Prof. Michael Caldwell
Department: Biology

Pre-requisite for a Summer Position: N/A

Description of Research:
In the Caldwell Lab, we study the ways in which animals use vibrations traveling through surfaces, such as the ground or plant stems, to assess their world. Although we know far less about how animals use vibrations, as opposed to other sensory modalities like vision or hearing, we do know that vibrational information is important in the communication, foraging, and risk assessment behavior of hundreds of thousands of species.

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.

Students joining the lab should expect a mix of theoretical discussions, intense fieldwork, software based data analysis, and fiddling with experimental technologies. We currently plan for this summer's research to take place in person, either in the field or on campus.

Prof. Veronique Delesalle
Department: Biology

Pre-requisite for a Summer Position: Preference for students who have taken Bio 214

Description of Research:
Have you ever wondered about the factors that allow a pathogen to jump from one host to another? What makes a pathogen capable of invading lots of hosts or just a few hosts? These are ecological and evolutionary questions and my lab is answering these questions, using bacteriophages, viruses that "eat" bacteria, as the model pathogen. In particular, we want to understand 1) what factors determine a phage's host range (their ability to infect a few versus many bacterial strains, to be specialists versus generalists); 2) how phages evolve as they encounter different bacterial strains to infect; and 3) the relative importance of mutation versus recombination (horizontal gene transfer) in the process of adaptation in phages. To address these questions, we are using the phages of the bacterium, *Bacillus subtilis*. This soil bacterium is one of the best-studied bacterial species and working with this species comes with all the benefits associated with model organisms. The following projects are planned for summer 2023:

Project 1: Analyze sequence changes in derived phages from evo/coevo experiment. In 2021, we conducted a passaging experiment with two closely related but genetically different phages eating two different strains of *Bacillus subtilis* under two treatments. For both the phages and the bacteria, one member of the pair was "domesticated" (adapted to laboratory environment) and the other "wild" (recently isolated from the natural environment). In the co-evolution treatment, one phage population and its bacterial host population were allowed to co-evolve. Both phages and bacteria were moved to new culture flasks every day (= passaging) for 2 weeks. In the evolution treatment, only phages were moved to a new culture flask with that flask containing a population of the original (thus "unchanging") bacterial host; only the phages are allowed to evolve in this treatment. We then extracted DNA from the experimental phages (from various passaging days) as well the original phages. Genetic differences between these phages tell us how phages evolve as they adapt to a changing or unchanging bacterial host.

Only 3 combinations still had phages after 2 weeks. Both the wild and domesticated phages survived on the wild bacteria in the evolved treatment and the wild phage survived on the wild bacteria in the coevolved treatment. The phages went extinct in all the other flasks. The surviving phage populations in the coevolved treatment accumulated more mutations (over 500) than those in the evolved treatment (ca. 10 mutations). A previous student analyzed the sequencing data from the end-of-experiment phages. However, we have not analyzed sequencing data from each passaging day which will allow us to determine how the number of mutations in the phage populations changed over time, when particular mutations appeared, when some mutations were gained and lost, etc. Basically we want to describe the temporal changes in the wild phage populations as they evolve.

Prof. Veronique Delesalle
Department: Biology
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Project 2: Host range changes from evo/coevo experiment. In addition, we can determine how the genetic changes in these experimental phages affect their ability to infect their bacterial hosts. We use spectrophotometry (how much light a chemical substance absorbs) and a plate reader to measure bacterial growth. Absorbance is used as a measure of bacteria population growth; more cells cause more light to be absorbed. By comparing absorbance curves for bacteria grown in the absence or presence of different phages, we can measure the ability of different phages to infect different bacteria. Our summer plan is to describe growth for the original bacteria when grown alone, grown with the original phage, or end-of-experiment evolved phages (at least 3) and coevolved phages (at least 6).

Project 3: Description of newly isolated phages. Over the course of the last 12 years, my lab has isolated numerous novel phages and published description of some of these phages (Delesalle et al., 2022; Vill et al., 2022). We have an additional 20 phages that have been sequenced but for which we lack data necessary for publication. In particular, we lack images and host range data. The summer goals will be to obtain transmission electron micrographs of these phages using our new TEM and to test the ability of these phages to infect our collection of lab and wild *Bacillus subtilis* (14 strains) through a simple technique known as spot testing (where you drop some phages on a lawn of bacteria and determine whether a “spot” develops indicating that the phage can eat this host).

