22nd ANNUAL

KALMAN

RESEARCH SYMPOSIUM

SATURDAY,
APRIL 1, 2023

Bucknell
UNIVERSITY

KALMAN RESEARCH SYMPOSIUM

INTRODUCTION

Spring 2023

Welcome to the twenty-second 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:

- Botanical Society of American Undergraduate Research Grant
- Bucknell Institute for Public Policy
- Bucknell Program for Undergraduate Research
- Cell Biology & Biochemistry Undergraduate Research
- Chemistry Graduate Research Fund
- College of Engineering
- D.D. Burpee Plant Fund
- Department of Biology
- Department of Chemistry
- Douglas K. Candland Undergraduate Research Fund
- Dr. Glenn A. Moser '69 Chemistry Master's Research Fund
- Fund for Undergraduate Research in Biological and Chemical Sciences
- Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities
- Geology Undergraduate Research
- Graduate Summer Research Fellowship
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- Joann E. Walthour Undergraduate Research Fund
- Kalman Fund for Biomedical Research Fellows
- Kalman Fund for Undergraduate Research in the Sciences
- Mellon Humanities Academic Year Research Fellowship for Faculty-Student Collaboration
- Michael Baker Jr. Summer Research Program
- NASA Artemis Student Challenge Grant
- NASA Solar System Workings Program and NSF's S-STEM Program #1742124
- National Institutes of Health

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

- National Science Foundation Grant (NSF)
- Pennsylvania Firefly Festival and the Pittsburgh Foundation
- Presidential Fellowship
- Program for Undergraduate Research
- Robert P. Vidinghoff Memorial Summer Internship
- Ruth Everett Sierzega Chair in Linguistics
- Schotz Family Interdisciplinary Fund
- Stephen Glenn Hobar Memorial Research Award
- Summer Research Award 2022
- Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences
- The Katherine Mabis McKenna Environmental Internship Program
- The Pittsburgh Foundation
- Torrey Botanical Society Undergraduate Research Fellowship
- US Forest Service
- Wayne Manning Internship Fund

Marisa Alkalay ‘23

Faculty Mentor(s): Professor Erica Delsandro, Professor Bill Flack, PSYCHOLOGY
Funding Source: Program for Undergraduate Research

Campus Sexual Assault: All-Male Organizations, Party Culture, and Rape Myths

Since college women are particularly vulnerable to sexual violence, it is essential to understand the knowledge and beliefs that students have about sexual assault. Numerous studies explore how college students, particularly members of Greek life, exhibit harmful attitudes and behaviors that contribute to the alarming prevalence rates of Campus Sexual Assault (CSA). The purpose of this study was to examine the mutually reinforcing relationship between all-male organizations (i.e. Greek life), party culture (gendered social scripts, drinking, and hook-up culture), and rape myths.

This study used a mixed-methods approach, including a survey and interviews. Survey results revealed that female students rejected rape myths and were more educated on effective consent compared to male students. Although members of Greek life drank significantly more than their non-affiliated counterparts, fraternity members were more likely to reject rape myths compared to non-affiliated men, suggesting that members of Greek life may have more experience with sexual assault awareness and education. Information from the interviews revealed important themes (e.g perceived prevalence rates and the power of fraternities) and captured nuances regarding subtle rape myths that are difficult to capture in a survey.

The data from this study demonstrates the need to address problematic behaviors and beliefs of college students. Improvements to sexual assault education and further research regarding rape myths will help diminish rape-supportive attitudes, and subsequently decrease the prevalence of CSA.

Will Amrhein ’24

Faculty Mentor(s): Professor Keith Buffinton, MECHANICAL ENGINEERING
Funding Source: College of Engineering, Presidential Fellowship

Development of Pneumatic Valves for Soft Robotic Arm

Soft robotics is a relatively unexplored field of engineering, yet it has the potential to be used in a wide variety of applications. The defining characteristic of a soft robotic mechanism is its ability to be flexible and gentle, which gives huge advantages when dealing with fragile objects and biological organisms. Because of the novelty of this field, an optimal control system for a soft robotic arm has not yet been established. Previous approaches include connecting pressure sources through flexible tubes to each individual actuator, called FREEs (Fiber Reinforced Elastomeric Enclosures). Each tube carries a variable pressure produced by a pressure regulator at the base of the arm, giving the operator precise control over the movements of each FREE. However, the thick tubes going to each segment of a full robotic arm would add significant extra stiffness and decrease the flexibility of the arm. This project focused on the development of a different solution that uses individual valves on each segment that control the airflow to each FREE from a central supply tube with the valves controlled pneumatically with thin, capillary tubes. A membrane inside the valve allows air to flow when the pressure is low in the capillary tube but stops the flow when the pressure is high. In this way, the valve works similarly to a transistor, allowing a small flow tube to control a high flow output.

Q Andrews ’24

Faculty Mentor(s): Professor Jaye Austin Williams, CRITICAL BLACK STUDIES, AFFILIATED FACULTY THEATRE & DANCE
Funding Source: Douglas K. Candland Undergraduate Research Fund

The Round Table: A Play for Black Intellectuals

This summer I worked with Professor Jaye Austin Williams of the Critical Black Studies department on understanding and detailing the intricacies of black playwriting while answering some of my research inquiries. Namely, what is a black intellectual? After my previous summer of work, I had come to the conclusion that black art was something I wanted to center myself on and black playwriting is completely different from normal playwriting. My work consisted of reading, writing, editing, and revising my own play to accurately portray Black lives, including those with which I am unfamiliar. Blackness, the entity, and the trait is vibrant and historically undefined. I spent much of my time asking Black people, of separate faith and mindset, how they exist and thrive at a predominantly white institution like Bucknell. My play is meant to bring life to an idea of possible conflict where black students tiptoe, hurdle, and stomp through their volatile collegiate careers despite the coliseum of white antagonism. I was influenced by black civil rights activists, black fraternities and sororities, black church culture, the Black Panther Party, and black athletes. My Black legends. Each group and its subclasses had a particular approach to opposing oppression and white supremacy within the country. Throughout this process, I gained a better understanding of the delicacy and accuracy required of writers and directors to produce veracious plays. This project expanded my theatrical mind and inspired me to focus my vision further on detailing Blacks and our complicated domestication.

Maliheh Azimi Roueini, Graduate Student

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

A Microfluidic Biosensor to Detect a Specific Respiratory Pathogen

The end goal of this project is to prototype a biosensor that provides a low-cost and real-time diagnosis of Moraxella catarrhalis at the point of care. Moraxella catarrhalis as a respiratory pathogen is responsible for 3-4 million cases of otitis media among children annually, with an associated healthcare cost of $2 billion each year. To achieve the goal of the project, we designed a microfluidic biosensor because it can decrease analysis time, work with small samples, and increase sensitivity. We designed micropillar arrays on the working electrode because micropillar arrays improve the interaction between target molecules and the surface and decrease the limit of detection and the time of detection.

Moreover, they provide a much larger surface area than the planar electrodes with the same projected area. In this study, COMSOL Multiphysics was utilized in order to design the microfluidic biosensor and make decisions about the number and the shape of the micropillars. We designed two different micropillar arrays (I-shaped micropillars and cylindrical micropillars) on the working electrode and compared their current response to optimize the working electrode. Designing dimensions of the micropillars, spacing between them, and the dimension of the working electrode are the other steps that were designed during the project. Additionally, the sensitivity of the biosensor was calculated by Cyclic voltammetry numerically. After completing the working electrode, the microfluidic channel was designed and fabricated. To fabricate the channel, we produced a mold with a CNC milling machine and then fabricated it with PDMS as a polymer.

Christian Baccay ’23

Faculty Mentor(s): Professor Reggie Gazes, ANIMAL BEHAVIOR, PSYCHOLOGY

Funding Source: Fund for Undergraduate Research in Biological and Chemical Sciences

Verification of Scratching as a Behavioral Marker of Stress in Tufted Capuchin Monkeys (Cebus [Sapajus] apella)

For social primates, interactions between conspecifics have the potential to cause or relieve stress. Stress is a biological response that can be measured by behavioral or physiological changes. From a behavioral standpoint, self-scratching has been reported to be a stress marker in several nonhuman primate species. Our goal was to assess the validity of scratching behavior as a stress marker in a group of tufted capuchin monkeys (Cebus apella), using both social-behavioral and physiological measures. We explored this relationship across three levels. First, we determined the relationship between scratching and behavioral measures to determine if monkeys in more stressful social situations, such as recipients of aggression, would show higher scratching rates. Second, we determined whether individual scratching rates were predicted by a monkey’s hair cortisol. Hair cortisol provides a measurement of physiological stress over a prolonged period and can be used to measure an individual’s chronic physiological stress. Finally, scratching behavior over a short period was compared with salivary cortisol. Salivary cortisol represents an acute cortisol measurement and can be used to measure a rapid physiological response to a particular stressor. Few studies have directly compared the relationship between cortisol levels and rates of scratching and fewer studies have been conducted on tufted capuchin monkeys. While our study is still ongoing, we hope to use our data to clarify the relationship between self-scratching and physiological stress in tufted capuchin monkeys.

Samuel Barnes ’23

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

Funding Source: Bucknell Program for Undergraduate Research

Characterizing the Motion of a Ball Under a Fluid Jet: Chaos or not?

When a ball is placed on a flat surface under a fluid jet, it becomes trapped and moves in an erratic fashion about the center of the jet. The erratic motion of the ball has been hypothesized to be chaotic. This project was conducted to characterize the motion of the ball and understand under what conditions different types of motion may occur. This required designing an apparatus that allowed for tracking the position of the ball while moving underneath a tap. This involved determining effective computer tracking software, creating a camera setup, designing a fluids delivery system, and collecting data.

The fluids apparatus had two different water delivery methods and various exit orifices that allowed for multiple different types of flow to be observed. Data was collected for each type of flow for one-directional position data (one camera), and for a few types in two dimensions (two orthogonal cameras).

The data was processed to analyze its frequency content and plot its trajectories in state space to reveal the chaotic nature of the data (if any). A specific type of shape would be created by chaotic data, called a strange attractor. However, in one dimension the data mostly implied the ball was just circling the flow stream. By changing the flow stream more noise was picked up in the data, indicating that one dimension was insufficient, and more information was needed from a second camera.

Clare Bassano ’23

Faculty Mentor(s): Professor Kris Trego, CLASSICS & ANCIENT MEDITERRANEAN STUDIES

Funding Source: Mellon Humanities Academic Year Research Fellowship for Faculty-Student Collaboration

A Study of an Ancient Oil Lamp: Iconography, Glazing and a Human Connection

In 2019, late emeritus Professor James Turnure (Samuel H. Kress Professor of Art History) donated a sizable collection of ancient artifacts, including seventeen ancient oil lamps. These lamps were unstudied prior to their donation, and the overall long-term research goal of this project is to properly publish the artifacts and make their data accessible to the international archaeology community. Oil lamps were widely used in the Ancient Mediterranean world, and since they were often used by those who were not well represented in the written records we have from their time, oil lamps and other ordinary objects can shed light on the daily life of underrepresented people. One of Turnure’s donated lamps, which is the focus of this study, has two nozzles and plant imagery on its discus. This lamp was drawn, measured, photographed, and described. Such careful examination and documentation of the physical characteristics of this lamp and looking through the records of documented collections of ancient oil lamps allow for conclusions about the lamp’s creation, including estimates of the lamp’s age and region of origin. Studying the iconography on the lamp can connect it to other ancient pieces of pottery. Details like the lamp's imperfect glazing and the marks of fingerprints left on the lamp's walls also give the lamp a human element. This kind of connection to the people who created or used an artifact is perhaps most easily seen through once mundane, small objects like oil lamps.

Michael Bolish '23

Faculty Mentor(s): Professor Katharina Vollmayr-Lee, PHYSICS & ASTRONOMY
Funding Source: National Science Foundation Grant (NSF)

Stress Analysis of a Sheared Athermal System with Pins

Numerous studies have investigated the jamming transition in granular media. Recent research has indicated that quenched disorder in the form of fixed pins provides additional stabilizing forces to the system, which causes the jamming threshold to decrease and therefore provides a fourth degree of freedom in the jamming transition. Using molecular dynamics simulations, we study a two-dimensional, granular system subjected to a wall-driven flow in the vicinity of jamming in order to understand how pins affect the dynamics of the system. We implement a shear by freezing the top and bottom of the binary mixture and moving the walls at a constant shear rate. The system is a 50:50 binary mixture with purely repulsive harmonic interactions of size ratio 0.004:1:1.4 of pins:small: large particles. Pins are located on a square lattice. We will present results concerning shear stress and pressure as a function of packing fraction and strain rate. We will also show preliminary results for the statistics of the shear stress as a function of time.

Brianna Bolorin '24

Faculty Mentor(s): Professor Sarah Smith, BIOCHEMISTRY/CELL BIOLOGY, CHEMISTRY
Funding Source: Cell Biology & Biochemistry Undergraduate Research

Designing Stapled Peptides as Protein-Protein Interaction Disruptors

Induction of alpha-helicity in otherwise unstructured peptides is advantageous for peptides with applications as protein-protein interaction (PPI) disruptors. Alpha-helical secondary structure is expected to improve the binding affinity of the peptide to its target protein while also improving proteolytic stability. One commonly used strategy to create structured peptides is to introduce staples to link two side chains, restricting the possible conformations of the peptide. Using solid-phase peptide synthesis, we have synthesized peptides (RBPs) that are expected to bind a protein from Trypanosoma cruzi, a protozoan parasite. The native protein is important for the energy metabolism of the parasite but must form a homodimer, or assembly of two identical proteins, to be active. Inhibiting this dimerization of PPI to inactivate the protein in parasites that cause leishmaniasis, a neglected tropical disease, would be fatal for the parasite. Therefore, these RBPs could provide opportunities for different therapeutic approaches to the treatment of leishmaniasis. Two of the stapling motifs we have introduced to the RBPs include a thioether linkage and a hybrid coordination motif designed to bind a divalent metal, a less commonly used strategy. Biophysical characteristics, including secondary structure, resistance to proteolytic cleavage, and the ability to bind the protein, of the stapled RBPs were analyzed and compared. Using circular dichroism spectroscopy, we found that neither of the stapled RBPs were more alpha-helical than their linear counterpart. However, fluorescence anisotropy experiments suggested that the disulfide-stapled RBP had a higher binding affinity for the protein from Leishmania donovani than the unstapled RBP.

Ashley Borseth, Graduate Student

Faculty Mentor(s): Professor Le Paliulis, BIOLOGY
Funding Source: Department of Biology, Graduate Summer Research Fellowship

Segregation of the Univalent X Chromosome in the Two-striped Planthopper Acanalonia bivittata

Correct segregation in meiosis I depend on homologous chromosomes pairing to form bivalents. To achieve a successful reduction in ploidy, bivalents align on the metaphase plate and then homologues segregate during anaphase I. While bivalent formation is generally required for correct segregation in meiosis I, many organisms pose an exception to this requirement. Our objective was to study one such exception, the two-striped planthopper Acanalonia bivittata (Hemiptera, Auchenorrhyncha), which has a univalent X chromosome. A. bivittata were collected and their identification was confirmed through DNA barcoding. Chromosome number was found to be consistent with previously published karyotypes for the species. To observe the behavior of unpaired chromosomes in male primary spermatocytes, live-cell and confocal imaging of stained cells was conducted. The univalent X chromosomes were found to be characterized by independent and delayed segregation that occurred after autosomal segregation during early anaphase I. Delayed segregation of the univalent chromosome was associated with the loss of microtubule connections to one spindle pole, leaving the chromosome aligned on the metaphase plate, often in a position outside the main spindle body. This study characterized the behavior of an unpaired chromosome in an alteration to the traditional meiotic program. This work has translational implications in organisms in which a chromosomal pairing partner is lost, such as the diminution and potential loss of a Y chromosome in mammals.

Joselyn Busato ’24

Faculty Mentor(s): Professor Elif Miskioglu,
CHEMICAL ENGINEERING
Funding Source: NASA Artemis Student Challenge Grant

Preparing Prospective Engineers for Artemis: Analyzing the Efficacy of MOOCs in a Specific Area of Expertise

The utilization of Massive Open Online Courses (MOOCs) in undergraduate education is increasing in popularity due to their accessibility, user-friendly format, and their ability to prepare students with the specific skills and knowledge to enter their desired fields. In 2024, NASA plans to land the next man and the first woman on the Moon through the Artemis program. Preparing for this mission requires astrodynamics and trajectory design knowledge that is beyond the scope of most undergraduate, and even graduate, education. It is critical that the engineers working on this mission overcome this knowledge gap to ensure a successful mission. Our team has created a MOOC entitled Teaching the Moonshot to help bridge this gap for engineering students preparing for a professional career with NASA, specifically those who will be working on the Artemis mission. To ensure that the course is best suited to a wide range of students, module efficacy and ease of use were tested by a group of twelve undergraduate engineering students before the course’s official release. Participants narrated their opinions and critiques about the course in real time in think-aloud sessions. Their recommendations and feedback led to revisions for the final release of Teaching the Moonshot, and offered insight into what methods and elements are beneficial to include in MOOCs targeted at advanced topics. The use of online modules in professional development has the potential to increase access to engineering expertise, subsequently creating a stronger workforce able to meet unique or changing needs.

Joseph Carey ’24

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

Braking Effectiveness from Post-Surgical Femur Fracture Patients Using Brake Force Simulator

Introduction: An objective measure of a patient’s ability to perform quick and forceful braking applications would aid physicians in making appropriate decisions on when a patient could safely return to driving. Safety is the most important factor in these decisions; however, it is undesirable to unnecessarily restrict patients from returning to their every-day activities and independence. Therefore, the purpose of this study is to investigate post-operative (post-op) brake force capabilities for patients that have experienced right lower extremity trauma, collecting quantitative assessment of brake pedal response time and force generation. Preliminary analysis focused solely on femur fracture.
Materials and Methods: A braking simulator was used to evaluate the speed and forces a patient can produce in a panic-stop situation. Patient data is collected post-op using an IRB-approved protocol from patients using a custom-developed braking simulator. Each patient’s files are anonymized, grouped with similar injury types, and analyzed using custom MATLAB code. The data is subsequently stored and analyzed further from a patient database. The maximum force produced within one second after braking was assessed, including 27 instances of femur injuries accounting for 57 post-op visits.

Results and Discussion: A literature review demonstrated the amount of force required to stop a vehicle in a panic-stop situation to be 350 N. To investigate the amount of time required for a patient to be able to exceed this threshold, the data was segmented, and the passing rate was calculated at various time intervals. There was a strong positive relationship between the max force and number of days after surgery (Figure 1A). The data is clustered around 14 days, 50 days, and 100 days post-op which may be indicative of the follow-up visits scheduled by the physicians. The visits were segmented into four-time interval segments post-op, and the percentage of patients capable of exceeding the 350 N brake application within one second was calculated (Figure 1B).
Conclusions: Within 125 days of surgery, the vast majority (90%) of patients have recovered enough to generate sufficient force to perform an emergency stop. However, it is evident that a small percentage of patients are able to surpass this threshold within 26-75 days of surgery, which underscores that recovery time is unique to each specific case and individual. The brake force simulator could be an effective and useful tool for quantitative assessment of patient recovery and aiding both physician and patient understanding of post-operative abilities. In addition, future investigations will utilize multi-variate analyses such as injury type, surgical technique, and unique patient information to better inform estimates of post-op recovery time.

