Prof. Michael Caldwell
Department: Biology

Pre-requisite for a Summer Position: Students joining the lab should expect a mix of theoretical discussions, intense fieldwork, software-based data analysis, and fiddling with experimental technologies. While the main focus of the lab is vibrational communication in vertebrates, highly motivated students interested in pursuing projects in visual, chemical, or other modes of communication, or with non-vertebrate animals are also welcome.

Description of Research:

Methods in our lab include the recording and playback of vibration and sound signals produced by animals, video analysis of behavioral responses to these signals, and the measurement of vibrations as they propagate through body tissues and the environment.

Current lines of research include:

- Teasing apart the communication roles played by airborne sound and plant vibrations produced by red-eyed treefrogs (Agalychnis callidryas) when they call to attract mates.

- Determining whether toe tapping behavior exhibited by some foraging frogs serves as a vibrational signal used to manipulate the behavior of termite prey.

- Measuring the physiological sensitivity of snakes to substrate vibrations, and testing whether snakes use vibrations to locate their prey.

Prof. Betty Ferster
Department: Biology

Pre-requisite for a Summer Position: N/A

Description of Research:

Butterflies are charismatic insects with close coevolutionary ties to plants. But they have been declining in abundance and diversity since the mid-1970's. Grassland endemic butterflies, like the regal fritillary butterfly (*Argynnis idalia idalia*), a candidate for ESA listing, were once widespread and abundant throughout the Northeast and mid-Atlantic region of the United States. However, populations throughout its range began to rapidly disappear due to land use changes; farming practices that once supported grassland species changed, and urban development encroached on natural areas. The only remaining population of the eastern subspecies of the regal fritillary butterfly is located at Ft. Indiantown Gap National Guard Training Center (FIG-NGTC) in south central PA. It is the busiest National Guard Installation in the country, and the continued persistence of the butterfly here is due largely to military-related activities that result in a patchwork of disturbances of different ages. These disturbances create a mosaic of habitat that includes temporary patches dominated by early successional vegetation including caterpillar host and nectar plants, as well as warm-season bunch grasses.

Gettysburg once supported regal fritillaries until the early 1990's. Sites formerly occupied within Gettysburg National Military Park (GNMP) still exist as open grasslands today, but four years of butterfly survey data has shown us that butterfly diversity is now low here. Along with the charismatic regal fritillary, many butterfly species that persist at Fort Indiantown Gap have vanished from this area. Our goal is to understand why, and to learn about butterfly conservation by building a diverse campus pollinator garden that we can monitor for diversity changes over time. Although butterflies are not the most important pollinators, we can use butterflies as indicators of ecosystem health; and conservation for butterflies will inadvertently benefit less charismatic, but more valuable native pollinators.

Research opportunities: Students with interest in biodiversity and ecosystem biology may find interesting questions to ask about our ephemeral grasslands and the complex interactions of species in them. We will grow native nectar and caterpillar host plants for habitat restoration on campus and elsewhere. Butterfly and plant populations will be monitored throughout the field season as part of a long-term effort to restore grassland ecosystems that support rare butterflies as well as other components of this ephemeral system.

Prof. Peter Fong
Department: Biology

Pre-requisite for a Summer Position: Students should be interested in aquatic organisms, bioactive chemicals, animal behavior, and pollution of the natural environment. Students should be comfortable being outdoors wearing waders and collecting animals in the summer heat and humidity of southern Pennsylvania, and have patience in observing small animals under the microscope.

Description of Research:

Current plan is for research to be performed on-campus and in-person.

1. One project will test the combined effects of heat waves and pollutants such as nanoparticles on the development of wood frog tadpoles. Previous experiments from summer'24 showed that temperature strongly affected the timing and mass at metamorphosis in wood frog tadpoles.

Furthermore, uptake of gold nanoparticles by tadpoles at half larval life (28-31 days in culture)

was greater at the warmest temperature than at the coldest temperature. Heat waves (days of extremely high temperatures) are suspected of having even greater effects than warm temperatures alone on organism physiology. This summer, we aim to test the effects heat waves and gold nanoparticles on the timing of and mass at metamorphosis in wood frog tadpoles.

The interplay between rising global temperature exemplified by heat waves and chemical contamination from nanoparticles is the focus of this project which concerns a group of animals (amphibians) with global interest among stewards of the environment.

2. Similar to project #1, the two additional projects will test the combined effects of heat waves and human pharmaceuticals (especially antidepressants) on reproduction and behavior of two species of freshwater snails which live in the same stream 25 miles north of Gettysburg. One of these species is invasive from New Zealand and poses a serious ecological threat throughout the U.S. The second species is native to Pennsylvania but is invasive in Europe.

Results from previous experiments showed that antidepressants modulate a variety of important endpoints such as reproduction and locomotion in snails. We will collect snails and culture them under different pharmaceutical concentrations and expose them to heat waves. We will measure the number of embryos laid, as well as testing their ability to re-orient (righting behavior) before and after heat waves. Thus, this project will examine the impact of global climate change (heat waves) on reproduction and behavior in species which have invaded both North America and Europe, and which cause significant ecological damage.