Prof. Melanie Eshelman
Department: Biology

Pre-requisite for a Summer Position: N/A

Description of Research:
The Eshelman Lab is a biomedical research lab focused on the cellular and molecular biology of intestinal diseases, including inflammatory bowel disease and colon cancer. We have identified the RNA-binding protein, tristetraprolin (TTP), as a master regulator of intestinal epithelial cell biology. It slows the growth of colon cancer cells but prevents healing in the context of inflammatory bowel disease. This suggests that TTP and the molecular pathways that it modulates must be tightly controlled to maintain homeostasis in the gut.

Therefore, we are interested in: 1) Elucidating the pathways and cellular processes regulating the activity and levels of TTP protein. 2) Identifying the critical mRNA targets controlled by TTP in normal and malignant intestinal epithelial cells. 3) Understanding how TTP affects cellular processes including cellular proliferation, apoptosis, and quiescence.

In my lab, there are opportunities for students to learn many cellular, molecular, and biochemical techniques, including cell culture, organoid culture, mRNA analysis, microscopy, and bioinformatics. There are no requirements to join my lab, but individuals who have completed BIO211 and BIO212 will be stronger candidates.

Prof. Betty Ferster
Department: Biology

Pre-requisite for a Summer Position: N/A

Description of Research:
Butterfly diversity and nectar plant abundance in and around Gettysburg National Military Park and Gettysburg College campus

Along with important pollinators like native bees, butterfly diversity has declined dramatically largely due to human actions. Climate change, habitat change and fragmentation, and a resulting loss of nectar plants have all contributed to the dramatic loss of insects including charismatic butterflies.
Butterflies are closely tied to the plants they share long co-evolutionary histories with resulting in coordination between butterfly populations and their host plant phenology and biochemistry. To facilitate butterfly conservation, land managers and conservationists must focus on conserving the plants that butterflies need to survive and reproduce. Inadvertently these efforts will act to restore other, less charismatic pollinator populations, and the animals that eat them.

Studies of regal fritillary butterflies at Fort Indiantown Gap found they were limited in the nectar plants they used (Ferster and Vulinec 2009). Other butterfly species also select among available flowers to gather food in the form of nectar. *Speyeria idalia* feed primarily on milkweeds and native thistles. Swartz et al (2011) found that nectar plants were largely lacking from fields that once supported butterflies at Fort Indiantown Gap. Recent plant surveys of Gettysburg National Park grassland fields suggest nectar plants are also lacking in the fields that once supported regal fritillaries here too. (Unpublished report to GNMP). The larval host plant, violets were not found to be significantly different between unoccupied and fields occupied by populations of regal fritillaries at Fort Indiantown Gap, and the plant survey for butterfly resources identified a large violet population.

Nectar plants provide energy and nutrients to adult butterflies. Floral nectar provides water, sugar, and amino acids for adult butterflies (Boggs 1987). A lack of resources has been linked to reduced fecundity (Bogs and Ross1993) and size (Kelly and Debinski 1989). Butterfly declines worldwide may be in part due to loss of nectar plants. In the Gettysburg area, as elsewhere, nectar plants used by many butterfly species were historically more abundant than they now are. The recent survey for plants necessary for supporting regal fritillary butterflies identified a lack of nectar resources as a possible barrier to successful reintroductions. Many butterfly species use the same sources of nectar used by this now rare butterfly, and enhancing that resource should benefit nectar-seeking pollinators of many species. The National Park in partnership with students at Gettysburg College planted native nectar plants known to be valuable nectar sources for regal fritillaries and other butterflies in June 2021. A survey to establish butterfly diversity trends in fields (wheatfield and New Jersey Brigade wet meadow) and gardens (Sherfy house, Painted Turtle Farm at Gettysburg College and Adams Co. Agricultural Garden) will allow us to understand the impact of supplementing nectar plants on butterflies at GNMP. We established a pollinator garden on the college campus in the summer of 2021, and hope to understand how such gardens can help pollinator diversity. Weekly transect walks to survey for flowering plants and butterflies will be conducted by GC students during the 2023 summer season.

2023 summer research will continue these weekly data collections and work on our campus pollinator garden to look at trends in butterfly diversity over time in different man-modified habitats.

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 in creeks and streams, wearing waders and collecting animals in the summer heat and humidity of southern Pennsylvania.

Description of Research:
1.One project will test the combined effects of increased seasonal temperature and human pharmaceuticals (especially antidepressants) on the behavior of freshwater snails.