Katie Chase ’23

Faculty Mentor(s): Professor Matthew McTammany,
BIOLOGY
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

The Restoration of Historically Logged Streams with the Addition of Large Woody Debris

We measured Large Woody Debris (LWD, wood >10 cm in diameter) in old-growth and second-growth forest streams in Pennsylvania in the summer of 2021 to determine if there was a significant difference in LWD volume. We calculated LWD volume for 7 sites (4 old-growth, 3 second-growth) by measuring the diameter and length of wood that intersected a 100-m long transect down each stream channel. Our data suggest that there was a significant difference in LWD volume in old-growth streams compared to second-growth – 0.020 m^3/m^2 for old-growth and 0.0026 m^3/m^2 for second-growth. Restoration in some second-growth streams implemented LWD additions in the fall of 2021 to try to change the valley floor habitat. LWD was again measured in the summer of 2022 at two of the second-growth sites: Little Arnot Run 1 (subject to LWD additions) and Cherry Run (used as a reference site). The goal of this was to compare the difference in LWD pre- and post-restoration and determine its potential impact. Our data shows that the volume was 0.0045 m^3/m^2 in Cherry Run and 0.015 m^3/m^2 in Little Arnot Run. Comparing the two years’ volumes, Cherry Run in 2022 shows similar results to the second-growth streams' 2021 volume, while post-restoration Little Arnot Run 1 shows similar results to the old-growth streams' 2021 volume. The addition of LWD and similarities in volume to previous findings could then suggest a future improvement in the streams' health by restoring them close to how they functioned prior to logging

Elle Chrampanis '24

Faculty Mentor(s): Professor Nicholas Roseth, MUSIC
Funding Source: Program for Undergraduate Research

Music and Psychological Well-Being with Children

This summer I developed an annotated bibliography exploring the effect of music on the psychological well-being of children. I explored this project by reading scholarly research articles, completing an annotated bibliography, and beginning the initial stages of crafting a literature review. I used Zotero as a source manager and gathered thirty two sources for my annotated bibliography. I organized published research using the PERMA model, a framework developed by positive psychologist Martin Seligman. PERMA is an acronym for positive emotions, engagement, relationships, meaning, and accomplishment. I found that music supported psychological well-being among children in their education and home settings. This is accomplished through activities like listening, performing, participating, and learning about music. A major finding was that music develops social skills and navigates social situations, thus strengthening relationships. I also found that active engagement was particularly significant for children as their participation required focus to obtain the benefits that music has to offer. Regardless of the type of involvement, music gave children enjoyment, confidence, motivation, resilience, and stronger relationships overall. I learned the vast benefits of music and this research emphasized the importance of music in early childhood. I aim to use this background information to craft my honors thesis in the upcoming year.

Ally Clarke '24

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

Characterizing Muscle Fatigue in sEMG Data with Topological Data Analysis

Half of stroke survivors require long-term rehabilitative care, which is often complicated by a high degree of deficit variability. One debilitating effect of a stroke is muscle fatigue caused by muscle weakness. Identifying fatigued muscles can allow for targeted treatment plans and quicker rehabilitation; however, such a strategy has been hampered by difficulties in accurately characterizing fatigue.

Various linear and nonlinear signal processing methods have been used to characterize muscle fatigue from surface electromyography (sEMG) data, but they only characterize the frequency domain. Efforts to capitalize on the topological properties of sEMG, which include frequency and amplitude information, are in their incipient stages.

My research explores using topological data analysis as a robust measure of muscle fatigue. I constructed a custom device that stabilizes the hand and processed the data using a frequency-based Fourier transform. Leveraging techniques from Chutani, my team and I extracted a topological property (number of simplices) from the raw sEMG data. I compared the results of the two analyses and determined that the number of simplices is a more accurate indicator of fatigue than the traditional process, laying the framework for a new method of fatigue detection that could have meaningful implications for rehabilitation and sports sciences.

Sophie Cooksey '25

Faculty Mentor(s): Professor Adam Burgos, PHILOSOPHY
Funding Source: Presidential Fellowship

Defining Feminism Through a Comparative Perspective: The Young Lords Legacy

Who gets to decide what is "feminist" and what is not? How would the world look if the word "feminist" wasn't so stigmatized? Does feminism even matter? These are all questions that will be pondered in this presentation by comparing feminists of the Young Lords, a Puerto Rican activist group from the late 1960s and early 1970s to the modern conservative feminist movement, two starkly different groups in ideology and time period. In this presentation, I will examine how it is that these differences shape ideologically different definitions of feminism. I will also argue that in order to understand feminism and all of its intricacies, we must first be able to establish a definition of feminism that most people can agree with. In this comparative presentation, I will provide some history of the Young Lords, introduce the modern-day conservative feminist movement, and use these comparisons to draw up some potential answers to the longstanding and pressing question of what feminism ought to mean. Comparing women's issues in the 1970s with women's issues in the 2020s along with comparing the motivations of particular women from different time periods are integral components in answering these questions. In this presentation, I hope to be able to draw out a definition of feminism that is best for all women, not just women who find themselves at the intersections of privilege.

Caiden Covell '25

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

Design and Manufacture of an Eel-Inspired Robot using 3D Printed Soft Pneumatic Actuators

For this summer research project, I worked with Professor Will Scott in the mechanical engineering department to look at developing a soft robotic eel made from a flexible 3D printing Filament called FilaFlex. Continuing from research conducted during the preceding academic year, we initially worked on designing a robot that utilizes a two-chambered actuator that permits movement in a flat plane. The robot creates motion by flexing in such a way as to create a wave that travels down the length of the robot which results in forward movement, similar to eels. In order to study the motion of the robot, we conducted tests in which we considered variables such as amplitude, period, and water pumping speeds to establish parameters that could be used to optimize this form of locomotion. Research into our two-chamber actuator robot is ongoing.

Additionally, after progressing sufficiently with the two-chamber actuator robot, we wanted to see if we could create a bending actuator that consists of three sets of chambers positioned around a central axis, so as to permit bending in any direction. Our hope for this actuator is to create an eel robot that could navigate more proficiently within a three-dimensional environment. We are still in the very early stages of developing this three-chamber actuator robot and the next steps include developing a code that uses images of the actuator to measure the amount of bending it can achieve. Research into the two and three-chamber actuator robots will continue into the fall semester.

Lucille Cullen, Graduate Student

Faculty Mentor(s): Professor David Rovnyak, CHEMISTRY
Funding Source: Graduate Summer Research Fellowship, Dr. Glenn A. Moser ’69 Chemistry Master’s Research Fund

Moving Towards more Robust Sparsity with Nonuniform Sampling in Challenging 2D-NMR by Reducing Repeat Subsequences

Pharmaceutical companies often face roadblocks in structure elucidation of both natural products and identification of impurities. Nuclear magnetic resonance spectroscopy (NMR) can overcome these problems in the drug discovery pipeline in a way mass spectrometry cannot by identifying absolute configuration. New technologies to accelerate structure elucidation include emerging advanced data sampling techniques like nonuniform sampling (NUS), which is powerful, but prone to artefacts. Sampling noise and aliasing artefacts are a barrier to using sparser NUS in complex 2D-NMR experiments. We find that weak aliasing artefacts are a growing concern in sparser 1D-NUS and can sometimes be misattributed to incomplete deconvolution of the broader point-spread function. As sparsity increases in NUS, we find that detrimental repeat sequences can occur early in the sampling schedule, correlating with aliasing artefacts in resulting spectra. By developing a convolutional screening approach to evaluate sampling schedules, these repeat sequences can be detected and characterized. Selecting schedules to avoid repeat sequences and using short periods of initial uniform sampling are effective at reducing these initial repeat sequences and enabling routine 25-33% 1D-NUS of challenging 2D-NMR experiments.

Amin Danesh ’24

Faculty Mentor(s): Professor Katharina Vollmayr-Lee, PHYSICS & ASTRONOMY
Funding Source: National Science Foundation Grant (NSF)

Shear Stress and Pressure of a Granular System with Pins

Granular media are large collections of disordered macroscopic particles interacting via dissipative and frictional forces. We encounter them every day in the shapes of sand, gravel, grains, foams, and even biological beings like bacteria colonies and human crowds. Our research focuses on the effects of pins, small particles that act like restraints, on “jamming”, a phase transition when granular media shift from a fluid-like state to a disordered-solid state. Our system contains three types of athermal, bidisperse, and repulsive disks in two dimensions with ratio 0.004 (pins) : 1.0 : 1.4 . A shear is applied by moving the top and bottom walls, made of rough particles. We study macroscopic properties such as shear stress, and pressure as functions of time and packing fraction for various shear rates.
We acknowledge the financial support from the National Science Foundation (DMR -1905737 and DMR-1905474) and ACCESS startup allocation (DMR-190064).

Andrew DeSana, Graduate Student

Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, Professor Reggie Gazes,
ANIMAL BEHAVIOR, BIOLOGY, PSYCHOLOGY
Funding Source: Graduate Summer Research Fellowship

Effects of Immediate Social Context on Attention and Salivary Cortisol in Tufted Capuchin Monkeys

Social context can alter cognitive performance in animals, but the mechanisms for this remain unclear. One possibility is that the stressors associated with social contexts mediate changes in cognitive performance through their influence on attention. In this study, we investigated how social context affects performance on an attention task in tufted capuchin monkeys (Cebus [Sapajus] apella). We additionally validated and measured physiological stress through salivary cortisol. Eleven socially housed capuchins were each exposed to three conditions where they were either isolated or paired with an affiliative or agonistic social partner. Following a period of social interaction or isolation, subjects were tested on an attention task, and saliva samples were collected. We analyzed the relationship between social condition, attention performance, and salivary cortisol levels. Neither attention performance nor cortisol differed significantly across the three social conditions. When animals were isolated, there was a negative correlation between cortisol and attention. However, this relationship was not present in either social condition, suggesting that adding social context may interfere with the physiological relationship between cortisol and attention. These results imply a potential role of cortisol in attention performance and highlight the importance of including social contexts in cognitive studies.

Nick DeVita ’24

Faculty Mentor(s): Professor Kenny Mineart,
CHEMICAL ENGINEERING
Funding Source: National Science Foundation Grant (NSF)

Polystyrene Discs as Barriers for Diffusion in Layered Organogels

Transdermal drug delivery is a vital mechanism for skin care, 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 the direction of diffusion in a polymer gel with an organic network. Organogels contain a diffusion probe, a tri-block copolymer, and an organic solvent. The tri-block copolymer forms a physically crosslinked network that consists of spherical polystyrene domains and a plasticized rubbery matrix consisting of ethylene-co-butylene and aliphatic mineral oil. The matrix phase is fluid-like and amenable to mass transport, which allows for probe diffusion. The main mechanism by which a probe maneuvers through a gel is time-dependent diffusion. Using Fourier Transform Infrared spectroscopy, the probe release rate can be tracked, and therefore, the fundamental parameter diffusivity can be determined. Controlling directionality allows for the delivery of probes to be tuned to our liking. Annealing external polystyrene was the main method employed to control diffusion. In particular, polystyrene pellets were annealed onto the face and walls of a gel. Sealed organogels were submerged in glass jars containing MO. Usually, gels submerged in MO gain in mass and thickness as a result of the inward diffusion of oil into the gels. Our data show that the mass transport of mid-block selective oil is limited based on how much Polystyrene covers the gel.

Mary Kate Dick ’24

Faculty Mentor(s): Professor Matthew Higgins, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Michael Baker Jr. Summer Research Program

Improving Anaerobic Digesters through Micro-aeration to Reduce Hydrogen Sulfide and Ammonium Levels and Increase Methane Production

The goals of this experiment were to reduce the amount of hydrogen sulfide (H2S) in biogas and ammonium (NH4+) in digesters through micro-aeration. This was done using two types of anaerobic digesters, one with a membrane that emits bubbles to mix the digest and one that used an aerator to mix the digest. Air for the micro-aeration was pumped into the membrane anaerobic digester and emitted through the membrane, whereas the digester that used an aerator to mix the digest was used as a control. In the experiment, methane measurements increased and hydrogen sulfide decreased. Through compiling the data it was found that there was an average 2.6% increase in methane levels and an average 352.4 ppmv decrease in hydrogen sulfide. It was also found that the membrane digester level of ammonium increased by an average of 905 mg/L, but compared to the digester that did not receive air which had an ammonium level of 941 mg/L there were signs of improvement. The results of this experiment prove that micro-aeration can reduce H2S and ammonium levels and improve methane levels.

Sophia Donati ’23

Faculty Mentor(s): Professor Jeremy Chow, ENGLISH
Funding Source: Douglas K. Candland Undergraduate Research Fund

From Graphic Novel to Graphic Memoir

This summer, I looked at the genre of graphic novels from both the lens of the reader and the author. Over the course of ten weeks, I worked closely with Professor Jeremy Chow of the English department. We researched the graphic novels genre by reading, discussing, and analyzing over twenty-one books. Congruently, I was working on my own self-narrative graphic novel entitled Swimming Lessons. The creative process of Swimming Lessons was directly impacted by the research of the graphic novels on our reading list. Our readings consisted of three categories: Self Narrative/Memoir, Women Authorship & Intersectional, and Growing Up with Love (of Sport). Over the ten weeks, in accordance with the reading list, Professor Chow and I would read two graphic novels and discuss my own work, usually in the form of a drafted chapter, on Swimming Lessons. These conversations were not mutually exclusive and almost always intersected to create fluidity and a deeper understanding of the graphic novel genre. The three proposed categories meshed well with Swimming Lessons’ format, style, and themes. By being both a reader and a writer through the PUR research opportunity, I have extensively been able to grasp and analyze the key dynamic of the graphic novel. The intersectionality of the analytical research of the outside graphic novels and my own graphic memoir allowed me to greatly expand my knowledge of the importance and strengths of the graphic novel genre

Sarah Downey ’25

Faculty Mentor(s): Professor cfrancis blackchild, THEATRE & DANCE
Funding Source: Helen E. Royer Undergraduate Research Fund

Writing the Socio-Political Stage Play

How does one write an effective play about issues that affect us all? This project examines the intersection between storytelling and theories of justice. Contemporary story structure and the playwriting process will be discussed

Marion Duval ’25

Faculty Mentor(s): Professor Moria Chambers, Professor Sarah Smith, BIOLOGY, CHEMISTRY
Funding Source: Presidential Fellowship

Does Insect Antimicrobial Peptide Structure Affect its Ability to Kill Bacteria?

The prevalence of antibiotic-resistant bacteria is rising as the number of newly approved antibiotics decreases, creating a global crisis of infections unable to be treated by antibiotics. However, many insect species have naturally occurring antimicrobial peptides (AMPs) which are short amino acid chains that are not prone to the development of bacterial resistance. My research focuses on analyzing how changes in the amino acid sequence of peptides may lead to structural changes that affect their ability to kill bacteria. The AMPs I am studying are Cecropins, a particular family of insect AMPs that are found in many species. The Cecropin family’s low toxicity to mammalian cells and diverse amino acid sequence across species makes it a good candidate to study. First, I performed peptide sequence alignments and grouped them based on their overall peptide properties which may affect their shape and antimicrobial ability. Specifically, I am looking at a central “hinge” region common to many insect AMPs which affects the flexibility of the peptide, therefore influencing its ability to insert itself into a bacterial cell membrane and ultimately kill the bacteria. Based on structure modeling, I have found three main peptide structure types: linear, bent, and hinged/U-shaped. The peptide structures are flexible and may differ in shape when in solution as compared to when it is inserted into a membrane. I am working to synthesize peptides from each group and will perform MIC (minimum inhibitory concentration) assays to gauge their bacteria-killing abilities.

Jessica Fenners ’24

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

Experimental Effects of Temperature on Telomere Length in Tree Swallows

When exposed to environmental stressors, vertebrates undergo a series of cascading hormonal signals which activate the hypothalamic-pituitary-adrenal axis (HPA) to trigger the release of glucocorticoids (GCs) from the adrenal glands into the bloodstream. Chronic exposure to glucocorticoids is linked to harmful long-term effects such as shortened telomeres– the non-coding, protective, terminal caps on chromosomes. When shortened, these telomeres serve as markers for both cellular and organismal aging. As the climate is rapidly changing, many species are facing a more unpredictable environment that is likely to challenge survival and reproduction. Particularly, frequent cold weather swells, known as cold snaps, have posed a significant thermoregulatory challenge. In birds, while the reproductive season poses its own set of stressors, cold snaps have been linked to elevating corticosterone (CORT)–the main GC released in avian species–which can alter the rate of reproductive success and phenotypic development. Here we investigated how climate change affects telomere shortening—and organismal aging—using the widely distributed and tractable Tree Swallow (Tachycineta bicolor). Telomere measurements of nestlings reared under both cold and control conditions were taken in 2020 and 2021 and analyzed using the telomere restriction fragment (TRF) assay. While telomere lengths did not differ during environmental challenges, telomere length was shorter in 2021 compared to 2020.

Katie Fonda ’23

Faculty Mentor(s): Professor Claire Campbell, Professor David Rojas, Professor Daniel Temkin, Professor Amanda Wooden, ENVIRONMENTAL STUDIES & SCIENCES, HISTORY, LATIN AMERICAN STUDIES, MUSIC
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Susquehanna Soundscapes

In discussing environmentalism and climate change, we rarely talk about sound. Yet urban noise and sound pollution are among the most prevalent and easily identifiable indicators of human industrialization and our encroachment on the natural environment. As a musician, I’ve wondered how my skills can help advocate for the environment. In my research project “Susquehanna Soundscapes” creative composing, audio production, and fieldwork in the anthropological domain of Acoustic Ecology combine, using sound as a focal point to interrogate the relationship between humans and the environment.

I wanted to craft a composition that told the stories of local residents and gave voice to the river itself. How do our perceptions of a river in person, or the recordings we hear of a sonic landscape, contradict reality?

I researched other soundscapes, nuances of audio recording, and carefully crafted interview questions. I visited targeted locations alongside the Susquehanna River. Some afforded me “sublime” natural sounds of water bubbling; others had inescapable sound pollution of machinery. At each site, I met residents of various ages and backgrounds, who spoke candidly about the Susquehanna River, their words emblematic of their relationship to nature as a whole.

Later, as an audio engineer polishing the raw material, and a composer forming a creative response, I had to make intentional choices. How could I portray sublime experiences, paradoxes of this sonically-polluted landscape, and larger issues plaguing the ecological health of the river? In three movements, Susquehanna Soundscapes tries to give voice to these conflicting, complex issues through an acoustic ecology

Paris Gallagher ’23

Faculty Mentor(s): Professor Brantley Gasaway, Professor John Penniman, RELIGIOUS STUDIES
Funding Source: Program for Undergraduate Research

Defining Q-Vangelicals

In 2020, a Pew Research poll revealed that over 50% of American Evangelicals sympathize with the right-wing conspiracy movement, QAnon. My research aimed to answer the question: why are so many Evangelicals attracted to QAnon? To answer this question, I studied the religiosity of both movements to understand how their similar theological commitments led to a mutually reinforcing relationship.