Prof. Kazuo Hiraizumi
Department: Biology

Pre-requisite for a Summer Position: Completion of Biology 211 (Genetics) by the end of the Spring Semester of 2025 would be desirable. An alternative qualification would be completion of Biology 212 (Cell Biology). Laboratory experience working with Drosophila would be a plus but not a requirement.

Description of Research:

Dipeptidases belong to a class of digestive enzymes and are found ubiquitously among organisms in every kingdom. These enzymes hydrolyze peptide bonds to provide amino acids for various metabolic and physiological processes. The level of catalytic activity of dipeptidases is a quantitative phenotype that varies between individuals in a continuous distribution within a natural population for any species. The genetic, molecular, and biochemical basis for such variation could be differences in the number of enzyme molecules that are produced (related to transcriptional or translational efficiency) or in the structure of the enzyme molecule (related to amino acid composition or sequence). Research projects focus on the characterization of genetic variation for gene regulation using the dipeptidase genes in Drosophila melanogaster as a model system. Identification and understanding of genetic factors that affect regulation of these enzyme-coding genes has relevant medical applications, given that reduction in enzyme levels of certain dipeptidases in humans is associated with disorders such as Huntington Disease, Alzheimer Disease, Crohn's Disease, and Celiac Disease.

Three of the Drosophila dipeptidase enzymes are encoded by independent genes (Dip-A, Dip-B, Dip-C). Each gene transcribes multiple forms of mRNA. Dip-B and Dip-C each produces mRNA isoforms that contain the same coding sequence (amino acids) for the primary structure of the enzyme but differ in the number and composition of nucleotide bases in the upstream non-coding portion of the mRNA (5' Untranslated Region or 5' UTR). For Dip-A, mRNA isoforms encode polypeptides of different amino acid sequences. How these molecular differences contribute to the expression of enzyme function is one of the primary research questions. Some of the ongoing and future research projects include: 1) molecular characterization of new mRNA isoforms of dipeptidase genes and transcriptional profile between genetic strains that differ in enzyme activity; 2) characterization of tissue-specific and developmental expression of mRNA isoforms for the three dipeptidase genes; 3) quantitative analysis of dipeptidase proteins at various developmental stages using antibodies; 4) comparison of DNA sequence and amino acid composition of dipeptidase isoforms between genetic strains that differ in enzyme activity; 5) knockout and knockdown modification of dipeptidase genes using CRISPR-Cas9 approaches; 6) development of biochemical assays to distinguish carnosinase and DIP-A activity; and 7) bioinformatics strategies for the identification of potential mRNA isoforms in other peptidase and proteinase genes. The summer internships offer an opportunity to contribute to these areas of research.

Current plan is for research to be performed on-campus, in-person.

Prof. Alex Trillo
Department: Biology

Pre-requisite for a Summer Position: Successful applicants will be highly motivated, be eligible for travel abroad, and be comfortable with intense tropical field-work. Preference will be given to students who have spent some time doing research in the Trillo Lab.

Description of Research:

Research in the Trillo lab integrates the fields of behavior, ecology, and evolution. We do a lot of field work and collect much of our data in the tropics, in affiliation with the Smithsonian Tropical Research Institute. We are currently examining the effects of eavesdropping predators and parasites on the calling dynamics of mixed-frog choruses.

Eavesdropper effects on mixed-species choruses of frogs: Males often use conspicuous mating calls that increase attractiveness to females. These calls, however, usually come with a cost: being attractive to females also means being attractive to eavesdropping predators and parasites. This trade-off, between attractiveness to mates on one hand, and attractiveness to eavesdroppers on the other, has been shown to strongly influence mating call evolution. We are particularly interested in how the mortality risk due to eavesdropping predators, such as the bat *Trachops cirrhosus*, and eavesdropping parasites, such as the midge *Corethrella* spp. gets transferred from one prey species to another in mixed-species aggregations of frogs. We investigate whether calling near males of another species makes signalers more or less vulnerable to 'eavesdroppers' – do attractive neighbors bring in additional eavesdroppers ("Collateral Damage"), or do these neighbors capture most eavesdropper attention themselves, reducing a male's risk ("Shadow of Safety")? Ultimately, we wish to understand how these prey species interactions drive calling site choice and calling behavior in mixed choruses of tropical frogs. Student researchers that work on this project conduct playback experiments, presenting a variety of acoustic stimuli to midges and to bats in flight chambers and in the field. They will also be trained in experimental techniques, bioacoustics software, behavioral analysis software, and methods in tropical fieldwork.