We have data from 2022 that shows the interplay between temperature and antidepressant exposure significantly impacts snail behavior. In summer'23, we will again collect snails from local creeks, maintain them in the lab at different temperatures and antidepressants, and perform behavior experiments each day. As pollutants and global climate change continue to be serious environmental problems in the aquatic environment, it is important to test multiple stressors that may pose unforeseen health risks for aquatic organisms.

2. A second project will be to test the effects of the antifouling chemical medetomidine on important behaviors in crabs. Results from previous experiments showed that medetomidine has toxic effects on freshwater animals. In summer'23, my lab will investigate its possible modulation of crab behavior. We will collect animals in New Jersey, maintain them in the our lab, and do a behavior experiment each day testing different concentrations of medetomidine. As pollution in the ocean continues to be a serious environmental problem, it is important to test emerging contaminants such as "new" antifouling chemicals that may pose unforeseen risks to aquatic organisms.

Prof. Kazuo Hiraizumi
Department: Biology

Pre-requisite for a Summer Position: Completion of Biology 211 (Genetics) by the end of the Spring Semester of 2023 would be desirable. An alternative qualification would be completion of Biology 113/114, Biology 115, or Biology 212 (Cell Biology). Laboratory experience working with Drosophila would be a plus.

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; and 6) 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. Matthew Kittelberger
Department: Biology

Pre-requisite for a Summer Position: Ideally, the selected students will already have completed our BIO 212 (Cell Biology) course.

Description of Research:
Students in the Kittelberger lab this summer will work with cultured melanoma cells, to identify viable fluorescent probes for labeling and examining subcellular structure and function. This project is intended to lead to a significant re-design of the lab curriculum in our Cell Biology (BIO 212) course. Currently, Cell Bio students engage in a month-long semi-independent project in which they treat melanoma cells with a drug of their choice, and examine effects on cell proliferation and differentiation (as measured by cellular production of melanin, or cell morphology). Our hope is to expand on these projects to a) give students more independence, with a broader array of experimental options; b) enable students to incorporate more modern microscopy techniques in their experiments, including timelapse imaging and quantitative microscopy methods; and c) better connect student experiments with material covered in lecture (e.g., cell signaling, cytoskeletal dynamics, the cell cycle, mitochondrial function and metabolism, etc). To this end, we seek to identify an array – perhaps 10-20 – of viable fluorescent probes, targeting different subcellular proteins and/or structures, that future Cell Bio students may use as tools to explore aspects of cell structure and function in control and drug-treated cancer cells. Such probes could include fluorescently-tagged antibodies, fluorescent fusion proteins (encoded by genes transfected into living cells), and/or fluorescent drugs that target specific proteins or organelles. Research students in my lab this summer will:

1) Work as part of a collaborative team to perform literature research to identify interesting potential proteins to target, and methods (antibodies, fusion proteins, etc) for labeling those proteins in living cells. This work will begin this spring, as time permits.
2) Select one or more probes, and design and conduct experiments to optimize those probes for use in cultured melanoma cells.
3) Help decide which probes are viable (e.g., cheap, easy to use, yield robust labeling) for use in the Cell Bio teaching lab, and create written protocols for their use.

Research students will learn cell culture techniques; methods for fluorescent labeling of proteins and organelles (immunocytochemistry, transfection methods); and fluorescence microscopy, using the new EVOS 5000 and 7000 microscopes the Biology Department recently purchased. Possibilities exist for interested students to continue to work on this project beyond the summer, and for potential publication (e.g., in the Journal of Cell Biology Education). I am seeking 2-3 research students for the summer; ideally, the selected students will already have completed our BIO 212 (Cell Biology) course. If you enjoyed the Cell Bio lab, this could be a fun way to take that experience further.

Prof. Jennifer Powell
Department: Biology

Pre-requisite for a Summer Position: Highly motivated students who love genetics and plan to continue their research project in the Powell lab during the school year. Preference given to rising sophomores and juniors.

Description of Research:
So much stress! Cells experience many different types of stress, including the stress of being attacked by pathogens, endogenous stresses such as the production of toxic metabolites or the accumulation of unfolded proteins, and environmental stresses such as changing temperature or salinity. The Powell lab focuses on how cells recognize stress, respond to stress, and integrate signals from multiple stressors. The tiny nematode *C. elegans* is an outstanding model system to answer these fundamental biological questions using powerful molecular genetic techniques.

