estimators and weighted control variates to further improve the accuracy.

Zachary Wasserman '26; Haley E. Kragness

Faculty Mentor(s): Professor Haley Kragness, PSYCHOLOGY
Funding Source: Helen E. Royer Undergraduate Research Fund

Beliefs About Musical Attributes

Though people dance, sing, and interact musically all across the world, there is substantial individual variation in musical abilities. What do children and adults believe about where musical abilities come from? We investigated 7- to 8-year-old children's (N = 48) and adult's (N = 100) beliefs about origins of musical abilities. First, children gave open-ended explanations based on prompts about musical and non-musical attributes ("There is a person who is very good at playing cello. People always clap when they play. Why do you think they are good at playing cello?"). Then, both adults and children were asked to rate how much genetic factors, environmental factors, and personal choices explained those same attributes (1 - "not at all" to 5 - "just about all"). In open-ended explanations, children tended to emphasize personal choices (e.g., "he practices a lot"). For positively-worded scale ratings, adults consistently rated personal choices highest and genetic factors lowest in importance, but again considered genetic factors to be relatively important for singing and rhythmic abilities. For negatively-worded questions, adults rated the environment highest for some of the characteristics, the outliers being singing and cello being highest in genetics and personal choice respectively. In contrast, children consistently rated environmental factors as least important, and rated genetic and personal choice factors as approximately equally important. Findings suggest that children and adults both emphasize practice and personal effort in musical skill acquisition. By adulthood, however, adults refine their beliefs about the relative importance (or unimportance) of genetic contributions to musical attributes.

Devin Whalen (Graduate Student)

Faculty Mentor(s): Professor Peter Jansson, ELECTRICAL & COMPUTER ENGINEERING
Funding Source: Graduate Summer Research Fellowship

Empowering Homes: The Future of Energy Management with Self-Sustaining Power Harvesting Sensors

Microgrids are localized, independent power grids that can operate while connected to the larger electrical grid. These systems make intelligent decisions regarding power management, and they use an array of components to monitor power generation, consumption, and environmental conditions. While this technology can save end users money, the complexity of installation and maintenance has limited the adoption of

microgrids in residential spaces. To simplify this technology for end users, the next evolution of microgrid components includes sensors and controls that are wireless and ambiently powered. Even with a microgrid installed, significant energy is wasted in residential spaces. To address this loss, energy harvesting circuits can be incorporated into microgrid components, enabling them to recapture otherwise wasted environmental energy. Light, heat, radio frequency (RF) energy, and mechanical energy are all abundant in most residential spaces. Microgrid components that can be reasonably powered using energy harvesting include controllers and sensors. Equipping these components with energy harvesters simplifies the end user experience by eliminating the need to route power cables. Implementing energy harvesting techniques may result in residential microgrid systems that are easier to deploy and require less maintenance.

Madeleine Whitsitt '25; Naomi Malone '25; Brian J Smith; Elizabeth Xia '26; Ellie Lowe '23; Elliott Kilgallen '26

Faculty Mentor(s): Professor Brian Smith, CHEMISTRY
Funding Source: Department of Chemistry

Selective Acetaminophen Polymorphism Crystallization Using Environmental Control and Additives

Polymorphism is the ability of a molecule to crystallize in more than one crystal structure. These polymorphs – crystal structures composed of the same molecule, but aligned in different packing orientations – exhibit different properties such as solubility and compressibility. This means that they may act differently in the body in terms of bioavailability. Thus, polymorph selectivity has become a vital part of the pharmaceutical development and formulation process. Several factors impact selective polymorph crystallization, including environmental conditions and the use of additives in the polymorph mixture. Acetaminophen, the active ingredient in Tylenol, is an example of a polymorphic compound with three well-characterized forms. Here, we use acetaminophen as a model to show the impact of the recrystallization environment on polymorph selectivity. We show that some acetaminophen polymorphs, otherwise difficult to prepare, can be preferentially nucleated during the melt crystallization process when humidity is controlled. The inclusion of additives can play a similar role in preferentially nucleating one form of acetaminophen versus another.