Ariana Gambrell ’23

Faculty Mentor(s): Professor Erica Delsandro, Professor Bill Flack, PSYCHOLOGY
Funding Source: Program for Undergraduate Research

Deconstructing Campus Sexual Assault Among Black Students

Interpersonal violence is a prominent issue on university and college campuses within the United States. The primary goal of the present study is to measure the prevalence of sexual assault within minority-based populations on campus. Researchers have found “members of minoritized groups (racial/ethnic minority women, people with disabilities, and transgender individuals) are at a higher risk of experiencing campus interpersonal violence than are white women, people without disabilities, and cisgender individuals (Klein et al., 2021).” In addition, being a part of a minority social group, such as being non-white, is associated with a lower likelihood of reporting (Wolitzky-Taylor et al., 2011).
A large contributor to the issue of minority students’ relationship to CSA victimization is the existence of well-known stereotypes. The Jezebel stereotype characterizes black women as promiscuous, seductive, and sexually insatiable which has caused detrimental consequences on black women’s sexual health and relationships (Jerald, 2019). The present study investigates the relationship between sexual assault and campus climate, the prevalence of sexual victimization of Black students at a predominately white institution, and how racial stereotypes affect sexual assault prevalence rates. Research has been conducted quantitatively through an online survey administered to a random sample of Bucknell students and contextualized through a qualitative interview project with Bucknell students of color.

Mingzixu Gao ’24

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

Transcriptomic Responses to Coronavirus Infections in African and North American Bats

Bats are the likely ancestral hosts of nearly all coronavirus lineages but, like most reservoir hosts, do not appear to experience significant illness. Using archived gastrointestinal (GI) tissue samples from two different species of bats, one from North America (Myotis lucifugus) and one from Africa (Epomophorus labiatus), we have characterized the presence of coronaviruses using viromic and PCR-based approaches. To determine how these hosts respond to infection, we are examining the whole-transcriptome changes in host gene expression that accompany coronavirus infection in the GI tract. RNA was isolated from the GI tracts of 26 North American bats and 150 African fruit bats and RNASeq was performed to a read depth of 40-80 million read pairs per sample. Coronaviruses were detected either by using Kraken2 or STAR to map reads to viral transcripts or by PCR using nested degenerate primers for coronaviruses. The levels of alpha-coronavirus BtCoV-CDPHE15 detected in the M. lucifugus RNASeq reads correlated with their white-nose syndrome status, as expected, and was significantly higher in juveniles than adults. However, no coronaviruses were detected in the RNASeq reads from 150 E. labiatus GI samples using this viromic approach. Using consensus PCR, we have identified 10 of these same African fruit bats as positive for coronaviruses in RNA isolated from blood or fecal swabs. Differential gene analysis on DEBrowser and R to examine up-and down-regulation in the host gene expression that correlates with infection to determine immune system signatures of viral tolerance.

Abby Gearhart ’23

Faculty Mentor(s): Professor Ben Hayes, WATERSHED SCIENCE & ENGINEERING
Funding Source: US Forest Service

Factors Controlling Spatial and Temporal Variations in Stream and Groundwater Temperatures in a Forested Catchment in Allegheny National Forest PA

This study looks at stream and groundwater temperature in the Little Arnot Run watershed, which drains an area of 9.5 km2 in the Allegheny National Forest. Temperature data were collected from 4 stream gage stations, 13 piezometers, and a weather station, from 2019 to present. This data was combined with weather station data to continue to find key factors that influence the spatial and temporal variability in both in-stream and adjacent unconfined aquifers. In August 2021, modifications to the valley floor included the addition of large woody debris and grade control structures in the channel as well as the partial removal of berm on the floodplain. These activities modified the groundwater elevation and amount of water diverted to abandoned side channels.

This study will continue to collect data and monitor the gage stations and piezometers to assess long-term changes to the watershed due to the restoration work. Other factors like solar radiation seem to not be a dominant factor influencing spatial variations due to tree canopy cover. Latent heat transfer from air is important as evident in seasonal and diurnal. However, the dominant influence is tributary inflows during rainfall events and hyporheic exchange during base flow conditions during the summer and fall.

Tia Gemechu ’23
Tyler Scopelliti ‘23

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

Investigation of a Novel Protein that Functions During Dorsal Closure in Drosophila

Wound healing involves the replacement of destroyed or injured tissue with fully functioning tissue. Parallels can be drawn between the process of dorsal closure in the Drosophila embryo and wound healing in humans. Both processes involve the movement of epidermal cells to achieve the closure of a gap to form a continuous epidermal layer. The actin cytoskeleton plays an essential role during dorsal closure as it provides the primary forces involved in moving the cells along the leading edges of the gap closer together. A genetic modifier screen was performed by previous members of the lab which implicated Garz as a protein that functions during dorsal closure. Additionally, in-situ hybridization revealed that garz mRNA is found in epidermal cells during dorsal closure. Garz is a Guanine Nucleotide Exchange Factor (GEF) that regulates the small GTPase ARF. In Drosophila, Garz plays a central role during salivary gland formation and tracheal tube expansion by regulating vesicle transport. We hypothesize that Garz regulates the vesicle trafficking of proteins in epidermal cells during dorsal closure. To investigate the role of Garz during dorsal closure, we generated embryos that were homozygous mutants for garz. We then determined whether these embryos were able to complete embryogenesis and hatch, as well as whether defects were present in the actin cytoskeleton of these embryos using immunofluorescence. We found that a subset of the homozygous mutant garz embryos fail to complete embryogenesis and display dorsal closure defects.

Eleanor Geno ’23

Faculty Mentor(s): Dr. Shaunna Barnhart, BUCKNELL CENTER FOR SUSTAINABILITY & THE ENVIRONMENT
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Sylvan Dell Indigenous Histories

The erasing of Indigenous histories has been a detrimental practice throughout the United States history and has resulted in the significant loss of Indigenous histories. The Robert Porter Allen Area is home to these forgotten Native histories, as oral and concealed histories have converged on the space. The aim of this research project has been to shine a light on the history of this space, largely through the exploration of oral histories. Stories relating to unearthed canoes and hidden villages have plagued the site for decades, but tangible evidence to back up these claims has been lacking. Through a series of interviews with academic and industry experts, archival research, and attempted contact with the companies that still occupy this space, this project sought to offer material evidence for community knowledge and beliefs. The presence of fossil fuel infrastructure along Sylvan Dell Road serves as a physical manifestation of the lost Indigenous history in this space. Built over a culturally significant location, the construction of these sites largely cut off the public exploration of the village that once existed at this location. While this project ultimately did not yield the desired results, it did help to illuminate future avenues of exploration. The most substantial opportunity for future research lies in the identification and locating of Gulf Oil's construction records for their tank farm along Sylvan Dell Road. Acquiring the records from Gulf Oil is a difficult task that will require relationship building and key informant location beyond the timeframe of this project.

Anthony Gesford '24

Faculty Mentor(s): Professor Karen Castle, CHEMISTRY
Funding Source: Department of Chemistry

Vibrational Energy Transfer in CO-CO Collisions at High Temperature

Transient diode laser spectroscopy was used to measure the rate coefficient for vibrational relaxation of carbon monoxide by other carbon monoxide molecules at high temperatures. The temperature dependence of this energy transfer has not been measured experimentally before. Our experimental approach begins with a mixture of CO, O3, and Xe/Ar bath gasses flowing slowly through a meter-long aluminum reaction cell which is wrapped in heating tape and kept at a constant temperature. The fourth harmonic from a pulsed Nd:YAG laser photolyzes O3 in the gas mixture to create a temperature jump, thereby shifting a small fraction of the CO population into higher vibrational states. A mid-IR diode laser is then used to monitor the vibrational state populations as collisional quenching occurs and the system approaches equilibrium at the new temperature. The dependence of collisional quenching rate vs. quencher concentration allows for the determination of the desired rate coefficients. We plan to perform this measurement as a function of reaction cell temperature between 300 and 400 K.

Grace Ginder '25

Faculty Mentor(s): Professor Moria Chambers, BIOLOGY
Funding Source: Department of Biology, Kalman Fund for Biomedical Research Fellows, Kalman Fund for Undergraduate Research in the Sciences, Presidential Fellowship

Fruit Fly Lessons: Can Insect Antimicrobial Peptides Inspire New Antibiotics?

The increase in bacterial diseases resistant to conventional antibiotics is a growing problem. Recently, insect antimicrobial peptides (AMPs) have been recognized as a potential source of novel antimicrobials that could be adopted for clinical use. To test the antibacterial effectiveness of AMPs found in the fruit fly Drosophila melanogaster, we used three different fruit fly lines: W1118, Δ10, and Δ14. W1118 is a control with intact genes for all AMPs, while Δ10 and Δ14 are missing ten and fourteen AMPs genes, respectively. Five different bacterial species of the Providencia genus were injected into the abdomen of male adult flies of each line. Survival was tracked every two hours for 24 hours, and bacterial load was measured at 12 hours and 18 hours post-infection.
Overall, AMPs significantly impacted resistance to infection of Providencia bacteria species. When infected, Δ10 and Δ14 flies had significantly higher amounts of bacteria present at 12 hours and 18 hours post-infection than W1118 flies. For survival, Δ10 and Δ14 flies had a significantly higher proportion of dead than W1118. In some infections, a significant difference in both bacterial load and survival was seen between Δ10 flies and Δ14 flies as well. This indicates that a certain family of AMPs, cecropins, are important to fighting infections. In the future, more experimentation is needed to determine the effectiveness of insect AMPs to resist human pathogens and to help further our understanding of the hosts' AMP response to an infection

Twity Gitonga '24

Faculty Mentor(s): Professor Erica Delsandro, Professor Bill Flack, COMPUTER SCIENCE, PSYCHOLOGY, WOMEN'S & GENDER STUDIES
Funding Source: Program for Undergraduate Research, James L.D. and Rebecca Roser Research Fund

Ecological Modeling of Campus Sexual Assault

Sexual assault on college campuses is a prevalent and well-documented problem. I set out to get more specifics and ask more questions. We decided to look at the stories of students on campus, starting from the moment they arrived and, specifically, with which groups did they become involved in Greek life or sports teams, and explored how group affiliation shaped their knowledge and experience of campus sexual assault. I utilized Professor Bill Flack's archive of campus sexual assault survey data to explore my questions. My goal was to create a virtual ecological model of campus sexual assault at Bucknell.

One issue that we had to negotiate was whether to look at one class year or compare data sets that include representatives of all class years.
The research questions for both approaches are:
Was there any change in resources for the students to report sexual assault on campus between the two years we examine?

Was there a significant cultural change (ie, new Title IX guidelines, #MeToo, etc.) that impacted the campus climate and, thus, patterns of campus sexual assault?
How does a student's group affiliation impact their knowledge and experience of campus sexual assault?
If a student was sexually assaulted, did they report it or seek advice on the actions to take?

I employed SPSS and Tableau. SPSS allowed me to convert the data into excel, which then gave me the opportunity to clean the data and conduct the analysis on the data visualization platform, Tableau, with the help of Ken Flerage.

Elliot Goepfert-Waterman ’23
Faculty Mentor(s): Professor Sarah Smith, BIOCHEMISTRY/CELL BIOLOGY, CHEMISTRY
Funding Source: Program for Undergraduate Research

Design of a Two Pronged Theraputic for LSD1

In this research, I am developing a novel approach to cancer treatment. We are working to combine cisplatin, a clinically available DNA-targeting platinum-based chemotherapeutic, with a peptide carrier that will target a protein-binding partner. Recent developments have used peptides to regulate how proteins interact inside the body, with applicability to treat various diseases, including cancer. The protein target we chose is Lysine Specific Demethylase 1 (LSD1), which is known to regulate various oncogenes or cancer-causing proteins within cells. By designing a peptide, a short protein that is a small portion of LSD1’s natural target, we can prevent this protein from performing its normal function and disrupt its ability to go awry and cause cancer. By pairing our peptide with cisplatin, there are various benefits; toxicity should decrease when the cisplatin-peptide conjugate is outside the cells, and it will be more difficult for cancer cells to develop resistance to the treatment. I have worked to express and purify LSD1 using E. coli cells to be used for subsequent experiments. I have also synthesized a peptide containing linkers that will ultimately attach to the cisplatin molecule, and allow release upon entering a cellular environment. We will first test the ability of the peptide-platinum construct to bind and inhibit LSD1 in vitro before doing cellular-based assays to determine the ability of our dual therapeutic approach to inhibit cell growth.

Victoria Hall ’24
Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Program for Undergraduate Research

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

Parkinson’s disease (PD) is a neurodegenerative disorder resulting from the death of dopamine-releasing neurons. Levodopa, a precursor of dopamine, is a medication used to treat PD. Like many medications, there is a greater chance of side effects as the dosage increases, which can negatively impact overall patient outcomes. Dyskinesia (involuntary and uncontrolled movement) is a common side effect of levodopa. When levodopa-induced side effects diminish the effectiveness of treatment, deep brain stimulation (DBS), the implantation of electrodes into the brain to electrically stimulate specific structures, is another option for patients. For PD, the standard target is the subthalamic nucleus (STN). Volume of tissue activation (VTA) modeling can be used to quantify the amount of stimulation in and around the target region. The aim of this study was to identify the optimal stimulation locations for levodopa and dyskinesia reduction to determine if the locations were distinct. Patient-specific STN and VTA point cloud data from 40 PD patients were analyzed in MATLAB. Activation in the dorsal-ventral, lateral-medial, and anterior-posterior subthalamic regions was calculated. Overall, stimulation within the STN was associated with levodopa reduction, whereas stimulation above the STN was associated with dyskinesia reduction. Dyskinesia reduction after STN DBS may result from stimulation of the pallidothalamic fibers dorsal to the STN, specifically the lenticular fasciculus, which originates from the globus pallidus internus (GPi). Stimulation of these fibers may be comparable to GPi DBS, an alternative treatment for PD patients with low levodopa tolerance that is reported to have a direct effect on dyskinesia.

Justin Higgins ’23
Faculty Mentor(s): Professor M. Laura Beninati, Professor Andrew Sloboda, MECHANICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences, Program for Undergraduate Research

Near Wall, Flow-Induced Vibration of a Circular Cylinder

Underwater pipelines are commonly used in the transportation of liquids and gases, such as gasoline or oil. Water flowing across these pipelines can induce vibrations, which can damage the pipelines. Such a pipeline can be modeled as a circular cylinder near a planar wall. This research project aimed to determine whether the mechanism of near-wall cylinder vibration differs from that of cylinder vibration far from the wall. A cylinder was mounted in a subsonic wind tunnel, and accelerometers were used to measure the cylinder vibration at various distances from a planar wall within the tunnel. Both a leaf-spring and a coil-spring mounting system were used to support the cylinder in the wind tunnel while allowing cylinder vibration. When analyzing the vibrational frequencies, it was found that the cylinder unexpectedly had two modes of vibration. The cylinder was expected to translate, but it was also rotating. Additionally, the leaf-spring system was found excessively noisy data. The coil-spring system was used to reduce the noise in the accelerometer data. Future work on this project should focus on eliminating the rotational mode of vibration and further reducing the noise in the data. This may be possible via the construction of a parallel-bar mechanism that would prevent the ends of the cylinder from rotating and the continued use of coil springs.

Ryan Hill ’24
Faculty Mentor(s): Professor Ryan Malone, MUSIC
Funding Source: Program for Undergraduate Research

Moravians, Manuscripts, and Musical Pedagogical Practices

For my research, I worked with faculty advisor Dr. Ryan Malone of the music department in order to investigate the history of Moravian music education in American communities during the eighteenth and early nineteenth centuries. My intention was to explore Moravian copybooks within the Bethlehem Moravian archives that students and teachers would’ve used in Moravian classrooms in order to discover what Moravian communities valued in their music and specifically their music pedagogy.

I spent the first weeks of this project reading scholarship and literature related to Moravian music, history, and education. I then prepared a comprehensive annotated bibliography of the works I read, before spending one week at the Moravian archives in Bethlehem, PA. My time there was devoted to working with and taking high-resolution photographs of manuscript books from both Bethlehem and Lititz, specifically with respect to how the music represents the community's values. I devoted the remaining weeks to synthesizing my findings while drafting and revising my paper.

I learned that the Moravians valued a comprehensive and musically diverse set of repertoire to study, which included everything from eighteenth-century European classical music to American folk and patriotic music. I also found that Moravian classrooms worked to facilitate complex collaboration between the teachers and students who they took lessons from and copied music from. All of this led me to believe and validate my original argument that Moravian educators worked to provide a well-rounded and fulfilling pedagogical experience that allowed for many perspectives to shine.

Maddy Hinkle '24

Faculty Mentor(s): Professor Karen Castle, CHEMISTRY
Funding Source: NASA Solar System Workings Program and NSF's S-STEM Program #1742124

Vibrational Energy Transfer in CO-N2 Collisions for CO in the V=1 and V=2 States

Titan is Saturn's largest moon, on which nitrogen is the most abundant gas, with CO as the 4th most abundant. In Titan's upper atmosphere, there is a region in which the states of CO are in non-local thermodynamic equilibrium (non-LTE). In order to properly model these states, accurate parameters for the vibrational energy exchange processes are needed. The goal of this project is to increase the precision of the kinetic parameters and therefore provide a better model, of the non-LTE region of Titan's atmosphere. A mixture of different bath gasses along with CO and N2 are flowed through an aluminum reaction cell at various pressures, flow rates, and temperatures. A small amount of ozone absorbs energy from a Nd:YAG laser to induce a temperature jump, and the population shifts to the CO(v) state of interest. IR transient diode laser spectroscopy is used to monitor the population of the state as the collisional quenching occurs. The results are represented as transient absorption curves, which are then fit to an appropriate function and turned into pseudo Stern-Volmer plots. When the experiment is complete, the rate coefficient will be determined.

Hannah Holmes '23
Sarah E. Lower, Gregory M. Pask, Kyle Arriola, Sean Halloran, Daphné C. Halley, Douglas B. Collins, Jocelyn G. Millar

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

Losing Light: Pheromone Use in Firefly Mate Attraction

Trait reversal is the phenomenon where a new trait arises in a species and then reverts back to the ancestral form. Previous studies have led us to believe that these traits are not lost, but instead, genes become non-functional due to adaptation from selective pressures. Fireflies are a great organism to study this in, as they are known for using light to attract mates; however, some species use pheromones, leading us to question whether their pheromone use is a newly-evolved mechanism of mate attraction or an inactive ancestral trait that may be present in other species. Photinus corrusca, the Winter Firefly, is the only winter-active firefly species in Eastern N. America. Because these organisms are day-active, using light to attract mates is no longer advantageous. Instead, P. corrusca may have reverted to pheromone release for mate attraction, an ancestral trait in insects. In this study, we sought to identify and validate the specific pheromone used in P. corrusca mating. By trapping vapors emitted in the headspace of wild-caught female specimens using mason jars and activated charcoal followed by gas chromatography-mass spectrometry, flame ionization detector-electro anemographic detection, and single sensillum recording, an isomer of the compound hydroxycamphor was identified as a main compound that elicited male antennae response. Field and lab assays with synthesized hydroxycamphor confirmed that only P. corrusca males were attracted to the compound. This data provides opportunities to further study and understand the mating behavior of unlighted fireflies, in regards to pheromone range, phenology of pheromones, and much more.