The immune response is a special type of cellular stress response to infection by pathogenic microorganisms. Cells must detect the infection so they can respond accordingly. An exciting hypothesis is that cells do so by monitoring for signs of cellular damage that might occur as a result of an infection. One example of damage that does occur is oxidative damage – both from the Reactive Oxygen Species (ROS) produced by pathogens to attack the host cell, and by ROS produced by the host cells to fend off the pathogen. We propose that the host's immune system may also sense the resulting collateral damage as a trigger to activate or reinforce a defense response.

We also study the response to a brief extreme cold exposure. Following cold stress, we discovered that worms face a decision to allocate resources toward repairing the damage or to provide those resources to their offspring. The choice to transfer lipids to their germline is a reproductive strategy called terminal investment because it results in a survival advantage for the resulting progeny if they experience a subsequent severe cold shock, but it comes at the expense of the life of the parent. In addition to dissecting the molecular mechanisms of cold-induced terminal investment, we are studying the combined effect of cold and other stresses on *C. elegans*.

Prof. Angel Solis
Department: Biology

Pre-requisite for a Summer Position: N/A

Description of Research:
The Solis Lab is seeking motivated students for the upcoming X-SIG program. Our research is aimed at better understanding how inflammation is regulated. Inflammation is a common pathological condition underlying a wide range of human diseases, including (but not limited to) cancer, Alzheimer's disease, and diabetes. By discovering new ways that inflammation can be regulated, we can unlock a whole new array of potential therapies that could significantly impact human health.

We are especially interested in macrophages. Macrophages are an immune cell that can be found in all human tissues and are often the immune cell that initiates and drives inflammation in many pathologies. In our lab, we use a macrophage cell line to measure the level, magnitude, and kinetics of the inflammatory response. We use an approach that combines genetics, cell biology, biochemistry, and molecular biology to understand the full context of our observations.

This summer, our goals are to identify novel proteins that play a role in the inflammatory response in macrophages. We have identified a handful of genes that are expressed at high levels in inflammatory macrophages, yet currently have no known immunoregulatory function. We are working to generate genetic knockout cell lines in our macrophage cell line, induce inflammatory responses, and measure changes in phenotypes in our cells. We also hope to discover new proteins beyond our current candidate genes. More information on our lab, including previous publications, can be found on our website: thesolislab.com

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 completed one semester of 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 bats in flight chambers and in the field. They will be trained in experimental techniques, bioacoustics software, behavioral analysis software, and methods in tropical fieldwork.

Prof. Katherine Buettner
Department: Chemistry

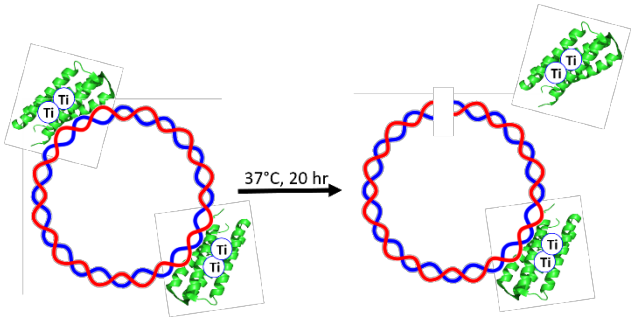
Pre-requisite for a Summer Position: Students should have completed general chemistry to work in the lab.

Description of Research:
The design and synthesis of mini-metalloenzymes.

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 recently 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 now working to understand structure function relationships of these enzymes, and their ability to function against a variety of substrates.

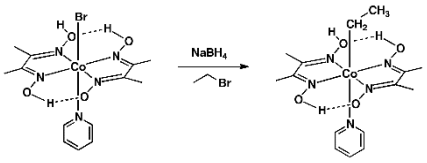
Projects in the Buettner lab include: the design and development of new active sites in our current protein scaffolds to optimize metal binding as well as enzymatic activity; characterization of metal binding using a suite of biophysical techniques; and the optimization of enzymatic activity studies.



Prof. Donald Jameson
Department: Chemistry

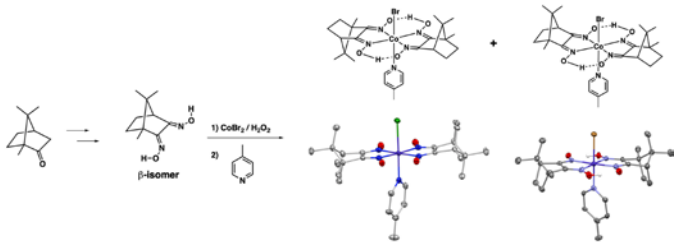
Pre-requisite for a Summer Position: The pre-requisite for a position in the Jameson group is CH204.