Prof. Katherine Buettner
Department: Chemistry

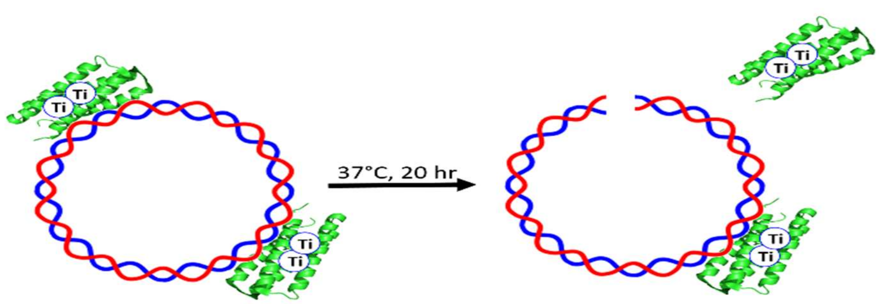
Pre-requisite for a Summer Position: Students should have completed general chemistry to work in the lab.

Description of Research:

The aqueous chemistry of hydrolysis-prone metals is often avoided due to their reactivity with water. Avoiding hydrolysis through careful ligand choice opens new uses for these metals. Two such metals, titanium and vanadium, have many uses as catalysts and materials under non-natural conditions. Harnessing their reactivity with water using biological ligands will lead to novel applications of these metals. While titanium and vanadium are not commonly native to enzymes, their reactivity with water can be controlled in the binding sites of many natural proteins. We design novel enzyme active sites to bind hydrolysis-prone metals and utilize their reactivity to generate new enzymatic activities.

Many *de novo* designed proteins bind metals, however none have been reported to bind hydrolysis-prone metals, such as titanium and vanadium. These metals are relatively abundant, but underused in catalysis compared to precious metals. We have shown the ability of our enzymes to stabilize and functionalize titanium, providing the first report of a titanium enzyme, as well as the ability of our model system to mimic natural binuclear zinc hydrolases. Both our titanium and zinc enzymes are able to cleave DNA, showing their potential to act as therapeutics. We are also working to understand structure function relationships of these enzymes, and their ability to function against a variety of substrates and as mimics of natural vanadium enzymes.

Projects in the Buettner lab include: the design and development of new active sites in our current protein scaffolds to optimize metal binding as well as enzymatic activity; characterization of metal binding using a suite of biophysical techniques; and the optimization of enzymatic activity studies.



Prof. Emily Dieter
Department: Chemistry

Pre-requisite for a Summer Position: General Chemistry

Description of Research:

Methanogenic archaea ("methanogens") produce ~70% of the world's methane, the second most abundant greenhouse gas after carbon dioxide. The ability to produce methane makes methanogens an enticing source of bioenergy; however, fundamental questions about their biology remain, due to the difficulty of culturing them in the laboratory. One group of proteins that is thought to be particularly important to methanogen survival is the radical *S*-Adenosyl-L-methionine (SAM) enzyme family. Radical SAM (RS) enzymes represent the largest known enzyme superfamily, and these enzymes use iron and sulfur to perform a variety of diverse chemical reactions; however, about half of the RS enzymes in methanogens have no established functions. Projects in the Dieter group will use biochemical techniques to elucidate and catalog the functions of these methanogenic enzymes. Enzymes will be expressed in *Escherichia coli* (*E. coli*), organisms that are more amenable to growth in a laboratory environment, then purified from the *E. coli*. This approach will allow us to biochemically characterize our proteins without the need to culture methanogens. Once the enzymes have been characterized, future work will focus on the role of these proteins in the native organism. A more thorough understanding of these proteins is expected to uncover novel chemical transformations, natural products, and biosynthetic pathways, which has the potential to contribute to strategies to both mitigate methane production and harness methane as a source of bioenergy.

Since this is will be the first summer for the lab at Gettysburg, students will be helping to get the lab up and running! We will be screening ~100 RS enzymes to determine which proteins are suitable for further characterization. Students will then optimize expression and purification protocols for their chosen target. Once the protein has successfully been purified, students will experimentally demonstrate that their protein is definitively a RS enzyme though different biophysical characterization techniques and enzymatic assays.

Prof. Timothy Funk
Department: Chemistry

Pre-requisite for a Summer Position: Completion of Chem 107 and 108 is required. Completion of at least one semester of organic chemistry is preferred. No college-level biology background is required.

Description of Research:

Synthesis of triazine-based lipids for RNA-based therapeutics – applied organic synthesis!

There are many potential applications of RNA-based therapies, including silencing gene expression, gene editing, and developing mRNA vaccines. RNA must get inside cells to serve its purpose, but its size, charge, immunogenicity, and instability lead to its degradation and do not allow it to pass through the plasma membrane. One of the most effective ways to protect RNA and transport it into the cytoplasm is by packaging it in a lipid nanoparticle (LNP). A key component of LNP formulations is an ionizable lipid, and the lipid's structure plays an important role in determining its ability to form LNPs with RNA and deliver it into cells. Ionizable lipids have two main components: a hydrophilic (water-soluble) head and a hydrophobic (water-insoluble) tail.