James Horton '23

Faculty Mentor(s): Professor Shahram Azhar, ECONOMICS
Funding Source: Douglas K. Candland Undergraduate Research Fund

Using Global Value Chain Analysis to Study the Current Structure of the Global Semiconductor Industry

Despite the swath of media coverage on the Semiconductor Industry and the shortages of semiconductor components experienced over the past two years, conventional dialogue often neglects to consider the heterogeneity within this sphere of industrial activity. To address these shortcomings, this paper offers a Global Value Chain (GVC) framework by which to model the current structure of the Semiconductor Industry. Section 1 provides a synopsis of semiconductor components, the industry responsible for their production, and proposes a GVC framework by which to evaluate both. Sections 2, 3, and 4 outline the input-output structure of the value chain, the key players that operate within the industry, and the geography of the value chain, respectively. Section 5 equips and applies this model to discuss three highly relevant topics: the end-use demand for semiconductors, the economics of foundries, and the industry's sales cycle. Section 6 builds upon these applications as well as the GVC framework to examine the causes of and implications behind the recent global semiconductor shortage. Section 7 offers our concluding remarks on these matters as well as our key takeaways.

Derek Huffman ’24

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

Analyzing the Fracture Behaviors of 3D Printed Metals

This work focuses on analyzing the fracture behaviors of 3D-printed metals. Materials produced using additive manufacturing (AM), such as 3D printing, have varying strengths in different directions as a result of the layering process. To analyze how AM metals fracture, the metals will be deformed using a small punch test, which allows for the use of very small samples, while being scanned with a micro-CT. Since fractures in AM metals may form with full internal voids and their behavior may depend on the manufacturing conditions, an x-ray is required to image the sample. The micro-CT will use x-rays to image the sample as it is deformed and use computed tomography to produce 3D images of the sample and its fractures, enabling the formations of fractures to be observed as they occur. This research is ongoing. Samples have been tested using a previous small punch test apparatus, which will serve as a baseline for testing materials to use in the final testing apparatus. A method to polish and prepare these samples by hand for testing was developed and refined. The design for the testing apparatus was developed and refined alongside material selection for dies. The materials will first be tested in simulation. The design for the testing apparatus has reached an acceptable version ready for prototyping.

Caroline Ionata ’24

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

Metallic Plastics: Strengthening ABS through Electroplating and Electroless Plating

Experiments with post-processes and fabrication methods of 3D printed parts were explored, focusing on how to strengthen and aesthetically enhance acrylonitrile butadiene styrene (ABS) plastic. The main limitation of 3D printed parts being used for end products is the quality of their finish. A variety of post-processing and finishing methods can be used on plastic parts in order to increase their material properties and aesthetics which would make them more appealing in the consumer world. However, some of these methods are time-consuming and costly. In order to bypass these concerns, electroplating and electroless plating were tested. This is the process of coating one object with metal ions onto metallic paints and mixtures such as graphite, silver, nickel, and copper, through chemical reactions to strengthen the base material. Comparisons between which metallic mixtures were best suited for each process, the highest yield strength, and the different processes themselves were explored. The experiment was conducted with ABS plastic dog bones as the base for the mixtures and coatings. Tensile testing on the finished, fully coated, specimens showed only slight differences in yield strength, about 0.5 - 0.7 MPa, depending on the metallic base mixture and the plating process used, with the highest being the copper paint base, and copper electroplated specimens. Despite the small changes in yield strengths, the specimens that were treated beforehand with prepping techniques such as degreasing and proper paint setting intervals generated the best results in all mixtures and platings.

Sal Iovino ’24

Faculty Mentor(s): Professor Christopher Magee, ECONOMICS
Funding Source: Joann E. Walthour Undergraduate Research Fund

Defining the Conditions for an Effective Transition to a Decentralized Currency Standard in Developing Economies

In an increasingly digitized world, there is currently a significant shortage of literature on the benefits and drawbacks of a digital economy, particularly in regard to a national digital currency standard. This research, conducted under the tutelage of Professor Christopher Magee in the Economics Department, is designed to research the monetary policy measures designed to establish a Central Bank Digital Currency that fosters greater economic growth and inclusion within developing economies. Economic growth, in this instance, can be defined as increased rates of individual participation within an economy as well as a greater per-capita income for individuals within the economy. The selected method of inquiry for this research is a literature review of existing literature pertaining to individual topics surrounding how digital currency currently functions in developing economies, and how monetary policy could potentially affect a digital currency standard.

Findings from this project include: nationalized digital currencies would allow for more efficient transmission of remittances, Bitcoin differs from a CBDC from a policy management perspective but could be fairly similar in regards to a technological/manufacturing perspective, and improved individual financial participation in developing countries as a result of the use of a digital currency is yet to be empirically proven. While these findings are significant, they are largely a baseline of information to inform future studies in the field. As a result of digital currencies being such a new development for all economies, and the limitations on that country’s economy or economic data as a result of its political situation, statistically significant findings about the effects of national digital currencies are few and far between.

Future research pertaining to the project aspires to provide an empirical correlation between the use of digital currency and improved individual financial participation, resolving the third finding of this study.

Colton Jiorle ’25

Faculty Mentor(s): Professor Amal Kabalan, ELECTRICAL & COMPUTER ENGINEERING
Funding Source: Presidential Fellowship, Program for Undergraduate Research

Economical System to Gauge Photovoltaic Health for Homeowners

As the need to reduce carbon emissions intensifies, more homeowners than ever are choosing to go solar, however, many homeowners lack the expertise to understand the daily operation and identify potential problems. While installation rates continue to rise, providing a reliable and economical system to gauge the effectiveness of photovoltaic modules garners increased interest.

Holly Jones, Graduate Student

Faculty Mentor(s): Professor Judy Grisel, PSYCHOLOGY
Funding Source: Summer Research Award 2022

Single Exposure Conditioned Place Preference to Ketamine in Mice

We evaluated the rewarding effects of ketamine in males and females in three different genetic strains of mice. Experiment 1 investigated the initial subjective rewarding effects of ketamine in C57BL/6J and DBA/2J mice using a single-exposure conditioned place preference paradigm (SE-CPP). In this paradigm, on the first day, animals were given an intraperitoneal injection of ketamine (10 mg/kg or 20 mg/kg) or saline and placed into one side of the apparatus. On the third day, animals were given the opposite injection and placed on the alternate side (in a counterbalanced protocol), and on the fifth day, animals were given free access to all three sides and a preference test was conducted (Grisel et al. 2014). Experiment 2 evaluated the contribution of the opioid peptide b-endorphin to the initial subjective rewarding effects of ketamine by comparing b-endorphin deficient (βE -/-; B6.129S2-Pomctm1Low/J) mice with C57BL/6J controls in the same SE-CPP paradigm. We found substantial influences of strain and sex on ketamine reward. In males, DBA/2J were more likely to demonstrate conditioned place preference than C57BL/6J and were more sensitive to the sedative effects of this drug. In females, both C57BL/6J and DBA/2J spent more time in the context paired with Ketamine compared to saline. The locomotor and rewarding effects of Ketamine are not related. In Experiment 2, βE -/- failed to show evidence of ketamine reward, suggesting that the peptide mediates ketamine reward in control C57BL/6J mice. Taken together, these results suggest that genetic factors contribute to individual differences in the addictive liability for Ketamine, and this information might be used to develop targeted treatments for depression.

Morgan Joseph ’24

Faculty Mentor(s): Professor Heidi Lorimor, LANGUAGES, CULTURES & LINGUISTICS, NEUROSCIENCE

Verb Agreement Avoidance

Why is it that humans use language the way we do? Humans communicate in numerous ways but one of the most significant components is language. We rely on the words we use and the sentences we compose to communicate but, we also avoid saying certain things, due to taboo or error avoidance. Previous experimental linguistic work has looked for agreement errors and ignored verb agreement avoidance. For example, “the label on the bottles are sticky” would be analyzed as an error, whereas, “the label on the bottles had been sticky” has no agreement at all, therefore, would be thrown out and assumed to have no impact on the data in an experiment.

It is known that humans avoid verbs, the real question is why do we avoid them? We examined data from agreement experiments that had already been collected, looking for patterns of verb agreement avoidance, and whether avoidance occurred in conditions where participants showed evidence of planning difficulty. We determined that difficulty planning does not correlate with verb agreement avoidance, but verb agreement avoidance is more common with certain conditions, such as when the verb comes after an adverb. We are still trying to understand why agreement avoidance happens, and what it means.

Trey Keister ’23

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

Quantifying Parameter Changes in Piecewise-Linear Systems Using Boundary Transformation Vectors

Dynamic systems with defects or variable stiffness are often nonlinear. These systems exhibit piecewise linearity, in that different ranges of system motion are associated with different linear responses. This research investigates using boundary transformation vectors (BTVs) to detect damage in piecewise linear systems, with the hypothesis that because BTVs are designed around nonlinearity, they will more accurately quantify system damage.

The hypothesis was tested in two ways. A simulation of a mass spring damper system with nonlinear magnetic forces, making it piecewise linear, was forced chaotically in a MATLAB simulation. Changes in stiffness and the magnetic forces served as simulated damage. A physical system consisting of two masses connected by springs and driven by a stepper motor was also created. Piecewise linearity was introduced into the system via magnets attached to the carts which only created large forces when the carts were close together. Motion data for this physical system was captured with a camera.

Analysis of data taken from both the simulated and physical systems showed that BTVs could be used to quantify parameter changes. Poincare sections representing the dynamics were constructed for both data sets. When analyzing these Poincare sections, changes in a particular parameter deformed the sections in a distinct way. This showed that the method can differentiate between different types of damage. Poincare section deformation is also scaled with the size of the change in a given parameter, showing that damage levels can be quantified.

Hannah Kim ’25
Faculty Mentor(s): Professor Craig Beal, MECHANICAL ENGINEERING
Funding Source: National Science Foundation Grant (NSF)

Building a Digital Twin: A Virtual Model of an Electric Vehicle

With the recent push for digital twin technology by Nvidia, a prominent computer graphics processing corporation, in tandem with the growing popularity of the Metaverse, the scientific community has been reminded of the potential digital twins offer. Digital twin technology provides significantly more insight into processes and systems compared to traditional simulations by using real-time data. The applications of digital twin technology reach far beyond the STEM community and can be applied in nearly any situation to foster algorithm development and life-cycle prediction. Over the summer, I worked with Professor Beal in the Mechanical Engineering Department here at Bucknell University. In this particular research setting, the development of a digital twin would allow researchers to safely run tests on the P1 vehicle without the need to transport it to Pennsylvania State University for testing. This digital twin aims to further aid the collaborative research Professor Beal is currently conducting with Penn State faculty and students by providing extensive data sets to ensure the road safety of connected autonomous vehicles. At the end of the nine weeks of research, a working digital twin of the P1 vehicle’s drivetrain was produced using Simulink and an Arduino Due.

Kayla Kisthardt ’23
Zachary Mahaney ’23
Faculty Mentor(s): Professor Jennie Stevenson, NEUROSCIENCE
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities,

Microtus Ochrogaster Exhibit Increased Anxiety Behaviors to a Stressor in the Absence of a Partner

Social isolation has been shown to be detrimental to mental and physical well-being. Its influence has been observed in impaired neuroendocrine, cardiovascular, and immune system functioning, and has been implicated in anxiety and depression, as well as in lowered self-esteem and suicidal ideation. Conversely, positive social experiences and meaningful social connections have been implicated in improved mental and physical health, increased immune response, and an increase in lifespan. The prairie vole (M. ochrogaster) has proven to be useful in the laboratory setting for their ability to demonstrate selectivity in their relationships, and, thus, were ideal for the purposes of this study.

The objective of this project was to examine whether social support during exposure to an ecologically significant stressor is capable of reducing the negative consequences of the stressor itself. For the stressor, we utilized an ecologically relevant chemical called TMT, which is a component of fox feces. We explore this topic in the hopes of illuminating the importance of social connection in the face of experiences that elicit a stress response.

Keira Korzeb ’24
Faculty Mentor(s): Professor Erin Jablonski, Professor Brandon Vogel, CHEMICAL ENGINEERING
Funding Source: Program for Undergraduate Research

Hydrogel and Diol Gel Degradation

Working with Professor Jablonski and Professor Vogel in the Chemical Engineering department, the main focus of the research was to study the development and degradation properties of hydrogels and diol gels along with their chemical properties. A hydrogel is a polymer with crosslinks developed with ETTMP, PEGDA, and the main component being water. A diol gel substitutes water for a different gel as the main component such as propylene glycol, hexanediol, and decanediol. To conduct the research, 30 samples of each type of diol gel were developed so that the degradation of 3 samples every other day for a period of 20 days was measured. The process needed to be adjusted because the hexanediol gels degraded rapidly after two days. After collecting the data, Plots were generated to display how much mass loss occurred inside each diol gel sample after the degradation experiment took place. Next, different materials such as jeffamine were researched to create the diol gel samples, but there were issues obtaining stock for this product. Thus, the research efforts rerouted into studying the purification process of the diol gel component, ETTMP. This compound needs to be purified in a column with alumina oxide, but there was very little knowledge about how much ETTMP could be purified given a distinct amount of alumina oxide. Therefore, the ETTMP would be vacuum pumped through a column of alumni oxide in order to perform titrations to find a breakthrough point for a ratio between ETTMP and alumina oxide.

Jacob Kozora ’23
Faculty Mentor(s): Professor David Rovnyak, Professor Tim Strein, CHEMISTRY
Funding Source: Stephen Glenn Hobar Memorial Research Award, National Science Foundation Grant (NSF)

Probing Bile Salt Pseudostationary Phase Migration Rate in MEKC Using a Homologous Series of Phenones

Micellar electrokinetic chromatography (MEKC) is a useful capillary electrophoresis technique for efficient separations of chiral analytes when bile salt micelle systems are used as the pseudostationary phase. Determination of the thermodynamic binding constant, Kd, is possible with MEKC, but requires knowledge of both the electroosmotic flow rate and the micelle migration rate. Unfortunately, directly measuring the bile salt micelle migration rate is difficult, as bile micelle formation exhibits a complex series of progressive aggregation steps, and furthermore, the guest molecule can affect bile self-aggregation, causing shifts in binding equilibria that favor the bound state. Thus, the use of lipophilic micelle markers such as Sudan III or IV is unattractive. Following the dansyl amine method reported by Bushey and Jorgenson (1989), we have developed a modified approach that uses the migration behavior of a homologous series of phenones to determine the micelle migration rate. As the hydrophobic chain length increases, the phenone partitioning increasingly favors the micelle, eluting later in the migration window. Then, by extrapolating the curve of migration rate versus hydrophobicity (carbon chain length), a measure of the micelle migration rate is obtained. Importantly, we show by NMR that the phenone aromatic ring binds to the same pocket in the bile micelle structure(s) as the model chiral binaphthyl analytes used to characterize these MEKC systems.

Dora Kreitzer ’25

Faculty Mentor(s): Professor Daniel Alvord, SOCIOLOGY & ANTHROPOLOGY
Funding Source: Bucknell Institute for Public Policy

COVID-19 and Collaboration: How Maryland Expanded the EITC

The Earned Income Tax Credit (EITC) is one of the most important anti-poverty programs. Yet, eligibility for the federal EITC is dependent upon filing taxes with a Social Security Number. This means that people who file taxes with an Individual Tax Identification Number (ITIN), a group that largely consists of noncitizens, are ineligible for this benefit. However, several states have recently extended eligibility for state EITC benefits to ITIN filers. Drawing upon exploratory research in Maryland, which expanded EITC eligibility to ITIN filers in 2021 through the passage of SB0218, we set out to understand the process, intentions, and effects of the extension of state welfare programs to noncitizens. For this research, we conducted eight semi-structured interviews with policymakers and members of advocacy organizations that were involved in the expansion of the EITC. Based on this research, we argue that the context of the COVID-19 pandemic and collaboration between invested individuals and groups both heightened and highlighted the need for ITIN filers to be included in the Maryland EITC. The context of the pandemic created a necessary sense of urgency for politicians to get a bill passed. However, what ultimately caused the bill’s success was the strategic collaborations between policymakers, advocacy organizations, and different caucuses which took advantage of the pandemic context. The information learned here can help in future studies looking at the policy processes in other states and understanding if it is replicable in states that have not yet expanded EITC eligibility to ITIN filers.

Matthew Kroen ’23

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

Comparison of Subthalamic Nucleus Activation Metrics in Deep Brain Stimulation for Parkinson Disease

Parkinson’s disease is a degenerative neural condition characterized by a gradual loss of motor control. One method of treatment for Parkinson’s Disease is deep brain stimulation (DBS) of the subthalamic nucleus (STN), a treatment that involves electrically stimulating the STN with a surgically implanted electrode. However, the STN is not a homogenous structure, and the procedure typically targets the dorsolateral STN, a region associated with sensorimotor function. Research into locating the optimal targeting location for an individual patient is ongoing. Through the use of data from patients who have previously undergone DBS, a patient-specific, orientation-specific towards segmenting the STN was developed, before data regarding where electricity was radiating in the brain was used to determine the electrical activation of anatomical regions as categorized by the novel approach. Subsequently, the same patient dataset was processed using the traditional segmentation method before the two methods were compared in order to determine if the novel method demonstrated a stronger correlation with clinical motor improvement than the traditional method currently in use. Ultimately, the two methods proved comparable, with neither demonstrating significant improvements over the other.

Leo Kuyl ’23

Faculty Mentor(s): Professor Jeffrey Trop, GEOLOGY & ENVIRONMENTAL GEOSCIENCES
Funding Source: Geology Undergraduate Research

U-Pb Detrital Zircon Geochronology of Paleogene Forearc Basin Strata in South-Central Alaska: Sediment Routing and Provenance in a Terrestrial Forearc Basin

Paleogene sedimentary/volcanic strata exposed in the Matanuska Valley, southern Talkeetna Mountains, and northern Chugach Mountains record forearc basin sedimentation, magmatism, and deformation. New U-Pb detrital zircon dates from the Chickaloon (n=2890) and Wishbone formations (n=505) build upon detrital zircon dates previously reported from the Arkose Ridge Formation (n=1686). These data are compared with compiled dates from modern rivers/bedrock to provide improved constraints on sediment routing and provenance. Detrital zircon and tuff/lava dates constrain Chickaloon and Arkose Ridge sedimentation to ca. 61-55 Ma; Wishbone strata yield ca. 55-53 Ma maximum depositional ages. Multidimensional scaling analysis and unmixing modeling of detrital zircon dates delineate three provenance groups: (1) northern (arcward) samples with Late Cretaceous to Eocene dates eroded primarily from volcanic-plutonic sources along the northern margin of the basin; (2) southern (trenchward) samples with Jurassic dates sourced chiefly from metasedimentary accretionary prism bedrock along the southern basin margin; and (3) central samples with Jurassic to Eocene dates that reflect mixing of northern and southern sources in axial fluvial systems. Syndepositional exhumation of arcward and trenchward sources is compatible with bedrock thermochronologic data that record rapid cooling ca. 61-45 Ma. Syndepositional exhumation and growth of active volcanic centers prompted progradation of gravelly fluvial environments across swampy fluvial environments in a transtensional depocenter. Extensional faults created accommodation and formed conduits for ca. 49 Ma and younger lavas that prograded across the basin. Transtensional basin development is consistent with models that invoke Paleocene-Eocene bending and slab window formation.