Description of Research:
Cobalt complexes of camphorquinone dioxime Cobaloximes, cobalt coordination complexes that are model complexes of vitamin B_{12}, were studied extensively in the 70s and 80s. Recent interest in these complexes focuses on their use as catalysts for both solar production of hydrogen and new organic photochemical reactions. The cobalt ion is in an octahedral geometry, bound by two dioxime ligands in the equatorial plane and anionic and neutral ligands in the axial positions. Cobaloximes are noteworthy for their ability to support a stable metal-carbon bond, a novel feature also found in vitamin B_{12}.



The dioxime of camphorquinone has been known since the early 1900s, but has never been used to prepare cobaloxime complexes. The interest in such a molecule arises from the fact that the camphorquinone ligand is chiral, which may confer on the cobaloximes unique properties, particularly as catalysts.

Camphorquinone dioxime exists as four possible isomers, but only one can be used to make a cobaloxime. Furthermore, the cobaloxime complexes exist as three possible isomers and all three are a product of their synthesis. These problems present challenges for purification; some which we have solved and some which remain to be solved. It is worth noting that the +3 oxidation state of the cobalt atom renders the complexes diamagnetic and therefore amenable to structural analysis by NMR.
In summers of 2019 and 2021, Emma Armstrong (’21) prepared, isolated and was able to grow high-quality crystals of the complex possessing a 4-methylpyridine ligand. X-ray crystallographic experiments (in collaboration with Nathan Schley at Vanderbilt) confirmed the structures of two of the possible three isomers (shown below).



Continuing work this summer will include preparation of new derivatives of these cobaloxime complexes (modifying both neutral and anionic ligands, including organometallic derivatives). We will be studying the properties of these molecules with an eye toward comparisons with the many related molecules that are reported in the literature. A primary focus will be the investigation of the electrochemical properties (oxidation/reduction reactions) of the complexes we have already made. These studies will complete the data required to begin writing a manuscript on this research.

Prof. Lucas Thompson
Department: Chemistry
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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 2023

Description of Research:
NanoLab http://nanolab.sites.gettysburg.edu/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. The plan for the summer of 2023 is to work on two projects that address these two facets.

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 width stays roughly the same.

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 (Figure 2) which you will be in charge of running after appropriate training.

Figure 2: Prof. Thompson at Princeton University picking up our new TEM.

Prof. Lucas Thompson
Department: Chemistry
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The second project that is planned for the summer of 2023 is to use the unique optical properties of gold nanoparticles as a handle to explore the interaction of these charged nanoparticles with

polyelectrolytes. Building on previous work where we unambiguously quantified the number of polymer strands adsorbed onto each particle, we are specifically interested in quantifying the number of ions that mediate this electrostatic adsorption process. We have found that the identity of the ions used (Na^+, K^+, Li^+) to mediate the adsorption process do not have a measurable impact on the number of polymer strands adsorbed but the strength of the interactions between the different ions and the polymers should certainly play a role and should scale with some periodic trend in terms of the ion-pairing interactions. These types of measurements do not exist in the literature and we

Are uniquely suited to contribute this knowledge to the broader community. This project will be completed in collaboration with Kurt Andresen and his group as we continue to build towards investigating the electrostatics of DNA-gold nanoparticle constructs.

In addition to the projects listed above, the NanoLab has on ongoing collaboration with Prof. Fong's group where we explore the toxicity of gold nanoparticles on aquatic organisms.

Prof. Ivaylo Ilinkin
Department: Computer Science

Pre-requisite for a Summer Position: See project descriptions

Description:
Project 1 - CS1App is a software framework for teaching CS111 with a goal of providing enhanced learning experience. It enables exploration of computer science concepts through app development for mobile devices. This project will focus on adding new features to the framework and reorganizing the existing code.

Qualifications: Strong completion of CS courses and ability to work independently. Familiarity with the CS1App framework preferred.

Project 2 - Non-photorealistic rendering is a subfield of computer graphics that aims to create or manipulate images for artistic effect. This project will look at implementations of recent algorithms and consider possible extensions. The initial focus will be on aspects of drawing representation. Other possibilities include studying machine learning algorithms with applications to non-photorealistic images.