Through a collaboration with Prof. Vince Venditto at the University of Kentucky's College of Pharmacy, we are designing and synthesizing ionizable lipids based on readily functionalizable cyanuric chloride. Each chloride can be replaced with a nucleophile chemoselectively, leading to a high degree of synthetic control over lipid structure (Figure 1A). The general lipid structures we are exploring and their reversible protonation are shown in Figure 1B. **We have shown that structural modifications to the ionizable head groups and the hydrophobic tails can have a dramatic effect on the lipid's ability to form LNPs with mRNA and deliver it into cells.**

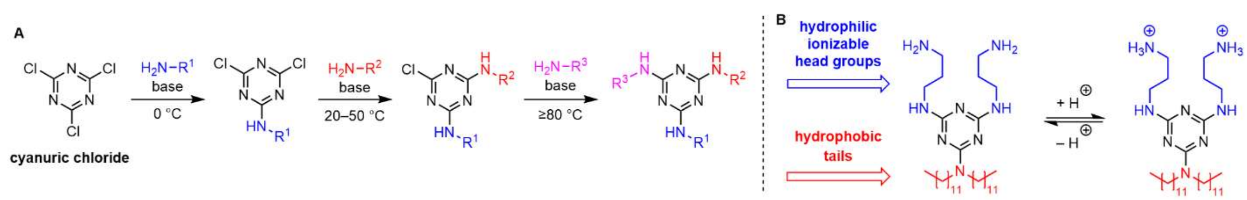


Figure 1. A. Temperature-dependent substitution of cyanuric chloride. **B**. Triazine-based lipids' reversible protonation.

This summer, we will be synthesizing triazine-based lipids with different head groups and tails. We will focus on unsymmetrical head groups containing tertiary amines and alcohols, and on hydrophobic tails containing unsaturation (e.g., cis alkenes) and branching. The general synthetic approach is shown in Figure 2, but in some cases, we will need to synthesize symmetrical and unsymmetrical secondary amines to use as hydrophobic tails. **The goal is to prepare a library of lipids and send them to the Venditto group to determine how effectively they deliver mRNA into cells**. If you're interested in multi-step chemical synthesis, this project is for you!

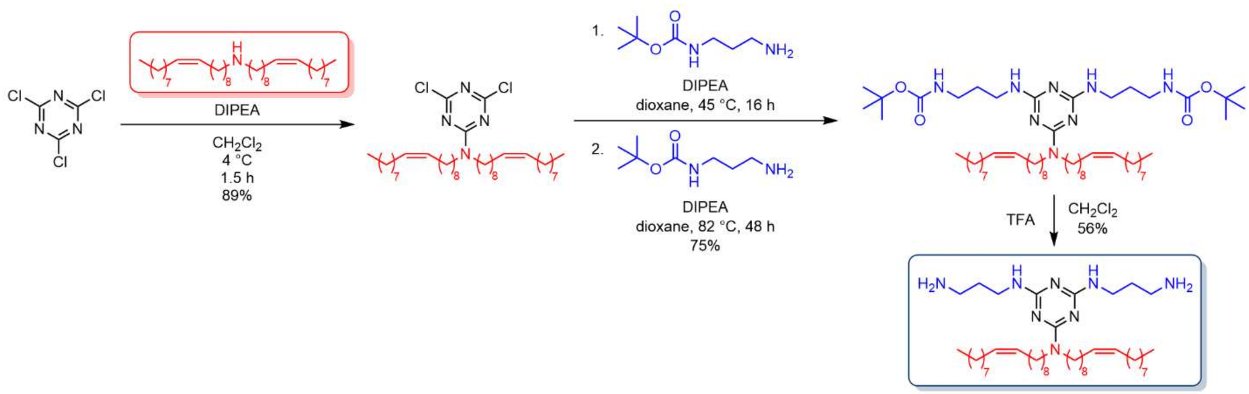


Figure 2. Example synthesis of a triazine-based lipid.

Prof. Lucas Thompson
Department: Chemistry

Pre-requisite for a Summer Position: To join the NanoLab it is expected that students will have completed one year of chemistry (107/108) by May 2025

Description of Research:

Figure 1: Gold nanorods in aqueous solution. The pink solution on the left are spheres and as you go from left to right the length of the rods increase as the

Many materials take on new and exciting properties when they are structured at the nanoscale. Many of the coinage metals like gold and silver exhibit new and unique optical properties that are dependent on their size and shape. The unique optical properties of gold nanoparticles are shown in Figure 1 where nanorods of differing aspect ratio (length/width) display their different colors. These optical properties have been harnessed for advanced applications in drug delivery, solar cells, disease detection (COVID tests), and catalysis. While these nanoparticles have shown great promise in diverse fields, there is still much to be learned about the synthesis, growth, and self-assembly of these particles to further enhance their impacts on our everyday lives. In order to tune the properties of gold nanoparticles for advanced applications, it is first necessary to specifically control the chemistry at the interface between the nanoparticle and its surrounding medium. At the core of our research group we are constantly thinking about how to modify and control the surface chemistry of gold nanoparticles with the goal of generating new structures or developing a better more quantitative understanding of the surface or to understand the implications of nanoparticles in the environment. The plan for the summer of 2024 and beyond is to work on two projects that address the control of surface chemistry and the environmental fate of nanoparticles.