Alex Le ’24
Sierra Pete, Graduate Student
Faculty Mentor(s): Professor Morgan Benowitz-Fredericks, BIOLOGY
Funding Source: Department of Biology

Factors Affecting the Level of Triglycerides in Seabird Chicks (Black-legged Kittiwakes)

Plasma metabolites such as glucose, cholesterol, and triglycerides, may act as health indicators in birds. There are many factors that can influence the levels of metabolites, such as sex, age, diet, body mass, and glucocorticoid-induced energy mobilization. However, to date, there is a lack of consistency in the patterns of metabolites in early chick development stages. Our study will provide insight into how biological processes including nutritional status, chick rank, age, and sex affect triglyceride levels in black-legged kittiwake chicks. Our experiments were conducted in Middleton Island, Alaska, with chicks of known age and rank. For nutritional status, chicks came from two types of nests: fed (experimental treatment) and unfed (control). Whereas the fed nests were supplied with unlimited fish, the unfed nests only had food from parental foraging at sea. The chicks were genetically sexed. We hypothesize that the level of triglycerides differs based on sex, age, food intake, body condition, and survival.

Jonathan Lei ’25
Faculty Mentor(s): Professor Ryan Snyder, CHEMICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Fabricating Thin Coating Using Electrospray Technique to Enable Controlled Drug Delivery

The objective of our study is to use biodegradable materials to design coatings, via the electrospray technique, that can achieve controlled release. Controlled drug release is a beneficial and powerful tool to achieve a reduced frequency of dosing, reduced side effects, and better control of drug concentrations in human bodies(Nokhdchi, 2012). These benets result in an improvement in both the drug’s treatment effect and patients’ compliance with the treatment(Maderuelo et al. 2011). Additionally, using the electrospray technique, it is possible to fabricate polymer coatings on medical devices, such as stents, to be able to modulate their integration with surrounding tissues(Guo, 2015). There are many ways to manipulate a coating’s properties to achieve controlled release. In our study, we are interested in how the thickness of the coating will affect the release prole of the drug. Rhodamine B(a pink dye) is used to simulate the drug, and PVAc(a biodegradable polymer) is used as the substrate of the coating. Coatings were made with different thicknesses. The desired coating, resulting from a successful electrospray experiment, has a shiny, smooth surface with a dark pink color. Scanning Electron Microscope(SEM) is used to verify the resulting lm has a at and smooth surface. After the coatings are made, a diffusion study is conducted by putting the coatings in the PBS solution. Cumulative percent release is calculated by measuring the absorbance value of the solution regularly. In the end, a percent release graph is plotted for each thickness.

Bangyan Li ’23
Faculty Mentor(s): Professor Janet VanLone, EDUCATION
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities

Note-taking Support for College Students with Learning Disabilities and English Language Learners

Many students utilized note-taking strategies to record information for classes. Studies have shown effective note-taking techniques are critical for all students’ academic performance. The purpose of this research study is to investigate note-taking support for college students with Learning Disabilities (LDs) and English Language Learners (ELLs) by answering these three research questions: (1) What types of note-taking support are available for college students with LDs and ELLs? (2) What are the strengths and limitations of currently available note-taking support? (3) How can currently available note-taking support be improved for college students with LDs and ELLs? This study employed qualitative and quantitative methods. Surveys and interviews were conducted to find out the strengths and weaknesses of current note-taking support at various institutions.

Kayla Lichtner ’24
Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Kalman Fund for Biomedical Research Fellows

Measuring Oxidative Stress, Damage, and Repair

Oxidative stress occurs when cellular defense mechanisms are not adequately balanced to combat highly reactive oxygen species (ROS) which are generated during cellular respiration. The biological defense system is designed to neutralize harmful ROS by both enzymatic and non-enzymatic antioxidants, preventing the ROS from reacting with and subsequently damaging DNA, proteins, and lipids. However, oxidative damage can overwhelm the defense system and induce damage to these macromolecules. Oxidative damage of primary macromolecules can be indicative of cellular aging and senescence. Telomeres are protective sequences located at the ends of DNA that prevent truncation during cellular division. Telomeres are particularly susceptible to ROS damage and as a result, can promote cellular aging. An 8-OHdG biomarker can be used to measure both oxidative damage and aging in cells and organisms. Guanosine is a nucleoside that is highly vulnerable to oxidation and is useful for the detection and analysis of oxidative damage. Through techniques such as high-performance liquid chromatography (HPLC), ultraviolet or electrochemical detection, and tandem mass spectroscopy (LC-MS/MS), we are able to isolate and quantify 8-OHdG. Using the 8-OHdG biomarker, our lab has established a method to simultaneously assess baseline oxidative damage, antioxidant defense mechanisms, and genomic repair efficacy. Furthermore, by introducing cells to the free radical agent hydrogen peroxide (H2O2), we can compare varying DNA damage levels among individuals. Our method, therefore, measures the efficacy of genomic repair and the capacity of antioxidant defense against oxidative damage.

Jessica Lineen ’25

Faculty Mentor(s): Professor Moria Chambers, BIOLOGY
Funding Source: Fund for Undergraduate Research in Biological and Chemical Sciences

Adipose Tissue and Immune System Issues: What Obese Fruit Flies can Teach Us About Survival and Resistance to Bacterial Infection

Obesity is associated with a state of low-grade inflammation, dysregulation of the innate immune system, and an increased risk for bacterial infection. Adipocytes and immune cells interact closely through a number of signaling pathways, and the adipose gene impacts fat storage in many different organisms. The fruit fly, Drosophila melanogaster, is a useful model because it has an innate immune system that is highly evolutionarily conserved and a genome that is easily manipulated. This study examines whether a specific deletion in the adipose gene impacts survival and resistance to natural bacterial pathogens. Male and female flies with the adipose mutation and Oregon R (OR) wildtype controls were injected with different bacterial species and monitored for survival and bacterial load post-infection.

Students in Biochemical Methods (BIO340) found that adipose mutant flies have an upregulation of antimicrobial peptides (AMPs), short amino acid chains that produce a first line of defense against bacteria. Therefore, I hypothesized that adipose flies would be more resistant to infection, living longer with lower bacterial loads. Data in males supported this hypothesis, as mutant males live longer than OR males and have lower bacterial loads when injected with P. rettgeri and E. faecalis, two natural bacterial pathogens of Drosophila. However, female flies were not similarly protected by the increased expression of antimicrobial peptides, indicating sexual dimorphism in regard to survival and immune resistance. Future research will be needed to determine why the adipose gene impacts the sexes differently and how it impacts other aspects of Drosophila immunity.

Ellie Lowe ’23

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

Controling Nucleation and Stability of Metastable Acetaminophen Polymorphs

Polymorphism is the ability of a molecule to crystallize into different structures in the solid state. While composed of the same compound, these crystal structures, or polymorphs, can vary in key properties such as compressibility and solubility. Because of this, polymorph selectivity has become an integral part of pharmaceutical development and formulation. There are many conditions that can affect polymorph formation such as temperature, additives, and environment. Acetaminophen, the active ingredient in Tylenol, is one example of a polymorphic compound. Here we use acetaminophen as a model system to better understand the sensitivity of polymorph selection and interconversion to environmental conditions. Using calorimetry and diffraction we show that polymorphs of acetaminophen often characterized in the literature as ‘elusive’ can be reproducibly crystallized through melt recrystallization when the atmospheric headspace is controlled at different stages. Moreover, controlling environmental conditions can increase the shelf stability time of certain forms by over an order of magnitude.

AKM Sadman Mahmud ’24

Faculty Mentor(s): Professor Katharina Vollmayr-Lee, PHYSICS & ASTRONOMY
Funding Source: National Science Foundation Grant (NSF)

Velocity and Shear Stress Profiles of a Sheared Athermal System with Pins

We use molecular dynamics simulations to study a two-dimensional athermal, bidisperse system with purely repulsive harmonic interactions. Via the motion of the rough top and bottom walls composed of frozen particles, we shear the system at a constant rate. Energy is dissipated via dissipative interactions, depending on the relative velocity during overlap. The system furthermore has fixed degrees of freedom in the form of ‘pins.’ The size ratio of pins: small particle: the large particle is 0.004:1:1.4. Pins are located on a square lattice. We study the microscopic and macroscopic properties of our system with and without pins in response to shearing. We show preliminary results for pressure and shear stress as functions of shear rate. For a constant shear rate, we further show results for pressure and shear stress as functions of packing fraction. We study local velocity and shear stress profiles. We find that pins impede the propagation of velocity and shear stress far from the walls. Furthermore, we study the time evolution of the average of D2min, a per-particle measurement of non-affine motion, and its relation to the contact number.

We acknowledge the financial support from the National Science Foundation (DMR -1905737 & DMR-1905474) and ACCESS startup allocation (DMR-190064 & TRA-100004).

Elena Marchetti ’23

Faculty Mentor(s): Professor Brian Smith, CHEMISTRY
Funding Source: Program for Undergraduate Research

Understanding Nucleation of 3D Covalent Organic Frameworks via Small Molecule Structural Analogs

Covalent organic frameworks are porous crystalline polymer networks characterized by high internal surface areas, with promising material applications such as purification, catalysis, and energy storage. With such a variety of potential applications, investigations into the synthesis, functionalization, and crystallinity of these frameworks is of key importance, but fundamental information about their growth and nucleation is still unknown. My research focuses on a 3D imine-linked framework, COF-300, a scaffold that to date has been extremely difficult to functionalize while still crystallizing. To study this, I synthesize a library of small molecule analogs and investigate the impact of functionalization on the preferred molecular crystal packing, as a model of the structure-directed polymer network. Using a combination of data obtained from single crystal growth and UV-Vis spectroscopy, I evaluate both the solubility of these compounds and how well their structures match what is needed for framework growth. With this data, we have assigned the likelihood of different functional linkers’ ability to crystallize in the desired packing. Overall, this work has identified the most promising systems to further study the nucleation mechanism of framework crystal growth and obtain functional materials.

Claire Marino ’23

Faculty Mentor(s): Professor Chris Martine, Professor Tanisha Williams, BIOLOGY
Funding Source: Department of Biology, D.D. Burpee Plant Fund

Solanum acanthophisum: a New Dioecious Bush Tomato Species from the Australian Monsoon Tropics

Estimates suggest that over 70% of the Australian flora and fauna has yet to be scientifically described. Numerous new plant species are still being described each year from across the continent. Here, we investigate a potential new species represented by just a few herbarium collections made in the remote Deaf Adder Gorge of Kakadu National Park, a biodiversity hotspot and UNESCO World Heritage Site. The new taxon was previously suggested as a possible localized variant of the functionally dioecious Kakadu endemic Solanum asymmetriphyllum and close relative of its sister species S. sejunctum. Using seeds removed from a herbarium sheet, a single ex situ plant was grown and used to assess more than 30 morphological characters to document the differences among S. asymmetriphyllum, S. sejunctum, and the putative new species. Morphometric analyses provide evidence that the three taxa are distinct from one another and support the segregation of the Deaf Adder Gorge variant as Solanum acanthophisum sp. nov. The specific epithet, “acanthophisum” is derived from the generic name of the sympatric death/deaf adder snake, Acanthophis praelongus. Solanum acanthophisum is now one of three recognized Solanum species occurring in Kakadu that exhibit functional dioecy, a sexual system in which morphologically bisexual flowers produce non-functional inaperturate pollen.

Henry Martin ’25

Faculty Mentor(s): Professor Kevin Myers, Professor Jennie Stevenson, PSYCHOLOGY
Funding Source: Robert P. Vidinghoff Memorial Summer Internship

Operant Conditioning in Prairie Voels

Operant Behavior is widely studied in laboratory settings to understand motivation and reward value in varying circumstances. Most commonly, operant experiments are performed with mice or rats. Dr. Jennie Stevenson, Department of Psychology, works with Microtus Ochrogaster, better known as the prairie vole. We developed a functioning system to run operant experiments with prairie voles to understand motivated behaviors through a new lens. The monogamous prairie voles have similarities in neural mechanisms for social affiliations to humans. The research process included assembling physical apparatuses, programming schedules to run automatically, and learning vole handling procedures. The apparatus consisted of a basic lever, a pellet dispenser with a trough, and a water sipper trough. Once all experimental design was completed, voles (n= 2) were individually assigned to an operant apparatus after a habituation period to the reinforcer in their home cages. On the first trial days, voles were placed in the apparatus and underwent magazine training schedules. After three days of magazine training, voles were introduced to a new Fixed Ratio-1 Schedule. Both these schedules occurred for 30 minutes, once a day, every day for a week. The data showed that voles learned the operant tasks, as demonstrated by the frequency of levers pressed per minute, cumulative reinforced lever presses, post-reinforcement pauses, and reward retrieval time. Therefore, we successfully developed an operant lever-pressing task for prairie voles.

Katy Martinson ’24

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

The Biological Alphabet: Finding the A’s, T’s, G’s, and C’s that Make a Firefly Smell

Photinus scintillans is a lighted species of firefly found in the Eastern United States. Although they primarily use flashes to communicate courting signals, it is possible they also use pheromones in addition to light signals to communicate for mating. One approach to begin to understand potential pheromone use in this species is to search for and examine the evolution of odorant receptors (ORs) in the P. scintillans genome. Here, I developed a computational pipeline to assemble long PacBio HiFi reads and Illumina Hi-C reads of a non-firefly test species of similar genome size, Rhagonycha fulva, the common red soldier beetle, into an accurate full-length genome. This includes: read assembly using the programs hifiasm and SALSA2 and assembly quality evaluation by assembly-stats and BUSCO, all wrapped in a reproducible Nextflow pipeline. The use of Nextflow was critical for this pipeline, as the pipeline can be reproducibly applied to any similar dataset and parallelized between multiple datasets at the same time. The importance of the Nextflow pipeline is its low difficulty of usage for all levels of biologists. The resulting genome was compared for quality with the published assembled genome on NCBI. The results of this comparison showed an identical, if not better, quality of gene content in our assembly as compared to the currently published version.

Marly McClintock ’23

Faculty Mentor(s): Professor Ronald Ziemian, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

An Investigation into Aluminum’s Torsional Behavior for Circular, Rectangular, and Square Cross-Sections

The purpose of this summer research was to compare experimental results to theoretical values derived using the current Specifications for Aluminum Structures and newly proposed equations. The intended goal was to highlight how conservative the current torsion standards are for aluminum design. Testing was completed on two different aluminum alloys, 6061-T6 and 5052-H32, which are two common alloys used in the structural engineering industry. Another changing variable was the specimen’s cross-section. A circular rod, square 0.5 in. bar and three rectangular bar cross-sections were all tested. A constant thickness of 0.5 in. was used for the rectangular sections with varying widths so that aspect ratios of two, three, and four were achieved. Six tests were performed on each section. The results were then plotted and compared to the predicted values calculated from the current standards and newly proposed equations. In order to ensure the most accurate results, tension tests were conducted on the alloys so that the correct yield strengths were used. The overall findings are still being completed, but a final deliverable and recommendation will be submitted to the Aluminum Association in early April.

Ethan McNamara ’24

Faculty Mentor(s): Professor Sarah Smith, BIOCHEMISTRY/CELL BIOLOGY, CHEMISTRY
Funding Source: Department of Chemistry

Biophysical Studies of Cell-Penetrating Metallopeptides

Interactions between proteins are necessary for biological functions, but when misregulated can result in pathology including cancer. Peptides have great potential to disrupt misregulated interactions as they are small enough to cross cellular membranes and can mimic natural interactions. However, it is essential to induce structure to short peptides; without modifications, they remain unfolded and unable to cross cellular membranes. My research involves designing metal-binding peptides to enter cells. I have synthesized peptides that bind metal ions at key locations on a peptide backbone, causing it to adopt an α-helical shape. I have performed experiments to quantify how changing peptide properties (e.g., structure, metal ion bound) alters the ability of a particular metal-bound peptide to enter human cells.

Through analysis involving circular dichroism spectroscopy, flow cytometry, and inductively coupled plasma mass spectrometry, I have found that the identity of the metal and the number of metal binding sites a peptide has are important factors in predicting its potential for cellular internalization.

Wuji Mi ’24

Faculty Mentor(s): Professor Ibrahim Sulai, PHYSICS & ASTRONOMY
Funding Source: Program for Undergraduate Research

The Development of a Cs-based Magnetometer

Dark matter is called dark because it is invisible. It does not interact with electromagnetic forces nor emit radiation, so observing dark matter is extremely tough. Fortunately, the dark matter still interacts with gravitational force and scientists managed to find evidence of its existence through this property. The standard model describes the electromagnetic, weak, and strong nuclear forces that are conducted by basic particles like electrons and quarks, yet the dark matter is not modeled by any of those particles. So, finding the possible candidate for dark matter is a crucial topic in science. Some theories show that dark matter may have the form of a scalar bosonic field produced when the earth encounters a dark matter cloud that is not uniformly distributed. In the research, we designed a Cs magnetometer that can capture the changes in magnetic fields and block the outer noise by putting it into a 4-layer magnetic shield made of 3 metal shields and a high magnetic permeability ceramic shield.

To capture this field that is one hundred billion times smaller than the Earth’s field, we need a really sensitive detector such as the Cs magnetometer. And my job was to set up the circuits and magnetometer and test their functions. I set up and calibrated the laser circuit with professor Sulai and also 3D-designed and printed the container to hold our laser inside the shield. Then we sent the data to the computer to plot the absorption spectrum andconfirmd the Cs transition features.

John Mirsky ’23

Faculty Mentor(s): Professor Matthew Baltz, SOCIOLOGY & ANTHROPOLOGY
Funding Source: Douglas K. Candland Undergraduate Research Fund

What if There’s No One Pulling the Strings? A Cultural Theoreitcal Analysis of the Rise of Big Tent Conspiracy Theories and Nationalist Populism

In the midst of what scholars regularly characterize as a “post-truth” age, I take a comparative approach, examining two of the largest extant conspiracy theories–Qanon and Anti-vaccine–in an aim toward better understanding their contemporary prominence. Methodologically, I conduct a critical discourse analysis of the speech associated with the theories, (including propaganda documentaries, social media posts, and political speeches). While the majority of the conspiracy theory literature has been conducted in psychology and political science, a more recent, burgeoning sociological intervention has more closely explored structural factors. In this paper, I advance literature in the sociology of culture that investigates these structural dimensions by examining a key structural force of late– the extensive increase in the speed and scale of information flow stemming out of neoliberalism. Taking Hartmut Rosa’s emphasis on the “cultural, ethical, and psychological” effects of speed as inspiration, I investigate empirically the relationship between a reified commitment towards the speed in the context of the crisis of burnout and the development of algorithms. I conclude by calling attention to a possible method of decreasing conspiratorial belief through the mobilization of Guy Debord’s concepts of “cyclical time” and “semi-cyclical time” in association with contemporary social and political trends.

Tsugunobu Miyake ’25

Faculty Mentor(s): Professor Alan Marchiori, COMPUTER SCIENCE
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Developing a Low-cost Turbidity Sensor Using Synchronous Detection

Turbidity is an essential measurement to assess water quality. Turbidity optically quantifies the cloudiness of a liquid and is commonly measured in Formazin Nephelometric Units (FNU). Commercial turbidity sensors are expensive, and previous work has developed numerous low-cost turbidity sensor designs. However, these designs face numerous challenges, causing inaccuracy in measurement, such as ambient light and bubbles in the liquid. This research developed an improved low-cost turbidity sensor that lessens the error caused by these challenges by adapting a colorimeter evaluation board, equipped with an analog-to-digital converter that reads the raw voltage output from a photodiode. The lock-in amplifier minimizes the effect of ambient light on the turbidity measurement by differentiating the light emitted from the LED and any ambient light. In lab tests, the developed continuous turbidity sensor was within 0.4 FNU from the actual turbidity more than 80% of the time, and nearly all of the readings fell within 1 FNU from the actual turbidity. Furthermore, analysis of the collected data revealed that the model can be accurately calibrated from only two distant turbidity measurements.