Qualifications: Strong completion of CS courses and ability to work independently. Prior background from (or current registration in) MATH112 would be helpful.

Prof. Sunghee Kim
Department: Computer Science

Pre-requisite for a Summer Position:

1. CS216 – successful and strong completion expected
2. CS360 – preferred
3. Familiarity with HTML, CSS, and JavaScript – desirable

Description:

Data visualization is the graphical representation of data so that it can be understood and explored by the users. Data visualization on the web has gained significant traction and popularity in recent years thanks to the development of powerful visualization libraries in JavaScript such as D3.

The goal of this project is to design and develop a user-friendly and fully functional integrated development environment (IDE) for web data visualization projects.

There are several web-based data visualization IDEs but they tend to have a severe limitation in input data handling and allow only inline data (no data file upload) for processing unless the users become subscribers with substantial monthly/annual fees. A small dataset can be directly copied and pasted into the IDE for processing but it is not practical for processing and visualizing large datasets in external files. The subscription fees pose a significant challenge to our student population and without a subscription, they end up having to spend a lot more time and effort setting up and creating data visualizations whenever they have external data files.

The IDE developed in this project will include a user-friendly file/folder browser for easy organization and also allow users to upload data files in different formats such as csv, txt, tsv, and json to be included in any visualization or JavaScript/HTML project.

Prof. Rebecca Eckert
Department: Environmental Studies

Pre-requisite for a Summer Position:

- Interest in aquatic ecology and/or taxonomy
- Successfully completed BIO111 with a grade of B or higher
- Ability to work with live insects
- Ability to use a microscope for long hours
- Conduct organized and precise work
- Good communicator

Description:

My lab explores the connections between living organisms in streams, how they interact with their environment, and how changes in the surrounding terrestrial environment can impact them. These organisms, though often overlooked when walking near a stream, help regulate water quality and provide other important ecosystem services including leaf decomposition. The process of leaf decomposition ties the terrestrial and aquatic worlds together and recycles nutrients, as leaves from outside the stream enter and are broken down by physical, chemical, and biological mechanisms. The biological interactions that occur during this process are complex and not yet fully understood, and I specifically examine how interactions between leaves, microbes, and macroinvertebrates in streams vary with changes in the environment. My lab's grand challenge is to untangle these relationships and investigate how they are altered by continued human impacts on the environment like the cutting of streamside vegetation, nutrient inputs, salinization of freshwater, and global climate change. Having a better understanding of these impacts will allow us to protect water quality and biodiversity within streams. To answer these questions, students in my lab utilize a variety of techniques both within the field in streams and in the laboratory.

Currently, we are conducting a temporal study examining changes in nitrogen and carbon associated with leaves (leaf plus microbial nutrient content) throughout the decomposition process. We are interested in how carbon and nitrogen vary when macroinvertebrate shredders are present to aid in the decomposition process versus microbial contributions to nutrient content without macroinvertebrate shredders. Work to be conducted this summer will examine leaf decomposition dynamics under varying salt concentrations to better understand what changes may occur with the input of road salt into streams after winter road applications. We will be examining how algal and bacterial communities change in response to salt additions, how salt may alter macroinvertebrate growth, and the impact on overall leaf decomposition.

Prof. Natasha Gownaris
Department: Environmental Studies

Pre-requisite for a Summer Position: To be a good fit, students should have completed ES 211 and should be comfortable analyzing data in the statistical program R. Note that there is phone service and limited internet access on the island, solar power, and showering. We have access to a kitchen with a propane refrigerator and stove, and food drop-offs occur weekly. 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 (5:00am), field living conditions, limited internet access, and for spending all of June and July on this remote island.

Description: 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 more 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, etc.). In addition to daily monitoring tasks, we will be focusing on two research questions this year:

1) How do individual common and Arctic terns vary in how they change their foraging behavior during marine heatwaves? How do these behavioral decisions influence the growth rate and survival of their chicks? This project will rely on tern nest check data, tern provisioning watch data, and adult tern tagging data.
2) Can camera traps be used to capture nest-level information on Atlantic puffin diet? How do individual Atlantic puffins vary in how they alter their chick provisioning in response to marine heatwaves and how does this influence chick growth? This project will rely on alcid nest check data, alcid provisioning watch data, and alcid camera trap data.

As a student researcher, you will have ownership over a specific aspect of this project, but will also help with general daily data collection. You can learn more about this research from students' perspectives here.