In the first project, we are interested in taking many little pieces (nanorods) and stacking them together into a larger structure using pH responsive polymers. The unique optical properties of gold nanoparticles can be further tuned by having particles in particular orientations to one another at close proximity. To accomplish this task we will be using gold nanorods that will have their surface modified with polyelectrolytes (highly charged polymers). We want to understand how polyelectrolyte modifications of gold nanoparticles engenders control and reversibility of the assembly of nanoparticles. In one part of this project we will be using a pH mediated structural transition (from random coil to alpha helix when the solution pH is raised above the pK_a) in an adsorbed polyelectrolyte, poly-l-lysine (PLL), to assemble rod shaped nanoparticles into higher order structures in a reversible manner. In addition to exploring pH, we will also test if the identity of the intermediate layer is important (PLL is positively charged so we need to have a negative layer between the particle (also positively charged) and the PLL). This project requires a wide array of instrumentation from UV-Vis Spectroscopy and Circular Dichroism Spectroscopy to Dynamic Light Scattering and Transmission Electron Microscopy which you will be in charge of running after appropriate training.

The discharge of pollutants such as pharmaceuticals, personal care products, heavy metals, and other toxicants into freshwater streams and oceans is a growing environmental problem. Despite their increasing industrial use, our knowledge of the environmental consequences of released nanoparticles in air, soil, and water, is wanting. The NanoLab has on ongoing collaboration with Prof. Fong's group where try to answer some of these questions as we explore the toxicity of gold nanoparticles on aquatic organisms

The NanoLab is particularly interested in quantifying the gold that is taken up by the animals and to correlate that to the dosage and environmental temperature that the tadpoles are exposed to. In addition to quantifying the uptake of the gold nanoparticles we are interested in identifying the route by which the nanoparticles are brought into the body. This project will involve the synthesis and characterization of the nanoparticles prior to exposure to the animals. After exposure, it will be necessary to quantify the uptake with ICP-OES, potentially identify the locations of uptake with electron microscopy, and explore how the experimental conditions impact nanoparticle stability

Our lab also has multiple other projects running that I am more than happy to chat with you about. These projects range from understanding how nanoparticle charge impacts protein structure to fabricating new polymer nanoparticle composite materials.

Prof. Natasha Gownaris
Department: Environmental Studies

Pre-requisite for a Summer Position: To be a good fit, students should have completed ES 211 and, preferably, at least one upper-level ecology class in the Environmental Studies Department. Note that there is phone service and limited internet access on the island. We generally have solar power, but this isn't a given, and we shower once every 7-10 days. We have access to a kitchen with a propane refrigerator and stove, and food drop-offs occur every 1-2 weeks. Students should be comfortable with the idea of handling birds and working with blood samples for stable isotope analysis and should be ready for very early mornings (6:00am), regularly witnessing animal mortality, rugged field living conditions, limited internet access, and for spending all of June and July on this remote island. This position requires grit, flexibility, proactiveness, and openness to constructive criticism.

Description of Research:
Research in the Gownaris lab focuses on how seabirds change their foraging behavior and diet in response to rapid environmental change. Our current research site is Petit Manan Island, a small island off the coast of Maine that is home to seven species of breeding seabirds. The Gulf of Maine is warming faster than nearly anywhere else in the ocean and, in recent years, warm water moves into the Gulf in July, just as seabirds are raising their chicks. When waters warm, preferred diet items of seabirds in the Gulf of Maine (fishes like hake and herring), move deeper and farther offshore. Seabirds can respond in two ways: 1) they can change their foraging behavior, or 2) they can prey switch to less preferred diet items. Our research focuses on how seabirds are adjusting their breeding and foraging behavior to handle climate-driven changes in food availability and in how these behavioral adjustments influence their fitness.

This summer, we will spend eight weeks on Petit Manan Island collecting data on four species of seabird (Atlantic puffins, black guillemots, Arctic terns, and common terns) that breed there. Each day on the island is slightly different, but a day's work is likely to include a mixture of these activities: measuring chicks, counting seabirds, observing what food items seabirds bring back to their chicks, collecting and processing blood samples, tagging adult birds and monitoring their nests, entering data. In the evenings and on rainy days, we will have time to cook meals and play games together or to take some solo downtime (reading, exercising, etc.). Two Gettysburg students will be joining Dr. Gownaris and two field technicians hired by US Fish and Wildlife, along with visits from other researchers and USFWS staff. Interested students can learn more about this research from students' perspectives in this article and about life on Petit Manan Island in this slideshow.

Both students will contribute to all island activities and will learn how to use a variety of approaches and how to handle seabirds ranging in size from <10 to >400 grams. Each student will also have ownership of one of the projects below.