Collin Murphy ’24

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

Predicting Patient-Specific Optimal Deep Brain Stimulation Locus in Parkinson Disease Patients Using Subthalamic Nucleus Anatomy

The subthalamic nucleus (STN) is widely accepted as the standard target for deep brain stimulation (DBS) in the treatment of Parkinson’s Disease (PD). Optimal stimulation location within the STN is seldom agreed upon in the literature. The objective of this study was to determine the relationship between STN anatomical features and patient-specific optimal stimulation location in PD patients.

The patient database included 87 previously segmented PD patient STN models and their associated stimulation parameters. The volume of tissue activated (VTA), a representation of the amount of tissue in the brain receiving stimulation, was previously produced using patient-specific tissue activation modeling2. Volume, sphericity, and two metrics for flatness were generated for each STN. VTAs were used to calculate activation percentages of the dorsal, ventral, lateral, medial, anterior, and posterior STN regions. Anatomical features were compared between active contact location groups. Regional activation percentages were also compared among active contact groups. STNs were then grouped by predominantly stimulated region using VTAs, and anatomical features were again compared between groups. No significant differences in anatomical features were observed between stimulation groups. Aside from the two, all differences in anatomy among active contact groups were also insignificant. Based on the lack of significance in anatomical comparisons between VTA-based groups, further evidence is necessary to suggest that any of the anatomical features analyzed are suitable predictors of therapeutic stimulation location. The difference in significance between VTA-based comparisons and active contact-based comparisons suggests some disconnect between active contact location and stimulation location and implies a bias in stimulation spread.

Quan Nguyen Tu ’24

Faculty Mentor(s): Professor Robert Nickel, ELECTRICAL & COMPUTER ENGINEERING
Funding Source: Program for Undergraduate Research

ProPANE Notetaking Assistive Technology

The Propane project is a collaborative project between engineering and education at Bucknell University. Our goal is to develop an assistive technology that will support note-taking for college students with certain learning disabilities (LD) and English Language Learners (ELLs) in the classroom to improve their content learning and academic performance. While research has shown that effective note-taking leads to better performance and content mastery, students with LD and ELLs may struggle with this task in lecture-based college classrooms. The purpose of the project is to reduce students’ cognitive load and free students’ working memory space to absorb lecture content.

Our approach is to create a smartphone application that will be used by the student to capture the lecture. The student will submit a video of the lecture, and the application will use various image-processing techniques and machine learning to extract the key information from the lecture. The extracted information is returned to the student for them to further review and or annotate. The extraction of the targeted information is a unique aspect of this project and presents major technical challenges but can potentially support effective and efficient note-taking. By allowing the student to focus on the lecture and not note-taking, it allows them to engage in other ways and use their working memory space on activities and discussions.

In this research, we focus on developing an image processing technique using machine learning to automate and enhance the process as more input is collected.

Tobi Oduoste ’25

Faculty Mentor(s): Professor Indranil Brahma, Professor Constance Ziemian, MECHANICAL ENGINEERING
Funding Source: College of Engineering

Improving Damage Modeling for Additive Manufactured Parts using Machine Learning

This research project was aimed at developing and improving predictive models for the fatigue properties of additively manufactured (AM) components using machining learning and deep learning Methods. A large dataset was available from recent fatigue studies on ABS specimens fabricated by fused deposition modeling, an AM method. The data was generated from physical testing where AM specimens with different fiber orientations and layer patterning were cyclically loaded until fracture. Test results included force displacement data per loading cycle, where the final cycle is the specimen’s fatigue life. Using MATLAB, statistical techniques were used to estimate the material stiffness for the tension portion of each loading cycle. The degradation of specimen stiffness during load cycling was then investigated, and a damage index per cycle was developed.

With the statistical analysis completed, work could begin to develop a general predictive model using the processed data. The machine learning method initially used (Regression and cross-validation) involves a set of process parameters and an equation to fit all the data. Initial efforts were unsuccessful, and it was concluded that the data is too diverse to use traditional statistical methods to create a general predictive model for the specimen damage index. The next course of action was to use deep learning to determine if the computer could fit the data, which is essential to demonstrate that prediction is possible. A predictive model for the damage index was created but is still yet to be tested on new specimens. This work is still ongoing.

Somtochi Ojiaku ’25

Faculty Mentor(s): Associate Dean Terri Norton, ENGINEERING SUCCESS ALLIANCE
Funding Source: College of Engineering

Police Body Cameras and their Relation to Law Enforcement

It was revealed that the data provided to display fatal police shootings in the U.S. were handled by the very police systems themselves, thus resulting in the risk of inaccuracy. In response, the Washington Post database recorded every fatal police shooting in the U.S., starting from Jan 2015. The data revealed that though a total of more White people were shot, Black people were getting shot at a disproportionate rate compared to them. In this research, we will analyze the same data while centering the presence of body camera footage within each shooting. In this research we ask, how many shootings with Black people involved body camera footage, and how does this relate to law enforcement’s treatment of Black people? This research should expose any further lack of vigilance and regard taken toward Black bodies by the law. To extract this information, R Studio, and Excel were utilized to quantify, organize, and analyze the given data. Results showed 80% of total Black people were involved in an arrest without a body camera, next to 89% of total White people whose situation did not involve a body camera. The results are very close in percentage, though Black individuals make up only about 13% of the U.S. Black individuals are being killed by ambiguous means at a quicker rate than their White counterparts. This disproportion in body camera footage exposes a lack of protocol used by law enforcement and discrimination towards the Black community that needs to be addressed.

Shaun Parrish ’23

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

Scroll Bar Topography Influences Soil Carbon Storage on Floodplains: Evidence from the Mississippi Floodplain, Central Louisiana

Vegetated floodplains are critical landscapes for the accumulation and storage of soil organic carbon (SOC), but alluvial floodplains have complex micro-topography that can impact soil properties and carbon storage. Scroll bars, and curvilinear ridges of sediment deposited on the inside of meander bends, are topographic features on floodplains, but the extent to which these small-scale geomorphic features impact soil carbon has not been quantified. We evaluate the controls on soil development and carbon storage within the paleo-Mississippi River scroll bars at Bayou Cocodrie National Wildlife Refuge, Ferriday, LA. We collected 1m deep soil cores and measured basal area and Serenoa repens density at eight scroll ridge-swale transects. Using a Shimadzu CHN analyzer, SOC concentration (%) was analyzed from 0-32cm, 32-64cm, and 64-96cm depth intervals.

Scroll bar ridge sites comprise silty clay and somewhat poorly drained soils with higher palmetto densities (mean = 1.26 P/m2) relative to swales, which comprise very poorly drained clay soils with lower palmetto densities (mean = 0.38 P/m2). The top 32cm of swale soil cores contained significantly higher SOC% compared to the ridges (swale mean: 2.88% vs 1.89% on ridges) at all transect sites, indicating that the scroll bar topography does impact soil carbon storage despite the opposite vegetation trends.

These results suggest that in the Mississippi River floodplain, scroll bar topography exerts a stronger control on SOC than vegetative density, possibly due to swale drainage and grain size. Understanding soil carbon storage across floodplains can assist conservation efforts to address emissions and ecosystem health.

Kurt Phipps ’24

Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Experimental Modal Analysis and Dynamic Parameter Verification

This summer during Research I learned a ton of skills that can be used in my field as well as many life skills that will be so useful for my professional life after college. My biggest takeaway from the project is I have a deep understanding of how to use Crystal Instruments Spider80XI software as well as SAP2000 software. These programs enabled me to gather actual data from our structure to use in comparisons and to visualize what is occurring in my cantilever experimental structure. I learned that 1-support cantilevers behave much differently than 2-support cantilevers especially when the 2nd support is hard to understand with what degrees of freedom it is truly restraining and I learned that structures don’t change very much from dynamic excitation over years, and it is possible to reproduce results from many years earlier. I learned these through experimental analysis by moving support conditions around and altering the mass the electrodynamic excitation would send through the structure. Every change would have a substantial impact on the frequency of the structure experienced in each mode. SAP was super helpful in this phase too, because it enabled me to theoretically see when the frequency should be for each mode based on my configuration and can use that visualization to tweak my structure to be as close as possible to what is theoretically expected. When the two matched up close I was able to determine, my structure was acting how it would be expected.

Iona Pitkin ’25

Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Investigations into the Compressive Behavior of a Miura-ori Folded Structure

Structural origami is an emerging field that combines the Japanese art of paper folding known as origami with structural engineering in order to assess the structures that can be created and their enhanced properties, such as compressive capacity and deformation pattern. Using an origami fold known as Miura-ori, a series of geometrical models were created representing three different angles along with two different thicknesses of the thin walls. The specimens were printed using plastic material called Polylactic Acid (PLA). A testing jig was designed and fabricated for the origami specimens to model a boundary condition with no translation during testing. The resulting deformation from compression testing appeared to follow a relatively consistent pattern of buckling, with some cracking and splitting happening on one edge. The specimens with a shallower angle could withstand less load. This correlates with elastic buckling theory as the height and width of the plates in these specimens are greater, and larger plates will buckle at a lower load. Further testing is needed to ensure the repeatability of these results. In addition, future research is needed to consider the deformation behavior of the individual plates to confirm whether the failure mode is buckling or a combination of crushing and buckling.

Patricia Poley '23

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

Solution Polycondensation Synthesis of Polyanhydrides Using Tosyl Chloride for Controlled Drug Delivery

Polyanhydrides are hydrolytically erodible polymers containing anhydride bonds. They are ideal drug delivery vehicles because of their tunable erosion time and surface erosion properties. Previous work found solution polycondensation conditions for diacids using 4-toluenesulfonyl chloride (tosyl chloride) and triethylamine (TEA) that resulted in polymers. However, when n-methyl imidazole (NMI) was used as a base in the reaction, a precipitate salt forms instead of anhydrides. My work aimed to optimize the reaction conditions to prevent NMI precipitation and to improve poly(sebacic anhydride) synthesis. We hypothesized that this reaction's inability to form a polymer stemmed from the diacid not being a strong enough nucleophile to displace the NMI leaving group. To synthesize polymer, sebacic acid, tosyl chloride, and dry acetonitrile was added to a vial. Once dissolved, NMI was added. After reacting under stirring for 2 hours, the solution was precipitated in diethyl ether. The filtered product was dried overnight under vacuum then analyzed using Fourier Transform Infrared Spectroscopy, Proton Nuclear Magnetic Resonance, and Gel Permeation Chromatography. To determine the most effective reaction conditions, polymers were synthesized using a range of temperatures, different bases and salts, and different orders of reagent addition. Inorganic bases with tosyl chloride, as well as increasing temperatures, resulted in cyclic anhydride formation, as determined by the collected FTIR spectra, instead of polycondensation. This method provides a means to make polyanhydrides with high molecular weight and use a commercially available, simpler-to-handle chemical reagent compared to other solution polycondensation reagents.

Jordan Polvere, Graduate Student

Faculty Mentor(s): Professor Karen Castle, CHEMISTRY
Funding Source: Chemistry Graduate Research Fund

Collisional Quenching of Vibrationally Excited CO in Non-LTE Environment

The atmosphere of Saturn's largest moon, Titan, is of growing interest to the space science community. However, since its atmosphere is not in local thermodynamic equilibrium (non-LTE), modeling it requires a deep understanding of the natural excitation and relaxation processes that occur there. Our group has studied CO, the primary reservoir of oxygen on Titan, and its rate of collisional quenching, to contribute toward improving atmospheric models. Using transient diode laser spectroscopy, a quenching rate can be elucidated to significantly higher precision than previously documented in literature. Our experimental procedure begins by flowing small amounts of CO, O3, and Ar through a 1-meter vacuum cell, and firing a 266 nm laser through the cell. O3 absorbs this wavelength and causes the mixture to undergo a temperature jump, allowing some amount of the CO to be excited to higher vibrational states. A mid-IR range diode laser is used to constantly measure the population of CO in a certain state, allowing us to determine the rate of change of the population in a state of interest as it collides with other molecules and is quenched. We use this to study the effects of bath gas identity on CO energy transfer measurements. Specifically, we are interested in the effectiveness of Ar versus Xe in quenching excited photofragments from the ozone photolysis that initiates the temperature jump. The most recent results of our work will be presented.

Sarah Preston '25

Faculty Mentor(s): Professor Sarah Lower, ANIMAL BEHAVIOR, BIOLOGY
Funding Source: Department of Biology, National Science Foundation Grant (NSF), Biology summer research funding

Dancing in the Dark: How Does the Absence of Light Affect Unlighted Firefly Mating Behaviors?

While fireflies are renowned for their bioluminescent flashes that are used to find mates, some firefly species have lost the ability to produce light as adults and are active during the day. In contrast to their night-active relatives, for these "unlighted" species, mating behaviors largely remain uncharacterized. Previous studies suggest that unlighted female exposure of the top surface of the abdomen may trigger the release of a pheromone - a smell that attracts males. This experiment sought to compare behaviors associated with mating among two unlighted species, Photinus corrusca and Pyropyga decipiens, and one lighted species, Photinus scintillans. By recording behaviors after a female and male were together in a container, we predicted that unlighted females would expose the dorsal surface of their abdomens before being approached by a male, while lighted females would instead reply to male flashes without a difference in posture. Our results suggest that P. corrusca females curl their abdomen prior to male attraction, and future studies are planned to increase sample size. This project was significant because lighted and unlighted firefly declines and threats to their populations are just starting to be investigated. Because not much is known about unlighted firefly populations, they are particularly vulnerable to vanishing before we even know what is there, so understanding how these fireflies identify, find mating partners, and reproduce is crucial to conservation efforts. Pinpointing key mating behaviors will also facilitate future studies in the Lower firefly lab to behavioral assay for firefly pheromone use and isolate those substrates.

Sam Pring ’23

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

What the Eyes Don’t See: Differential Expression of Odorant Receptor Genes in the Common Eastern Firefly, Photinus Pyralis

Like rapidly disappearing stars above the grass, fireflies have captivated the eyes of children around the world. As we stare in admiration, these light shows are actually mating signals, a private conversation between adult fireflies. But, while we focus on their dazzling, summertime performance, is there more happening behind the scenes, a conversation the eyes cannot see? Many other insects rely primarily on chemical signals, pheromones, to locate mates. In such cases, odorant receptors (ORs) are important to perceive these signals. But do lighted fireflies use pheromones alongside bioluminescent visual cures? If so, we predict that ORs would be “switched on” in male antennae during the mating season. To investigate these questions, we sequenced the RNA from antennal and back leg tissues of 7 individual common Eastern fireflies, Photinus pyralis, four male and three female. The sequences were cleaned, filtered, and matched to the species’ reference transcriptome. A differential gene expression analysis is ongoing to see which, if any, ORs are upregulated during the mating period, where these receptors are located on the beetle’s body, and if ORs are conserved across species by comparing the data to that of their closest related unlighted species, the winter firefly, Photinus corrusca. Through increasing understanding of an insect’s olfactory system, as well as their mating and communicative behaviors, one can use this information to implement research and strategies for conservation efforts, a topic with increasing importance as firefly populations begin to decline due to light population and other environmental detriments.

Jimmy Pronchick ’23

Faculty Mentor(s): Professor Heidi Lorimor, LANGUAGES, CULTURES & LINGUISTICS
Funding Source: Ruth Everett Sierzega Chair in Linguistics

Parallel Planning and Verb Tense Errors

Speech errors are a common phenomenon, even in one’s native language. Thus, speech errors have been widely researched in psycholinguistics as a way of understanding the mental processes involved in language production. In this study, we investigated the type of errors that occur when a speaker uses a tense form of a verb when a non-tensed form should have been used. For example, in the sentence “She didn’t meant that,” the tensed form “meant” should be the non-tensed “mean”.

One cause for this type of error is interference from parallel sentence plans, where speakers may be planning multiple sentences in parallel, and errors may arise when elements from a competing sentence leak through. (Brehm et al, 2022). An example of parallel planning is when a speaker begins activating both “No problem” and “One moment”. They might start responding “One [moment],” but if the other response is still active, they might actually end up saying “One problem.” In order to investigate this effect with verb tense errors, we conducted an online behavioral study of English speakers using audio data that participants recorded on their own computers. We manipulated factors such as past/present tense, ir/regularity and non/connectedness to nouns in the sentences to determine whether any of these factors made tense errors more likely. We are in the process of analyzing the data. The results will help us better understand the cognitive processes underlying verb tense production and sentence planning in general.

Jaehoon Pyon ’24
Reva Sharma ’25, Katrina Wilson ’25

Faculty Mentor(s): Professor Evan Peck, COMPUTER SCIENCE
Funding Source: Presidential Fellowship, Program for Undergraduate Research

Visualization Islands: Surveying Visualization’s Performance and Accessibility Barriers on the Web

This summer we – Reva, Jaehoon, and Katrina – worked with Prof. Evan Peck from the Computer Science Department on a research project.

Data-driven decision-making has permeated all aspects of our society, from where we get lunch to which credit cards we apply for, to formulate better plans of action in order to save lives during a pandemic. While the expansion of network infrastructure in the 21st century has made the internet available to the common people, we cannot equate the availability of data with access to data.

We investigated how websites and data visualizations on the internet are impacted by device limitations and unreliable internet connectivity. For these purposes, we used a covid-19 dataset with over 3000 URLs that communicated health information during the COVID-19 pandemic. With the help of open-source web performance analysis tools and APIs, we aimed to determine the accessibility of these websites.
Results:
• We collected more than 120 GB of detailed web performance and accessibility data, including almost 200,000 image files, which will be made publicly available.
• We categorized our results based on which device, i.e., desktops vs. mobiles, and which bandwidth, i.e., 3GS, FIOS, or DSL, the public is using.
• Our ongoing publication will give insight into the performance of a website based on the language it is written in, the source that created it, its publisher, and guidelines that will improve its accessibility.

Gwen Radecki ’25

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

Learning Through Sounds and Shapes: An Analysis of Multi-sensory Statistical Learning

Statistical learning (henceforth SL) is the unconscious acquisition of structured information from environmental inputs. For example, we can extract word boundaries from the frequency of syllable transitions. SL is a multisensory phenomenon, having been demonstrated in multiple modalities and stimulus domains. However, it remains to be seen whether SL is supported by independent modality-specific mechanisms (i.e., a separate mechanism for vision, hearing, and touch) or a singular modality-general mechanism. In the present study, we test these models by manipulating the rate of presentation for auditory and visual SL. If the mechanism is modality-general, the rate of presentation should not affect learning and performance will be similar across modalities. If the mechanisms are modality-specific, the rate of presentation should affect learning: subjects should learn auditory sequences better at faster presentation rates and visual sequences at slower rates. Preliminary results suggest that auditory and visual sequences are learned most effectively at different rates of presentation, providing evidence of a 'modality constraint' on SL. This suggests that multisensory SL may be supported by modality-specific mechanisms, though further research and data collection are required.