Dates: Expected dates of May 30th – July 30th, most of which will be spent on Petit Manan Island.

Prof. Andrew Wilson
Department: Environmental Studies

Pre-requisite for a Summer Position: N/A

Description of Research:
Estimating the abundance of organisms is a basic element of ecology, field biology, and biological conservation. For songbirds, traditional survey methods include counting singing birds during the species' breeding season. In some instances--for example in terrain that is difficult to access--it can be challenging or time-consuming to conduct bird surveys on the ground. For the last few years, the Wilson lab has been pioneering the use of drones to conduct songbird surveys by attaching a lightweight recording device to a small quadcopter drone. Our previous research has shown that the technique is not only feasible but is potentially very time-efficient and can cause less disturbance to birds than traditional surveys where habitat is cross-crossing habitat on foot.

This year's research program will have three components:

1. compare bird counts from the drone system with counts from recorders placed on the ground
2. develop methods for fine-scale mapping of bird distribution
3. use a drone to produce fine-scale habitat maps that can be used to assess bird-habitat relationships

The fieldwork for all three parts will be conducted together as a team, but each of the three students will take the lead on field protocol development, data curation, and data analysis for one of the above. Students will need to be self-motivated to study for a remote drone pilot test during the first 2 to 3 weeks of the summer program (https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot)

Prof. Josef Brandauer
Department: Health Sciences

Pre-requisite for a Summer Position: N/A

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 mouse model of Down Syndrome. The student(s) working on this project will primarily assess mitochondrial protein expression, activity, and NAD concentrations in skeletal muscle tissue. (We receive these tissues from a collaborator at another institution, so you will most likely only work with frozen tissues, not with live animals.)

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.

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!

Prof. Kurt Andresen
Department: Physics

Pre-requisite for a Summer Position: N/A

Description of Research:

1. Measuring the Kinetics of the Disassembly of Mononucleosomes

There is two meters of DNA packed into the nuclei of every one of our cells (a container that is approximately one micrometer in diameter). One of the major steps in compacting this DNA is the wrapping of the DNA into hockey-puck shaped spools called nucleosomes. In this project, we will be using our in-house Circular Dichroism Spectrometer to measure the timed unfolding of nucleosomes. This will give some idea as to the energies involved in unwrapping the DNA form the nucleosome in important biological processes like transcription. Students will learn wet lab techniques (pipetting, equilibrium dialysis), basic Python analysis, and some interesting biology all while exploring the underlying physics that drives these processes.

2. The Entropy and Enthalpy of DNA systems

One of the major questions in biophysics is what energies and entropies drive complex systems to behave in the way they do. One of the systems I have been studying throughout my career is the self-attraction of DNA when in a solution of +3 ions. In this project, we will subject DNA systems to measurements utilizing our in-house isothermal calorimeter. We will explore how different ions and osmotic pressure affect the binding of DNA. Students will learn how to use the isothermal calorimeter, wet lab techniques, some basic thermodynamics, data analysis using the Python programming language, and some interesting biology.

3. Measuring Zn^{2+} binding to DNA (in collaboration with Professor Kate Buettner

One of the fundamental questions in DNA electrostatics is whether or not certain ions bind strongly to specific parts of the DNA or whether they just bind through general electrostatic interactions. Building on previous work, we will be measuring the binding of Zn^{2+} to DNA utilizing a combination of circular dichroism and ICP-AES (a technique used to measure the concentration of ions around the DNA). We will investigate whether there is specific binding of the Zn^{2+} to the DNA, and if so how much. These measurements will be useful in understanding how the small amounts of Zn^{2+} in our body affect DNA and the binding of other biomolecules (e.g. proteins) in the cell. Students will learn wet lab techniques (pipetting, equilibrium dialysis), basic Python analysis, and some interesting biology and physics.

4. Simulating Cobalt Hexamine +3 Binding to DNA

There has been a fair amount of data collected looking at the +3 ion Cobalt Hexamine binding to DNA in competition with other ions (much of it taken by me). However, there has not been any studies that look at this binding through simulation. I plan on using molecular dynamics simulations (and a new Cobalt Hexamine model) to try to predict the binding of ions to DNA. Students will learn simulation methods, a lot of Python programming, and need to think deeply about the electrostatics of DNA binding.