- **Student 1: Interspecific Diet Overlap throughout the Breeding Season.** Student 1 will leverage previously and newly collected stable isotope data to ask how competition among seabirds (Arctic terns, common terns, Atlantic puffins) varies throughout the breeding season.
- **Student 2: Using Camera Traps to Assess Nest-Level Puffin Diet.** Student 2 will fine-tune an approach to using camera traps to study nest-level diet. This diet information will be linked with chick growth and fledging success data and to movement data collected using GPS tags.

Dates: Expected dates of May 30th – July 30th, most of which will be spent on Petit Manan Island. We will also need to find time in May for 4-5 days of training.

Prof. Megan Benka-Coker
Department: Health Sciences

Pre-requisite for a Summer Position: Students interested in this X-SIG project should have a passport and be able to travel to Barbados during the dates listed. Students should also have an interest in working in another country and be flexible, open, and respective of others and new environments.

Description of Research:

Air pollution is a mixture of particles ($PM_{2.5}$, PM_{10}) and gases (CO, VOCs, CO_2, NO_2, ozone). In Barbados, sources of air pollution for the general public include diesel-based transportation, agricultural burning, and seasonal Saharan dust that transverses across the Atlantic Ocean. Studies suggest that exposure to NO_2 and ozone can impair lung development and those exposed to higher levels of NO_2 have a greater risk of asthma. Barbados has one of the highest rates of asthma in the world, and more needs to be done to understand the role of air pollution and lung function in Barbados. Populations in specific occupations, such as cooks and food vendors may at elevated risk of the health impacts of air pollution, due to their cooking and frying activities.

We will conduct a pilot study of the environmental pollution experienced in occupational settings in Barbados in collaboration with the Centre for Biosecurity Studies at the University of the West Indies. The field research will build on studies conducted by Professor Benka-Coker in Ghana and will leverage her expertise in exposure monitoring and health outcomes. The team will utilize several personal monitors to measure air pollution exposure among the food vendors before, during, and after cooking in the market. We will also assess lung function (and asthma symptoms) of the food vendors, using a small portable spirometer. Finally, we will leverage the robust network of ambient air pollution monitors on the island to understand pollution from other sources, including Saharan wind-blown dust.

Role of each student:

Student 1: The student researcher will play a role in coordinating and facilitating the field research and analyzing data. Prior to fieldwork, the student will complete human subjects training, and understand and finalize the IRB protocol. The student will learn to use all the equipment for the fieldwork and assist in organizing and prepping for the field. The student will travel to Barbados for 2 weeks and be the designated team leader for all **air quality** monitoring equipment and samples. After the fieldwork is complete the student will process air quality samples, download and clean real-time data, and analyze air quality data.

Student 2: The student researcher will play a role in coordinating and facilitating the field research and analyzing data. Prior to fieldwork, the student will complete human subjects training, and understand and finalize the IRB protocol. The student will learn to use all the equipment for the fieldwork and assist in organizing and prepping for the field. The student will travel to Barbados for 2 weeks and be the

designated team leader for all **lung function** equipment and samples. After the fieldwork is complete the student will download, clean, and analyze the lung function data.
We will conduct a pilot study of the environmental pollution experienced in occupational settings in Barbados in collaboration with the Centre for Biosecurity Studies at the University of the West Indies. The goal of our research is to evaluate the association between exposure to air pollution from cooking-related activities and lung function among workers. The project will introduce students to field-research in environmental health and exposure assessment. The team will utilize several personal monitors to measure air pollution exposure among the food vendors before, during, and after cooking in the market. We will also assess lung function (and asthma symptoms) of the food vendors, using a small portable spirometer. Finally, we will leverage the robust network of ambient air pollution monitors on the island to understand pollution from other sources, including Saharan wind-blown dust. The fieldwork will also be supported by Professor Hawkins from Environmental Studies Department.

The group will participate in all related activities prior to fieldwork (completing human subjects training, preparing surveys, gaining approvals, learning and preparing to use field equipment). The team will travel to Barbados for 2 weeks in June (roughly June 10-June 24th) and conduct our pilot project. Students will play a large role in interacting with participants and collecting data. Upon return to the Gettysburg College campus, we will analyze field samples and conduct data analysis.

Previously funded X-SIG output:

I participated in X-SIG last summer (summer 2024) with two students. So far, we do not have any scholarship output from the research project. We are currently working with our colleagues at Dickinson College to finalize data analysis and start working on a manuscript for publication. Students from Gettysburg College and X-SIG and students from Dickinson College are all anticipated to be co-authors on any publications. We may also submit some data for an international conference for later in 2025.

Prof. Josef Brandauer
Department: Health Sciences

Pre-requisite for a Summer Position: For all of my research projects, I look for curious and motivated students. With focused practice, students working in my lab routinely become quite skilled at the specific techniques we use. While previous lab experience is generally helpful, it is not completely required. Rather, I look for motivated and hardworking individuals who are excited about scientific discovery, problem solving, and passionate about working collaboratively within a small team. I look forward to meeting you!