Matthew Repke '24

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

Funding Source: Kalman Fund for Biomedical Research Fellows, National Institutes of Health

Antiviral Immune Responses to Ebola Virus-Like Particles in Hibernating Thirteen-Lined Ground Squirrels

Hibernation induces a significant physiological change through decreases in metabolism, respiration, heart rate, and immune response. In particular, this study sought to understand how antiviral immune responses were affected by hibernation, using thirteen-lined ground squirrels as a model organism. Ebola virus-like particles (particles that resemble Ebola but are not infectious) were used to simulate a viral infection. Twenty-four squirrels were placed into a hibernation chamber, while eighteen were kept at room temperature for this study. The squirrels were given adjuvants, which are biological molecules that help stimulate a more robust immune response. Blood was both drawn before immunization as well as on day 35. Antibodies to Ebola virus-like particles were measured through an ELISA. Additionally, on day 35, terminal splenocyte and bone marrow samples were collected. The squirrel's immune response to Ebola VLPs was measured through a stimulation challenge of splenocytes with Ebola peptides and glycoproteins. If a squirrel mounted an immune response during the 35-day study, then when peptides are added to the splenocytes, T cells should proliferate. Fluorescent antibodies were used to label proliferating cells, which were detected using a flow cytometer. It is predicted that there will be less proliferation of T cells in the hibernating squirrels than in the non-hibernating squirrels. The analysis of these results is ongoing.

Elena Roe '23

Faculty Mentor(s): Professor Courtney Burns, Professor David Mitchell, INTERNATIONAL RELATIONS, POLITICAL SCIENCE

Funding Source: Presidential Fellowship, Bucknell Institute of Public Policy Summer Research Fellowship

Women Leaders in the Baltic States: Breaking the Double-Bind

Across the post-Soviet region, but particularly in the Baltic states, women executives have gained power in greater numbers and at higher rates than many other regions in the world. This defies existing literature, as these states maintain conservative gender stereotypes while also facing a major security threat from Russia close to their borders. This thesis posits that the increase in women within Baltic legislatures across time creates a political pipeline, or a pool of qualified candidates that makes the election of women to executive power more likely. This is not the only factor, however, as the influence of NATO as a guarantor of Baltic security cannot be understated. Thus, this research finds evidence that NATO's Article V has provided a security guarantee for the Baltic states, removing the burden of proving security competence from women leaders - an area which often complicates womens' elections or aggravates the effect of stereotypes. This allows women to maneuver around the double-bind, and in combination with the political pipeline, NATO's security guarantee leads to a higher likelihood of women executives being elected in the Baltic states. Estonia and Lithuania are selected as case studies, which culminate in an examination of the election of current Estonian Prime Minister Kaja Kallas and Lithuanian Prime Minister Ingrida Simonyte.

Maddi Roth '24

Faculty Mentor(s): Professor Elif Miskioglu, CHEMICAL ENGINEERING

Funding Source: National Science Foundation Grant (NSF), Presidential Fellowship

Characterizing the Relationship Between Experience and Internal Factors in Engineering Practitioners

Experience is known as a major contributor to expertise in engineering practice, but the types of experiences available to individuals vary widely. The disparate opportunities individuals have in access to different types of experiences are a mechanism that can perpetuate inequity. With the goal of adding to the literature regarding the role of experience in the engineering workplace, this work explores the pivotal role of different types of experiences in engineering practitioners' careers, in particular their development of expertise, decision-making in their roles, and perceptions of engineering intuition. We analyzed a dataset of 27 interviews with practicing engineers from 0 - 25+ years of experience. The interview protocol included three distinct sections: expertise, decision-making, and intuition. Each interview was qualitatively coded by multiple experienced coders during and following the development of an emergent codebook. Through this work, sub-codes were developed and applied to all interviews to further explore the contexts of relationships between codes and the concepts they capture. Across all interview sections, the most common relationship in the data links experiences to an individual's mindset and personal conditions, highlighting the personal nature of experience. The interaction between one's experience and the consequences it has is cyclical as these consequences then affect future experiences. The strong connection here between individual circumstances and experience suggests that it is imperative to divert more attention to creating opportunities for positive experiences that promote an individual's professional development. If promoting positive experiences is not prioritized, negative experiences have the opportunity to have a discouraging influence.

Maddie Sanders ’23
Faculty Mentor(s): Professor Kelly Salyards, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: Presidential Fellowship

Development of Origami-Inspired Geometric Models for Structural Applications

Determining the geometric and mechanical properties of origami-inspired folded systems for engineering applications is beneficial to identify and take advantage of their unique properties. Due to the construction of origami with stiff peaks and a folded nature, origami-inspired systems provide a rigid structure that is also compressible and deployable. These characteristics have been beneficial in various engineering fields, such as with solar power arrays, medical stents, and temporary shelters. Through this research, the Japanese Miura-Ori origami pattern has been determined to best align with structural engineering applications. Six versions of the Miura-Ori fold with varying angles and plate thicknesses were designed to enable 3D printing. The research process began with an exploration of the Miura-Ori pattern through paper and cardboard folded models. Through careful analysis, calculations were made to determine the geometry for models of varying angles and accounting for element thickness. Numerous extruding and layout techniques, as well as modeling software, were used to produce optimum model results with reduced structural weaknesses. Because of the uniquely thin elements and complex geometry of the Miura-Ori fold, the 3D printer properties were critical to avoid printing errors. After countless revisions, the Miura-Ori-inspired models were successfully designed and 3D printed. Preliminary structural analysis was conducted to better understand plate buckling in SAP2000, a commercially available structural analysis program. The geometric modeling and 3D printing that was completed is the foundation of the current experimental testing and future computational analysis that will be used for verification of the experimental results.

Sabrina Savidge, Graduate Student
Faculty Mentor(s): Professor Jessica Newlin, CIVIL & ENVIRONMENTAL ENGINEERING
Funding Source: The Katherine Mabis McKenna Environmental Internship Program

Characterization of Transient Storage in Varying Small Stream Environments

The transient storage zone processes are investigated in a small second order stream with a 2.2 square kilometer watershed. Sections of the stream study site are impacted by varying types of stream restoration practices and watershed management practices. The presence of transient storage zones in small streams impacts the available flow paths for water and results in a wider range of residence times for water and dissolved chemicals than would be predicted by considering only the main channel flow path. Residence time can be used to quantify the health of a stream as several biogeochemical and ecological processes occur in water slowed by transient storage. A combination of data collection, field experimentation, and data analysis is used to characterize the variability in transient storage zone processes and residence times in a small stream and to relate the identified storage zone processes to physical characteristics of the stream. Field experimentation took place along measured sections and included geophysical investigations of the subsurface and continuous tracer studies using a conservative tracer with samplings from main channel and transient storage zones. Previously collected tracer study data from a similar location on the stream is also used. Data analysis leads to a preliminary understanding of how various stream and watershed management practices can impact the presence of transient storage zones and the range of residence times and flow paths in small streams.

Jan Schmid ’23
Faculty Mentor(s): Professor M. Laura Beninati, MECHANICAL ENGINEERING
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Flume Flow Conditioning

Flow conditioning was conducted on the large flume in Bucknell University’s Renewable Energy Lab using a Laser Doppler Velocimeter (LDV) to induce ideal flow conditions for future laboratory testing. Flow conditioning is essential to establish similitude between the laboratory and real-world environment. High-quality testing at a reduced scale in a flume leverages the research and development capability of prototyping and provides immense value in simulating real-world conditions. Due to the plumbing architecture of the flume, a swirl is induced in the flow resulting in a non-uniform flow velocity profile across the four-foot width of the system. The effects of the swirl are detrimental to accurate and precise testing, and as a result, flow conditioning was performed over the course of a month. A variety of flow control devices available in the laboratory were installed systematically to observe and document their effects in tandem and individually. Testing was conducted at the safest maximum flow rate of around 600 GPM: significantly reduced as compared to the flume without flow control device installations. Data and analysis prior to testing established the testing depth and positioning of the LDV along the 32-foot length of the flume. The LDV data provided verification of the observed effects of the flow control devices and a significant reduction of non-uniformity in the velocity profile. In establishing repeatable idealized flow conditions future prototypes under testing in the flume will be armed with meaningful dynamic results to leverage the success of real-world designs.

Sonja Schmoyer ’23
Faculty Mentor(s): Professor Jigjidsurengiin Batbaatar, Professor Jeffrey Trop, GEOLOGY & ENVIRONMENTAL GEOSCIENCES
Funding Source: Program for Undergraduate Research

Short-Term Morphological Changes in Icy Debris Fans along a Retreating Glacial Terminus, Southern Alps, New Zealand

This research focuses on the short-term morphologic transformations in a rugged periglacial landscape in the Southern Alps of New Zealand that is actively deglaciating in response to climate change. Analysis of satellite imagery between 2012 and 2021 quantified changes along the retreating terminus of Mueller Glacier, overlying icecaps, and intervening icy debris fans (IDFs), largely unexplored landforms that are common in actively deglaciating environments. The surface area of the icecaps decreased 14-21% and decreased by as much as 46 m in elevation. The valley glacier terminus retreated 1,077 meters eastward up valley and decreased in elevation as much as ~300-meters, creating significant accommodation space and a proglacial river downslope of easternmost IDFs. Three easternmost IDFs located along the terminus of the valley glacier changed considerably and migrated eastward, filling accommodation space created by thinning/debutressing of the valley glacier, whereas the three westernmost IDFs upslope of the terminus experienced little migration and change due to their proximity to the terminus. Icy debris fans changed variably in the apex location, surface area, slope, and morphology. The observed spatial variations in geomorphic change in IDFs, and lack of corresponding variations in the icecap indicate that thinning and retreat of the valley glacier terminus exerted primary influence on fan evolution. Understanding short-term changes in IDFs is important in understanding hazardous hillslopes along the terminus of retreating glaciers given the ongoing effects of climate change. Results of this study demonstrate that IDFs may rapidly prograde onto proglacial rivers and influence stream hydrology.

Hannah Schultheis ’24

Faculty Mentor(s): Professor Ellen Herman, Professor Molly McGuire, CHEMISTRY, GEOLOGY & ENVIRONMENTAL GEOSCIENCES

Funding Source: The Katherine Mabis McKenna Environmental Internship Program

An Analysis of the Transportation of Metals and Trace Metals in an Abandoned Mine Drainage Treatment Site

Abandoned mine drainage (AMD) is a contaminant problem that watersheds across the United States face. AMD is the result of water traveling through abandoned mines, dissolving harmful metals into the water, which is then brought out into streams and rivers. These toxic metals can cause harm to aquatic life, and can affect recreational activities. The treatment site known as scarlift site 15 works to remove iron from the contaminated water and lower the pH. The main goal of this research was to analyze the travel and transportation of these toxic metals in scarlift site 15, a passive mine drainage treatment site located in Ranshaw, PA. Water samples from the treatment center were collected, filtered, and analyzed using inductively coupled plasma mass spectrometry (ICP-MS) and ion chromatography (IC). These results were used to observe the patterns of where the metals precipitated in the system. These patterns were used in conjunction with the size of the particles in order to see if they were traveling attached or with another metal.

Cobalt, nickel, and zinc all follow the trend of precipitation out of the water that aluminum has. Iron primarily comes out without other trace metals, implying that the trace metals were finding another way out of the water. In the system, the iron was not coming out from the treatment within the system, but rather it was precipitating out of the water from sitting in the pools of the treatment site.

Joshua Semken ’24

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

Funding Source: Program for Undergraduate Research

Synthesis and Purification of Diacids

This Summer I had the privilege of working under Professor Brandon Vogel in the chemical engineering department. My project revolved around synthesizing and purifying diacids from diamines such as Hexamethylenediamine (HMDA) and Jeffamine. Using the chemical formula, I would change variables to attempt to either improve conversion rate or make purification easier. We believe that polymers synthesized from these diacids will possess interesting properties that we want to study with their application to drug delivery. However, we could not begin the synthesis of anhydride containing polymers without the diacids. We need these diacids to be of high purity or else the polymers will never synthesize. This is why the research we conducted this Summer was important. We were able to develop methods for synthesis and purification for the Hexamethylenediamine utilizing strong hydrochloric acid to adjust the Ph of the solution. We were also able to achieve synthesis and purification of Jeffamine utilizing heat and a strong vacuum. Jeffamine (diamine) has a low boiling point, so we were able to separate the unreacted material from the desired product in this manner.

Harry Shi ’25

Faculty Mentor(s): Professor William Scott, MECHANICAL ENGINEERING

Funding Source: College of Engineering

Design and Fabrication a Caterpillar-inspired Soft Robot by 3D Print Method

Soft crawling robots can potentially access locations that are unreachable by humans and traditional rigid robots. And their delicate body parts prevent them from damaging the environment and themselves when falling. In this case, the soft crawling robots play a crucial role in conducting the missions like observing, monitoring, and even rescuing. During the summer, we developed a soft robot inspired by the crawling mechanisms used by the caterpillars. The robot is constructed by 3D printed parts and actuated by motors and strings attached to it. The uniformity between each segment makes modifying and manufacturing the robot easy. And its simple structure provides it the feasibility to adapt to and move in the complex 3D environment. Experimental results show that the 3D print soft parts can store and release elastic energy, and the designed structure allows the robot to mimic the motion of the caterpillars.

Crystal Dawn Snyder, Graduate Student

Faculty Mentor(s): Professor Jasmine Mena, PSYCHOLOGY
Funding Source: Graduate Summer Research Fellowship

Strengthening Communities: Mental Health Literacy and Social Connection

Community Health Needs Assessments and Pennsylvania Youth Surveys indicate that mental health concerns and social disconnection are on the rise in the Hazleton area. The Mental Health First Aid (MHFA) program has been shown to produce positive long-term effects, including increased mental health literacy, more positive attitudes about mental illness, and confidence and intention to perform helpful actions. The Hazleton Integration Project (HIP) launched a local mental health literacy program. The program evaluation involved surveys and focus groups with course participants designed to answer the following questions: 1. Was the MHFA program delivered as intended (fidelity)? 2. Did participants' mental illness knowledge, attitudes, and stigma improve over time? 3. Do participants feel a stronger sense of social connection?

After registering for the course, participants completed a pre-survey designed to capture their current knowledge, attitudes, and stigma related to mental illness. After completing the course, they completed another survey that assessed changes in their mental illness knowledge, attitudes, and stigma. This survey was repeated after three months to see if the changes were long lasting. After six months, participants joined a group conversation which allowed them to share their perspectives in their own words. After taking the Youth MHFA course, participants gained mental health knowledge, increased their intentions to help someone in need and reduced their stigma toward people with mental illnesses. The next step is to continue evaluating the effects of the program on mental health literacy and a sense of community.

Isabel Steinberg '23

Faculty Mentor(s): Professor Ken Field, Professor DeeAnn Reeder, BIOLOGY
Funding Source: Kalman Fund for Biomedical Research Fellows, National Institutes of Health

Response of a North American Bat Species to Immunization with Ebola Virus-Like Particles

We conducted a pilot study in big brown bats (Eptesicus fuscus) as a part of a larger comparative study examining bat immune response to Ebola virus-like particles (eVLPs). We immunized bats at two dosages: a low dose (n=6) that is typical of eVLP studies in other mammals, and a high dose (n=5) that was 5x the typical dose. The bats were boosted at 21 days post-initial-inoculation. Big brown bats are not natural Ebola hosts, so we predicted a modest response to the initial inoculation and a larger response to the booster. Additionally, we predicted a higher response in the bats with the higher dose. Blood samples were collected periodically for 56 days post immunization, and body temperatures were collected via temperature loggers affixed to the bats skin every ten minutes. We developed an ELISA to assay anti-Ebola glycoprotein (GP) titers in samples. In the initial round of ELISAs, results showed a greater response in the high-dose group and a higher response after the booster shots. Unexpectedly, 9 bats had positive titers prior to inoculation, despite having no possible prior exposure. We have been working on optimizing the ELISA protocol and re-running ELISAs to further explore why 9 bats had positive titers pre-inoculation. Analysis and results from these ELISAs are ongoing and will be presented. The results of this study have informed ongoing studies in Uganda bats. The results also show that bats may need a higher exposure to Ebola proteins than other mammals to have a robust immune response.

Rebecca Stinson '23

Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Program for Undergraduate Research

Impact of Atlas Transform Type on Stability and Accuracy of a K-Means Thalamic Segmentation Algorithm using 3T dtMRI

Background: The ventral part of the ventral lateral posterior nucleus of the thalamus is a target for Deep Brain stimulation treatment of Essential Tremor. The thalamus has no visible subdivisions between nuclei, and therefore surgeons must rely on an atlas or a patient-specific algorithm for targeting. Many segmentation algorithms rely on a mapped version of the Morel atlas. The purpose of this study is to investigate the impact of the type of atlas transformation on the final segmentation produced by the algorithm. Methods: A k-means segmentation algorithm was run on diffusion tensor magnetic resonance imaging data from 22 patients who underwent DBS treatment of ET. Final segmentations were compared against a rigid and non-rigid transformation of the Morel Atlas and evaluated for stability and accuracy. Segmentations were assigned to a thalamic nuclei using the transformed atlas and the volume, centroid position, and dice coefficient of each cluster was recorded. Results: The type of transformation applied to the Morel Atlas impacted both the stability and accuracy of the final segmentations. Certain nuclei performed better under the rigid transform, while others performed better under the non-rigid transform. Overall stability of the algorithm using either transform type was too high to be used in a clinical setting. Conclusion: The type of transformation used to map an atlas to a patient's thalamus has a significant effect on the segmentation algorithm. Further testing should be done on other algorithms and on higher-resolution data to determine the full extent of the impact.

Aidan Sullivan '25

Faculty Mentor(s): Professor Moria Chambers, Professor Sarah Lower, BIOLOGY
Funding Source: Department of Biology, The Pittsburgh Foundation

Firefly Immunity: How do Firefly Immune Systems Change Throughout Their Life Cycle?

When an organism is young, they're largely focused on growing and surviving, while later in life their focus shifts to finding a mate and reproducing. We hypothesize that during these distinct stages, the immune system is differently regulated due to changes in available energy and objectives. The common eastern firefly, Photinus pyralis, has a long larval stage of two years but only live for two weeks as adult in the wild with minimal consumption of food. From this, we predicted that larvae may have a more robust immune response than the adults because larvae allocate more energy to survival and immunity, whereas adults allocate more energy to reproduction. P. pyralis larvae are difficult to find in their natural habitat, so we opted to rear them in the lab.

I collected 14 female P. pyralis from the F. D. Brown Conference Center in Mifflinburg, PA. The females were mated with males and laid eggs. These eggs were then placed in eco-shoeboxes with soil, moss, and organisms which mimic their natural environment. This was a change from previous years of time-intensive single container rearing, which was less successful. After three months of observing and feeding the larvae earthworms, 16 larvae were injected with bacteria strain Serratia marcescens. After 24 hours, the larvae were ground up in Trizol to preserve their RNA for extraction during the spring semester. Through sequencing the extracted RNA, we will determine what mechanisms larvae use to fight bacterial infections comparing the mechanisms to those used in adults.