Elizabeth Williams '25; Melody P. Sain; Scott Schuette; Christopher T. Martine

Faculty Mentor(s): Professor Chris Martine, BIOLOGY
Funding Source: David Burpee Endowment; Manning Intern Botanical Science; PA Wild Resource Conservation Program

Assessing the Genetic Diversity of Aconitum Reclinatum (Ranunculaceae), a Rare Pennsylvania Wildflower

High genetic diversity in populations allows for increased resilience and adaptability to changing environmental conditions. Establishing the level of genetic diversity for rare plant species is important in developing conservation strategies. Aconitum reclinatum is a globally at-risk flowering plant species belonging to the family Ranunculaceae. It is critically imperiled in Pennsylvania, with only two extant locations remaining. Its primary threats are the disturbance of wetlands, clearing of forested land, and deer browsing. The species range spans parts of West Virginia, Virginia, and North Carolina with Pennsylvania populations occurring at the northernmost edge of the species range. Edge populations often have higher genetic diversity than central populations due to gene flow from neighboring populations. However, if they are isolated by distance there may be decreased genetic diversity. Therefore, in collaboration with the Pennsylvania Natural Heritage Program, we aim to assess the health of range-wide A. reclinatum populations utilizing population genomic methods to determine genotypic variations among and within populations. I have performed genomic DNA extractions and quality control of dried leaf material which will be used for genotyping-by-sequencing (GBS) data. Future population genomic analyses of the GBS data will be used to assess the standing genetic variation within and among A. reclinatum populations. The results of this study will allow for informed decision making regarding the best species recovery and conservation plan for this rare wildflower.

Anna Marie Wingard '25; Michael Drexler

Faculty Mentor(s): Professor Michael Drexler, ENGLISH
Funding Source: Mellon Student Summer Research Fellowship (through the Bucknell Humanities Center)

Exploring Feminine Expression and the Aftermath of Gender-Related Trauma in Romantic Literature

This study delves into the intricate interactions between expressions of traditional femininity and the psychological complications of gender-based trauma in Romantic literature. Through a nuanced analysis of Mary Shelley's "Valperga" and "Matilda," alongside Julia Ward Howe's "The Hermaphrodite," this research project investigates how characters negotiate societal expectations, complex desires, and traumatic experiences shaped by gender roles.

In "Valperga," the protagonist Euthanasia exemplifies a blend of feminine and masculine traits as she grapples with the conflict between political loyalty and love. Her ultimate demise underscores the struggle of individuals occupying undefined spaces within the Symbolic order. Similarly, Matilda's narrative unveils the consequences of patriarchal dominance, leading to her self-destructive behavior rooted in complex and taboo love and the ensuing emotional turmoil.

Contrasting traditional gender binaries, ""The Hermaphrodite"" explores the journey of Laurence, an intersex individual navigating identity and societal expectations. Laurence's liminality disrupts conventional norms, prompting questions about belonging and acceptance within the Symbolic order.

By applying Lacanian psychoanalysis, this research illuminates how rigid gender roles perpetuate emotional dependency and traumatic experiences. The analysis highlights the need for greater flexibility and diverse representation to address the shortcomings of the Symbolic order. Recognizing the complexities of gender expression is crucial in fostering healing and empowerment for individuals grappling with trauma-induced narratives.

This study contributes to a deeper understanding of gender dynamics in literature and advocates for transformative narratives that transcend traditional binaries, offering avenues for healing and agency in the face of trauma.

Kevin Wu '25

Faculty Mentor(s): Professor William Scott, MECHANICAL ENGINEERING
Funding Source: College of Engineering

Development of Soft Gripper for Caterpillar-inspired Robot

This project is designing a caterpillar-inspired robot that can climb on pipes or branches. The project involved creating 3D models of clamps and brackets using Solidworks and Ultimaker Cura, and printing hard and soft parts using PLA and Filaflex respectively. The force sensors are connected to the Arduino board to collect force data, which is analyzed using Matlab. The N20 motor is used to activate and reset the grippers and pull up rigid parts of the body to deform. The design process involved exploring different gripper and body designs, including those with flat and curved stems as well as fin ray designs. Finally, data were collected to evaluate the force ratio metrics and ideas for future development were presented. In this project, we aim to create a gripper with the highest force ratio and coordinate the body with the gripper to help to robot climb on the pipes. In the experiment, we measured the four forces of each gripper and find the parameters that have the most positive effect on gripping and extracting force and the most negative effect on less closing and opening force which helps the grippers work much better helping caterpillar robots to move, climb and hang. The force required to pull up the body was also measured and analyzed with position.

Emma Yorke '26

Faculty Mentor(s): Professor Gulay Guzel, MARKETS, INNOVATION & DESIGN
Funding Source: Freeman College of Management

The American Dream: Divergence Between Class, Race, and Gender

The term "American Dream" encompasses diverse notions of economic and social success in the United States, rooted in the ideals of the Declaration of Independence. However, its meaning has evolved over the centuries. This project investigates contemporary perceptions of the American Dream and its evolution, questioning its tangibility in modern society.

Using primarily questionnaire-based research, we surveyed college students from various universities nationwide, representing diverse socioeconomic, gender, and racial backgrounds. The questionnaire explored current perceptions of the American Dream and the attributes associated with achieving it. Additionally, we plan to augment our data collection through in-depth interviews and archival research.