Description of Research:

The current focus of my research lies on understanding how mammals regulate mitochondrial content and activity in various tissues. A particular focus is the investigation of how cellular concentrations of nicotinamide adenine dinucleotide (NAD) contribute to this regulation.

This summer, we will continue ongoing work on determining mitochondrial biology in skeletal muscle of a mice using in-vitro incubation models. This means that we will incubate whole mouse muscle in a culture bath using important NAD precursors. The student(s) working on this project will primarily assess mitochondrial protein expression, activity, and NAD concentrations in skeletal muscle tissue.

Student Expectations

I typically design X-SIG summers so that students can support each other in learning lab techniques and other ways, and have somewhat separate projects for which they are individually responsible.

For example, this could mean that one student is responsible for protein expression assays, while another analyses NAD concentrations. This opens up the possibility for combined (and more meaningful) data sets, yet gives students the chance to complete a defined project.

Prof. Victoria Wolf
Department: Health Sciences

Pre-requisite for a Summer Position:

Description of Research:

Project 1 Summary

Elevated blood pressure is a major risk factor for age-related cognitive decline. Hypertension has also been associated with accelerated age-related cognitive decline in females. More research is needed is needed to understand the sex-differences in age-related cognitive decline in male and female hypertensive animal models. Social isolation, a lack of physical activity, and sensorimotor stimulation are also strongly associated with cognitive decline. Environmental enrichment provides opportunity for additional social interaction and promotes physical activity, compared to standard housing conditions for laboratory animals. The goal of this research project is to determine if environmental enrichment prevents the progression of cognitive decline in male and female spontaneously hypertensive rats (SHRs). Aged-match, reproductively senescent male and female SHRs will be randomized to either the environmental enrichment group or standard enrichment group for 6 weeks. Blood pressure will be monitored by tail-cuff plethysmography and a variety of behavioral tests will be performed to assess changes in cognitive function. I am looking for **two students** to assist with the animal care, physiological measurements, and behavioral testing for this project.

Project 2 Summary

Post-stroke cognitive impairment (PSCI) is a major long-term complication of ischemic stroke and a leading cause of vascular cognitive impairment and dementia (VCID). Although significant strides have been made in stroke recovery and rehabilitation research, our understanding of how interventions affect VCID development and other complications of ischemic stroke is limited. The inadequate incorporation of hypertension, the leading cardiovascular risk factor for VCID and stroke, in preclinical stroke recovery research has expanded this gap in knowledge. Enriched rehabilitation strategies have been shown to enhance brain plasticity and improve behavior in preclinical studies using relatively young, healthy, adult male animals after stroke. This major goal of this research project is to determine if rehabilitation in the form of enriched housing (EH) improves the gait of spontaneously hypertensive rats (SHRs) recovering from stroke compared to standard housing (SH) conditions. Gait analysis was performed using the Catwalk XT (Noldus) automated gait analysis system. A large data set was generated that requires additional analysis to determine the effect of EH on gait recovery following experimental stroke. I am looking for **one student** to assist with the post-acquisition statistical analysis of this large data set. The ideal candidate will have experience with R or another similar programming language.

Prof. Bret Crawford
Department: Physics

Pre-requisite for a Summer Position:

Description of Research:

Proton Energy Loss through Thin Films (Bret Crawford, Physics) (3 positions)

The Student Proton Accelerator at Gettysburg College (SPAGetty) creates beams of protons up to several microAmps with energies between 50 and 200 keV. Continuing on past year's work, I plan to use the accelerator to study proton energy loss through thin films. While this phenomenon has been well studied, accurate modeling gets more challenging at low energies. Energy loss is important for solid-state ion detectors which have thin "dead" layers of material through which the ion must pass before the entering the detector's active region. This dead layer significantly affects the detected energy spectrum for low-energy ions. In high-precision measurements that use these detectors, correct modeling of the detected energy spectrum can be quite important, e.g., the on-going neutron-lifetime measurement at NIST to which I am a collaborator. To study this, students and I will deposit thin films (10s of nm) of gold or possibly other metals onto the bare silicon surface of our proton detectors, Passivated Implanted Planar Silicon (PIPS) detectors. The proton beam will then be adjusted so that it is detected either on the bare silicon of the PIPS or after first going through the layer of gold (or other material). With the purchase of a new 3D optical profiler, we will now have a reliable way to measure the thickness of the films, a key stumbling block in past years. The plan for the summer will be to learn to use the new 3D profiler and make a number of measurements of energy loss through different thickness layers of gold (and other materials if time allows). These results can be compared with simulation software to assess the accuracy of the models being used in the software.

The three summer students would learn about energy loss mechanisms, learn to run the accelerator, evaporate thin films, run the simulation software, collect proton energy data, develop and run Python scripts to analyze spectra, and become expert 3D optical profilers. There are sufficient task that they can be divvyed up, one student becoming the expert who then instructs the other students who can be helpers. I envision three primary responsibilities: accelerator operator, film evaporator, optical profiler.