Keeler Thomas ’25
Faculty Mentor(s): Professor Karlo Malaga, BIOMEDICAL ENGINEERING
Funding Source: Tague Family Fund for Undergraduate Research in Biomedical, Biological and Biochemical Sciences

Tissue Composition of Activation Volumes in Thalamic Deep Brain Stimulation for Essential Tremor

Essential tremor (ET) is a neurological movement disorder characterized by involuntary shaking that manifests primarily in the hands, affecting 1% of the world. One treatment for ET is deep brain stimulation (DBS), a surgical technique where implanted electrodes stimulate local brain tissue. The standard stimulation target for ET is the ventral intermediate nucleus of the thalamus (VIM), a gray matter (GM) structure established as an alleviator of tremor. Recent studies suggest that nearby white matter (WM) structures are better stimulation targets. This study aimed to determine if increased WM activation was associated with tremor reduction without side effects. 18 ET patients previously received unilateral VIM DBS and had individualized volumes of tissue activation (VTA) modeled. From diffusion tensor imaging data, mean diffusivity and fractional anisotropy values were calculated in MATLAB, and k-means clustering and support vector machine algorithms were implemented to classify cerebrospinal fluid (CSF), WM, and GM. Algorithm performance was evaluated on a separate dataset of 41 Parkinson disease patients with ground truth subthalamic nucleus GM and internal capsule (IC) WM previously identified. The best WM classifier, indicated by the ground truth IC, was the k-means clustering algorithm which was subsequently adopted to determine the tissue composition of ET VTAs. Wilcoxon rank sum tests were used to analyze WM activation. No significant difference in percent WM activation was found between therapeutic and side effect VTAs. Coordinate location (x, y, z directions) of mean stimulated WM tissue will be analyzed to explain differences in clinical outcome.

Sarah Townsend ’24
Ryan Walker ’24
Faculty Mentor(s): Professor Moria Chambers, Professor Sarah Lower, BIOLOGY
Funding Source: Pennsylvania Firefly Festival and the Pittsburgh Foundation

A Bright Immune System: The Common Eastern Firefly Resistance to Bacterial Infection

Urbanization and climate change pose new threats to fireflies; amongst these threats include facing new pathogens and altered environments. To expand our knowledge of insect immunity, we examined how the common Eastern firefly, Photinus pyralis, responds to bacterial infection. We analyzed how survival and bacterial load post-infection with Serratia marcescens, a pathogen found naturally in the soil environment and lethal to P. pyralis, was affected by year, condition of the firefly, collection date, and location. To do this, we collected over 1,000 fireflies (June - August) at three locations with different levels of human disturbance surrounding Lewisburg, PA to additionally study if human disturbances result in immunity differences.

Similar to a study done last year, we found that higher concentrations of S. marcescens resulted in lower survival rates and that better firefly condition improved survival. Additionally, collection date appeared to influence survival rate with fireflies caught later in the season dying faster compared to those caught earlier in the season. This reflects differences in environmental conditions as the summer progresses but also represents the response of younger versus older fireflies. We also found that collection location did not significantly impact survival. Furthermore, bacterial loads were higher in fireflies infected with the highest dose and increased over time post infection, suggesting that the infections were successful and an immune response was activated. Analysis of the contribution of collection data and location on bacterial load post-infection is ongoing. Future studies will investigate whether other local firefly species are similarly affected by S. marcescens.

Ahn Tran ’24

Faculty Mentor(s): Professor Edward Talmage, COMPUTER SCIENCE
Funding Source: Kalman Fund for Undergraduate Research in the Sciences

Improving Partially Tight Multiplicity Queue Lower Bounds

Distributed computing is the study of coordinating information among a large set of computers over a network and focuses on developing the fastest and most efficient communication protocols between computers. For this research project, we studied a specific data structure used to store data for a set of computers called a multiplicity queue, which relaxes constraints on the behavior of operations occurring at the same time to achieve speed benefits. More specifically, we attacked two questions: how fast can multiplicity queues be, and is there an algorithm that achieves that speed? The project mainly consisted of theorizing about complex scenarios to see where multiplicity queues would fail, and using that intuition from these failed cases to build a safe and fast algorithm to implement the data structure. At the end of the summer, we achieved two results: the first was a strong bound on the speed of multiplicity queues which concretely proves that multiplicity queues cannot be too much faster than normal queues, and the second was writing an algorithm that matches this speed limit in for specific network setups.

Laurel Utterback ’24

Faculty Mentor(s): Professor Katherine Ward, PHILOSOPHY
Funding Source: Douglas K. Candland Undergraduate Research Fund

The Ethics of Covid-19 Vaccination: Moral Purity, Justice, and Coercion

After more than a year of one of the worst pandemics of the modern age, three vaccines were developed in quick succession: Pfizer’s and Moderna’s mRNA vaccines, and Johnson & Johnson’s viral vector vaccine. Because the Johnson & Johnson vaccine utilizes aborted fetal cells in its production and manufacturing, some bishops urged church members to avoid this “morally compromised” vaccine, which they deemed “intrinsically evil” due to its direct connection to abortion. Throughout the early stages of vaccine development and approval, patients rarely had a say in which vaccine they received. So, many church members were forced to choose between their religious commitments and getting vaccinated. Now, two years later, and still in the midst of a tumultuous medical world, enough data has been acquired, and we have gotten to the point where most people can choose a specific vaccine. However, it is critical to realize that the Church’s anti-abortion stance deterred many from being immunized, which would have benefited the greater good, because of their personal views. Although everyone’s opinions should be respected, putting the public’s safety at risk, especially in the event of a pandemic, is not warranted. *research is going to be continued for IDPT major project in fall 2023.

Hunter Vestal ’24

Faculty Mentor(s): Professor Benjamin Wheatley, MECHANICAL ENGINEERING
Funding Source: Gary A. and Sandra K. Sojka Fund for Research, Teaching and Scholarship in Developmental Disabilities

Analysis of Upper Extremity Joint Kinematics and Surface Electromyography

This summer I contributed to an ongoing study between Professor Ben Wheatley in the Mechanical Engineering department and Dr. Chulhyun Ahn at Geisinger Musculoskeletal Institute. The aim of the study was to identify individual kinematic synergies that correspond to electromyography (EMG) synergies. Muscular synergy analysis is useful in understanding and improving movement for individuals with neuromuscular disorders. The ability to identify these kinematic synergies would give rise to a similar rehabilitation method that precludes the need for expensive equipment associated with the current procedure. My role in the project involved collecting upper extremity data in the Biomechanics laboratory, developing an approach to perform inverse kinematics on said data, and processing surface EMG data to later extract EMG synergies from. Using Opensim, I modified two different models and compared the kinematic results to determine which model will give more accurate joint angles. In addition to this inverse kinematics approach, I developed Matlab code that uses kinematic data in order to identify exactly when movements start and end so that movements can be normalized and joint angles can be compared across many different subjects. Similarly, I spent time developing Matlab code to process, smooth, and normalize sEMG data. Moving forward, we need to continue collecting data from 20 healthy adults and then identify the EMG synergies from their data. Thereafter, subjects will return and be asked to generate a UE movement that produces the same surface EMG profile as the EMG synergies with visual feedback.

Marianne Voigt ’24

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

Modeling the Effects of Femoral Anteversion and Miserable Malalignment on Hip Joint Loads

Introduction: Excessive pathological torsion of the lower limbs can cause gait impairment, joint pain, and in extreme cases is treated with surgery. These torsional profiles can present in conditions such as high, femoral anteversion and miserable malalignment. Motion analysis and musculoskeletal modeling enable the analysis of human movement to determine joint loads. Thus, the goal of this project was to use musculoskeletal modeling to determine the impact of varying degrees of femoral anteversion and miserable malalignment on the joint loads of the hip.

Materials and Methods: To begin the modeling process, the Rajagopal full-body model and freely available experimental data were used as baselines. The Modenese bone deformation tool was then applied through MATLAB and OpenSim to alter the geometry of the baseline model and create one set of models with increased femoral anteversion and one set of models with miserable malalignment. OpenSim Moco –an optimal control tool– was used to generate kinematics with actuator driven tracking problems and hip joint loads with muscle driven inverse problems. The simulations tracked the force throughout the stance phase of gait, by determining the root mean square (RMS) value of the joint loads.

Results and Discussion: The results of the simulations showed an increase in hip joint loads in both femoral anteversion and miserable malalignment models in the anterior-posterior and superior-inferior plane directions. Hip joint load increases were larger for models with increased femoral anteversion only in comparison to models with miserable malalignment.

Michelle Vovsha '24

Faculty Mentor(s): Professor Moria Chambers, Professor Sarah Smith, BIOCHEMISTRY/CELL BIOLOGY, BIOLOGY
Funding Source: Kalman Fund for Biomedical Research Fellows

Super Insects: Could Insect Antimicrobial Peptides Be the Future of Medicine?

Antibiotic resistance continues to be a worldwide concern with more than 2.8 million antibiotic-resistant infections occurring in the United States each year. Natural antimicrobials, specifically antimicrobial peptides (AMPs) are showing potential for addressing antibiotic resistance. A group of naturally occurring AMPs in insects, cecropins, are promising for human therapeutics due to their anti-inflammatory activity and low toxicity against mammalian cells. This project focuses on P. pyralis CecX, a cecropin isolated from the Photinus pyralis (common eastern firefly) genome. CecX and its truncated versions (N-terminus, middle and C-terminus) were tested to determine whether the whole peptide is required for antimicrobial activity or if smaller pieces retain antimicrobial activity. Synthesized peptides were tested against nonpathogenic bacteria, specifically focusing on E. coli and Providencia sneebia using minimum inhibitory concentration (MIC) assays and minimum bactericidal concentration (MBC) assays. In addition, scanning electron microscopy (SEM) was used to examine the ultrastructure of bacteria for future comparison of bacterial membranes disrupted by AMPs. The results for the MIC assays indicate that the N-terminus fragment of CecX exhibits antimicrobial activity against E. coli, almost as effectively as the naturally occurring, full-length peptide. The results for the MBC assays show that the overall MBC concentration is expectedly higher than the MIC concentration, meaning that inhibition of growth does not necessarily kill the bacteria. Future work will focus on testing CecX and its truncations on pathogenic bacteria, and using SEM to identify membrane pores formed by AMPs.

Elizabeth Whitmer '23

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

Gendered Inequalities in Japanese Politics and Biases in News Media

Although a democratic and economically successful country, Japanese women are significantly underrepresented in politics. This research examines the puzzle of underrepresentation of women in Japanese politics, with particular attention to the role played by gendered rhetoric in the media. In order to analyze this puzzle, articles from three widely read news sources were collected and examined for their mention of women politicians and women's political interests; the presence of various types of gender biases, including benevolent sexism, overt sexism, and political saviorism; the amplification of the voices of women politicians; instances of sexual harassment or assault experienced by women politicians or carried out by politicians; and rejection of norms that lead to women's underrepresentation. These analyses are an extension of literature suggesting that issues of gender norms and instances of sekuhara (sexual harassment) are particularly detrimental to women interested in running for office. By analyzing these factors within the news media, this research aims to understand the discussions and biases present within the Japanese culture that may be hindering the political success of women due to the way in which these narratives shape the minds of voters.

Madeline Wickers '23

Faculty Mentor(s): Professor Chris Martine, Professor Tanisha Williams, BIOLOGY
Funding Source: Department of Biology

Conservation of a Rare Species: Taxonomic Uncertainty and the Potential Role of a Narrowly-occurring Specialist Pollinator

Heuchera alba and H. pubescens (Saxifragaceae) are closely related species of the Appalachian Region of eastern North America that are difficult to distinguish morphologically. Heuchera pubescens is currently understood to occupy a range from Kentucky to Pennsylvania, with the distribution of H. alba restricted to Virginia and West Virginia – plus a recently-recorded extension into Pennsylvania discovered with the help of Twitter. In addition to the discovery of H. alba in Pennsylvania, a pollinator known as the alumroot cellophane bee (Colletes aestivalis) was seen visiting its flowers – the first state record of this bee in over a century. The uncovering of H. alba as well as its specialized pollinator in Pennsylvania has challenged historical perceptions of Heuchera distributions in the state, particularly as this relates to current records for H. pubescens. Through a partnership between Bucknell University and the Western Pennsylvania Conservancy, substantial fieldwork was completed this past summer, including the collections of H. alba samples and C. aestivalis at multiple sites. It was found that records for H. pubescens in the Susquehanna River Valley can instead be attributed to H. alba. This finding has potential implications for the assessment of the true distribution for both species and the genetic status/health of each species in the local region. Our lab will now use population genomics to generate measures of genetic diversity and population structure, with the goal of updating the conservation status for each study species and informing future conservation management of H. alba, H. pubescens, or both. We also hope to assess the link between genetic structure among H. alba populations and its reliance on a habitat-specific oligolectic bee.

Tyler Will, Graduate Student

Faculty Mentor(s): Professor Kat Wakabayashi, CHEMICAL ENGINEERING
Funding Source: Graduate Summer Research Fellowship

Effects of Polymer Properties on Solid-State Shear Pulverization: Thermoplastic Processability and Nanofiller Dispersibility

Solid-state shear pulverization (SSSP) is an alternative polymer processing technique based on twin screw extrusion with a continuous cooling system. In SSSP, low temperature-mechanochemistry modifies the macromolecular architecture and morphology, which in turn leads to physical property changes in the material. While a wide range of homopolymers, polymer blends, and polymer (nano)composites have been previously developed with SSSP, fundamental understanding of how the mechanochemistry affects polymer chain architecture and structure, and in turn, material properties, have not been elucidated. This paper conducts a systematic, processing-structure-property relationship investigation of ten thermoplastic polymers with varying properties, as they are subjected to consistent SSSP mechanochemical pulverization and nanocomposite compounding. Structural, mechanical, and thermal characteristics of the neat polymers are correlated to their response to SSSP, by way of process covariants. Further, the multiple processing SSSP parameters dictate structural changes such as molecular weight reduction and filler dispersion level, which in turn dictate system properties like melt viscosity and thermal stability.

Zoe Wilson ’23

Faculty Mentor(s): Professor Chase Gregory, ENGLISH
Funding Source: Program for Undergraduate Research

When The Only Cure For Motion Sickness Is To Keep Moving: A Travelog of Angels in America

The project is invested in the impact travel can have on a dramatic text and the value of archival research within production dramaturgy and critical responses to theatre. Using pre-Broadway drafts of the script of Angels in America (which Wilson gathered by traveling to archives in London, New York, San Francisco, and Los Angeles over the past two years), Wilson will summarize the key textual changes made to Kushner’s classic play over the first seven years of its production history. She also will summarize her own process crafting her departmental thesis in English Literary Studies, which will take the form of a podcast.

Redeit Woldebirhan ’24

Faculty Mentor(s): Professor Mark Haussmann, BIOLOGY
Funding Source: Department of Biology, Kalman Fund for Undergraduate Research in the Sciences

A Novel Technique to Quantify Oxidative Damage

There are several endogenous and exogenous sources of DNA damage. One common endogenous source is oxidative stress. Oxidative damage occurs from the inefficiency of antioxidant defense mechanisms to adequately combat the reactive oxygen species (ROS). Activities such as sleep and a healthy diet can increase our bodies’ defense mechanisms against ROS while activities such as smoking, excessive exercise, and alcohol consumption can increase ROS. High levels of ROS can negatively affect cell signaling and ultimately lead to cell and tissue damage. 8-hydroxydeoxyguanosine, or 8OHdG, is the oxidized version of the nucleoside guanosine (dG). 8OHdG is an important damage biomarker in DNA. In the Haussmann lab, we developed a novel technique to assess three critical steps in the oxidative stress process in nucleated red blood cells from Chinese button quails: baseline measures, measures following a free radical challenge, and cellular repair ability. I will present results on several methods to assess 8OHdG in our samples including High Proficiency Liquid Chromatography with both Ultraviolet Detection (HPLC-UV) and Electrochemical Detection (HPLC-ECD) as well as Liquid Chromatography-Mass Spectrometry (LC-MS/MS).

Yuqin Yang ’24

Faculty Mentor(s): Professor Thiago Serra, ANALYTICS & OPERATIONS MANAGEMENT
Funding Source: James L.D. and Rebecca Roser Research Fund

Visualization of Neural Networks

Our research is about the Visualization of Neural Networks. We first created a random convolutional neural network in Pytorch to identify images of happy and sad faces and then transferred parameters to an Excel spreadsheet for visualization. Next, we conducted backpropagation to update parameters and train the model for improved predictions. In the end, we enhanced the Excel spreadsheet by adding buttons like “Reset” and “Repeat” for ease of operation. We finally got a spreadsheet which shows the structure of a neural network with all the layers in it and the process it predicts the happy face or sad face.

Caitlin Yant’24

Faculty Mentor(s): Professor Daniel Street, ACCOUNTING & FINANCIAL MANAGEMENT
Funding Source: James L.D. and Rebecca Roser Research Fund

Individual Investor Self-Expression During the 2021 GameStop Short Squeeze

In late 2020 and early 2021, institutional investors believed that GameStop was destined to fail and sought to profit off decreases in the stock price by short selling shares. Individual investors, coordinating on the Wallstreetbets subreddit platform, took opposite trading positions and executed a short squeeze. We examine these individual investors’ self-expression in the stock market by evaluating the effect of stock market returns upon the language of these individual investors’ posts. Drawing upon prospect theory, the theory that individuals dislike losses more strongly than they enjoy equivalent gains, we compare individual investors’ self-expression during periods of positive versus negative stock market returns. Consistent with prospect theory, investors used positive words during periods of favorable returns but reacted more strongly by using a greater magnitude of negative words during periods of unfavorable returns. Individuals increased their use of vulgarity when they experienced unfavorable returns for other firms in the market, but when posting about GameStop, users of Wallstreetbets altered their normal posting behavior and increased their vulgarity during periods of favorable returns. These individual investors' formative experiences during the GameStop short squeeze are likely to affect their future participation in and influence upon the stock market.

Ding Zhang '23

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

Smartphone Based Turbidity Estimation with Inherent Calibration

Water is one of the most vital natural resources; it is essential to daily life. In many developing countries, however, access to clean and safe water is a crucial issue due to a lack of economic and infrastructure resources. The most broad and universal measure of water quality is turbidity. Traditional lab use urbidimeters, though highly accurate, may be prohibitively expensive for wide-scale use. Thus, proposing cost-effective water turbidity estimation systems has long been a trend. In this paper, we introduce an innovative water turbidity estimation system. Different from other approaches which have only one water sample for analysis, our system consists of a low-cost illuminated cuvette holder containing a test and a control sample, where the control always contains clear water. Acquired images of the two samples are input into an image processing chain to estimate the sample's turbidity. We evaluated our approach in both lab and in-situ environments and found that in the lab environment, our approach achieved mean error of 19.07 NTU over the range 16.1 to 417 NTU compared to 69.86 NTU without using the control sample. In outdoor real-world use, we found mean error of 20.68 NTU in the shade and 57.34 NTU in full sun.

Jimmy Zhu '23

Faculty Mentor(s): Professor Paul Botelho, MUSIC
Funding Source: Schotz Family Interdisciplinary Fund

AR Music-Making Environment

In this AR environment that I created, the user plays the physical midi keyboard that is wirelessly connected to the headset, and the headset calculates the pitches and the wave signals of the synthesizer. The user can use hand tracking to control the settings of the synthesizer. Another feature is the surround sound system. The players can place the virtual speakers in different locations to get the sounds to come from different directions. This makes surround sound configuration much simpler to understand than existing methods.

Diamanda Zizis '23

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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 for 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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