Our objective is to gain a deeper understanding of the modern interpretation of the American Dream. Initial findings suggest that historical trends persist, with white males often viewed as the quintessential embodiment of the American Dream. However, our analysis also reveals nuanced perspectives on the attainability of this concept across different demographic groups, considering factors such as the cost of living and efforts to enhance gender and racial diversity in the workforce. Our research sheds light on how individuals from diverse backgrounds interpret and pursue the American Dream in contemporary society.

David Youn '26; Brooke Griffin '26; Brian Garthwaite; Ibrahim Sulai

Faculty Mentor(s): Professor Ibrahim Sulai, PHYSICS & ASTRONOMY
Funding Source: National Science Foundation Grant (NSF); James L.D. and Rebecca Roser Research Fund

Development of Induction Coil Magnetometers for a Dark Matter Search

Dark matter and dark energy make up over 90% of the observable universe. That is, over 90% of the universe is unknown and cannot be seen or measured directly. Since the discovery of the dark matter problem, several theories regarding the composition of dark matter, or candidates, have been formed. The difficulty in confirming these candidates is that dark matter is so far only observable indirectly via its gravitational effects. This past year, we measured Earth's magnetic field with the intent of measuring a signal related to the Dark Photon and the Axion, both dark matter candidates. With collaborators across the country, we hope to either detect these dark matter candidates or constrain their parameter space. To make such a measurement, we employed magnetic field sensors capable of detecting low-frequency, low-power signals. An induction coil magnetometer was the suitable choice because the principle of its functionality allows us to measure oscillating signals from 1 kHz to nearly constant magnetic fields. Furthermore, by modifying the physical properties of the magnetometer, we can detect changes in Earth's magnetic field of around a femtotesla (10^-15 T) – or about 10^9 times smaller than Earth's ambient magnetic field. Since May of 2023, we have spent time developing and characterizing our sensors both up to and since our initial measurement made in late July of 2023. By our next measurement later this summer, we will have a fully realized sensor that is low-noise and synchronous with other sites around the country.

Angela Ziganshina '25

Faculty Mentor(s): Professor Charles Kim, MECHANICAL ENGINEERING
Funding Source: James L.D. and Rebecca Roser Research Fund

Stroke Rehab Using Negative Stiffness Compliant Shell Mechanisms

The goal of this project was to characterize, verify, and optimize compliant shell geometry that exhibited prolonged negative stiffness. Because research into devices exhibiting negative stiffness is limited, this project added to basic scientific knowledge about such mechanical structures and added to the field's understanding of them. In addition to this, this research worked towards helping patients in stroke rehabilitation in their journeys of recovery. The approach to this project was greatly motivated by the need for negative stiffness within a rehabilitation device. This is precisely what maximizes the efficiency of repetitive rehabilitation exercises, such as bending of the fingers for hand recovery after a stroke, which was my focus.

Diamanda Zizis (Graduate Student); Chris Martine; Melody P. Sain; Tanisha Williams
Faculty Mentor(s): Professor Chris Martine, BIOLOGY
Funding Source: Department of Biology; David Burpee Endowment

Heading for a Breakdown: Assessing Evolution through the Hybridization of Two Sexual Systems

Hybridization is an important evolutionary pathway that has contributed to the world's vast biodiversity. Hybrid seeds were acquired from crosses between Solanum dioicum (dioecious) and S. ultraspinosum (andromonoecious). The only successful hybrids from the original crosses were those derived from S. dioicum as the pollen donor and S. ultraspinosum as the pollen recipient. Due to strong maternal effects, all F1 hybrids resembled S. ultraspinosum, thus all F1 plants were andromonoecious. A series of statistical analyses were conducted based on morphometric data with a focus on sexual characteristics. A principal component analysis confirmed that the hybrids were distinct from both parents, but were most similar to the pollen recipient. The F2 hybrids demonstrate variability in inflorescence architecture, which may be suggestive of a change in sexual system. The F3 hybrid inflorescences were widely aborted, with a few inflorescences displaying mostly cosexual flowers, suggesting a possible switch to cosexuality. In both attempts to create an F3 and F4 generation, nearly all of our crosses have failed—suggesting that a hybrid breakdown is occurring. Fluorescent microscopy was used to determine the mechanism of hybrid breakdown in the F3 generation, although the lack of flower growth presents challenges to the F4 generation. This study should promote a better understanding of hybridization—a driving force in plant diversification—among Australian Solanum, a group in which hybridization is known to be widely possible but rarely confirmed in nature. Likewise, hybridization between taxa with two distinct sexual forms may shed light on the evolution of reproductive strategies in this clade.

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