Prof. Jena Meinecke
Department: Physics

Pre-requisite for a Summer Position:

Description of Research:

This summer, I am looking for 3-4 students to support a new laboratory astrophysics experiment to be conducted at UCLA using the Pheonix laser system. During the experiment, we propose driving asymmetric blastwaves capable of generating seed magnetic fields via the Biermann battery mechanism by ablating a cylindrical carbon target in a gas-filled chamber using a 16-J laser at 1,053 nm with a 20-ns pulse length and repetition rate of 1 Hz. A 1-T electromagnetic solenoid will provide a background magnetic field in a region of the plasma evolution, and the resultant seed magnetic fields will be characterized at thousands of locations and times using a 1-mm diameter B-dot probe. Due to the high repetition rate, the plasma density and temperature will be characterized at thousands of locations and times using optical Thomson scattering. Such an extensive study will provide insight into the development of magnetic fields in the present-day interstellar medium.

Two students will need to physically attend the UCLA experiment from 12 May-6 June. They will be in charge of setting up the diagnostics, running the daily laser shot schedule, and ensuring the successful retrieval of publishable data. These will be long days in the laser lab, and students will have daily meetings with our collaborative team of scientists from Gettysburg, UCLA, and Rochester. Upon return to Gettysburg, these two students will begin analysis of the data in hopes of publication.

One or (potentially) two other students will be fully based in Gettysburg for the summer, performing one of two tasks to support this work. The first task would include fabricating and characterizing B-dot probes. This will require a student to embark on electronics work and possible time in the machine shop. Additional responsibilities may include CAD drawing and some theoretical work. The second task would entail simulation work using the FLASH code. A student would need to quickly learn how to use the code and produce simulations to support the experimental results obtained at the Pheonix laser facility.

Prof. Mitchell Powers
Department: Physics

Pre-requisite for a Summer Position: prior programming experience is required for any prospective researcher. Applicants should have demonstrable experience working in Python, C++ or Fortran.

Description of Research:

Small molecules often appear simple, but complex interactions between them can lead to a variety of surprising behaviors. Our current research project focuses on a group of small triphenylene based liquid crystals that are extremely sensitive to small changes to their molecular structure. These molecules possess a columnar liquid crystal mesophase: a partially ordered state formed by the molecules stacking themselves into long columns, while still retaining liquid like properties that allow them to spin, twist and wiggle. This mesophase structure has a number of potential applications, but in order for them to be practical, the molecular interactions need to be modified in order to have better control of the phase properties (namely, the phase transition temperature). Our work focuses on better understanding the way these molecules interact with each other in order to inform new molecular design strategies. This work is part of an ongoing effort, involving chemists, physicists and data scientists in order to design, synthesize, characterize and understand a growing group of tail-free discotic liquid crystals.

Our primary project for summer 2025 is to better understand the role played by hydrogen bonds in these systems and in those featuring similar molecular interactions. This will be done through the analyzing a combination of experimental data, crystal structures and molecular dynamics simulations and the develop of a machine learning model for advanced liquid crystal engineering. Student researchers will receive a crash course in the fundamentals of liquid crystals, and will learn relevant programming skill on the job.

Prof. Sara Keefer
Department: Psychology

Pre-requisite for a Summer Position: Prerequisites include Psych 236 and/or 237 or strong interest in neuroscience, behavior, and rodent research.

Description of Research:

The field of behavioral neuroscience first examines behavior in rodents that directly reflects behavior in humans. My overarching behavioral research goal is to examine motivated behaviors when they occur adaptively but also when they occur maladaptively in rats. Motivated behaviors that are adaptive include food seeking and using environmental cues to learn about and find rewards (e.g. Pavlovian conditioning). Motivated behaviors that are maladaptive include persistently attending to and seeking out food and food cues despite not being hungry or when there are negative consequences, such as during risk-taking behaviors. My research examines the innate differences between these behaviors and identifies ways to change them -behaviorally or neurobiologically.

As a neuroscientist, I am interested in studying the neurobiological mechanisms of adaptive and maladaptive behaviors by using psychopharmacological drugs and brain manipulation techniques to observe resulting changes in behavior. The behaviors described above can be combined with neuroscience manipulation techniques, such as lesions and pharmacology, to investigate the necessity and involvement of different brain regions (e.g. the amygdala, hypothalamus, nucleus accumbens, ventral tegmental area, and prefrontal cortex) and/or neurochemicals of interest (e.g. dopamine, orexin, serotonin, just to name a few!).

In the lab, students can expect to search for, read, and comprehend primary research articles relevant to the research question. From these readings, students will be involved in the planning of the project including minimal coding that is involved in equipment setup. Students will run the rats through the behavioral paradigms and be involved in data collection and analysis. If desired, students can be trained in rat brain surgery with heavy guidance from myself and at the end of the projects, be involved in brain collection, histology, and microscopy.