Prof. Bret Crawford
Department: Physics

Pre-requisite for a Summer Position: N/A

Description of Research:

Proton Energy Loss through Thin Films The Student Proton Accelerator at Gettysburg College (SPAGetty) creates beams of protons up to several microAmps with energies between 50 and 200 keV, which I would like to use 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). Alternatively, we could evaporate the gold onto a low-mass surface, such as silicon, and then detect backscattered protons. Using the college's Atomic Force Microscope (AFM) and/or optical techniques, we can measure the film thickness and thus study energy loss and energy spectrum shape as a function of film thickness and incident proton energy. These results can be compared with simulation software to assess the accuracy of the models being used in the software.

The two summer students would learn about energy loss mechanisms, learn to run the accelerator, evaporate thin films, use the AFM and UV-Vis, run the simulation software, collect proton energy data, develop and run Python scripts to analyze spectra, etc.

Neutron Transport Simulations of Neutron Spin Rotation Experiments The Neutron Spin Rotation collaboration has developed a neutron polarimeter that can measure deviations in the average spin direction of a polarized neutron beam to a sensitivity in rotary power less than a micro-radian per meter of target matter. This precision allows us to study effects of the weak interaction and search for exotic fifth forces, depending on the target and apparatus configuration. The effect of ambient magnetic fields on the neutron spins, even after significant magnetic shielding, are sufficient to require a series of experiments to cancel remaining magnetic effects. The precision with which we can remove these potential systematic errors depends on a number of factors that can be studied through simulation of the neutron transport through our apparatus. We have two computer codes that we can use to study the neutron transport, one written in the FORTRAN programing language and one that uses a neutron transport simulation package called MCSTAS. These codes need to be compared in terms of accuracy and speed, and then used to plan for upcoming experiments at the NCNR (NIST Center for Neutron Research).

The student would do some caparisons between the two simulations (homegrown FORTRAN versus MCSTAS) to evaluate accuracy and speed. The student will learn some coding, make adjustments to the codes, and do studies of how the experiment depends on changes to the apparatus and/or input neutron parameters. It may be necessary to use COMSOL, a commercially available physics simulation package, to alter magnetic coil designs to adjust magnetic field maps. Some programing experience is a plus.

Prof. Ryan Johnson
Department: Physics

Pre-requisite for a Summer Position: See project descriptions

Description of Research:

Project I: **Quantifying the Effect of Light's Travel Time on Projected Galaxy Cluster Data**

This project is a continuation of a study I began several years ago into the phenomenon of the effect of finite travel speed of light on astronomical observations of galaxy clusters. When we use simulations to predict where and how these clusters should evolve, we must project the data onto a 2D observational plane, in order to mimic the projection of that data onto our sky. Specifically, we will be examining the observational effect of projecting 3D astronomical data onto a 2D observational plane when the object we are projecting is so large that light takes millions of years to get from one side to the other. Because of this, all currently used data projection methods are not taking into account that different parts of the object are also being projected to different times. Our goal is to develop and test several different numerical projection methods which will both project the data onto the same plane, and correct it so that it will all be projected to the same time as well. This project is best suited for a Physics major interested in theoretical astrophysics.

Projects II and III: **Geospatial data analysis using COVID data.** Since spring of 2020, copious amounts of data have been collected on the spread of the COVID-19 virus throughout the world's population. In each of these proposed data science projects, we will be using python's geospatial visualization libraries to numerically analyze relationships between COVID-19 infection rates, hospitalizations, and deaths, and other regional demographic data. The first project is a continuation of previous work looking into the regional correlations between the peaks in COVID infections, hospitalizations, and deaths. The second project is an extension of the tools used in the first, but with an eye towards identifying geospatial demographic data that also correlates with COVID statistics. The goal of both of these projects will be to create analytical tools for the community to use in understanding how public health statistics are spatially correlated. These projects will use publicly available data from sources such as usafacts.org, which is the central repository for all COVID data in the US, and the Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. These projects are best suited for students with an interest in data science or computer science and interested students should have at least an introductory facility with some computer language.

Prof. Yoshihiro Sato
Department: Physics

Pre-requisite for a Summer Position: Knowledge about Python programming language is desirable but not required. Completion of one of the following courses: PHY310, CHEM203, CHEM204, CHEM305, or CHEM306.

Description of Research:
Molecular Excitation Energy and Charge Transfer Mechanisms in Photosynthesis.
Plants, algae, and many kinds of bacteria capture natural light to sustain their life by photosynthesis. These organisms are using specific proteins to convert the light energy into molecular excitation of pigments, and they eventually create electricity for subsequent chemical reactions of photosynthesis. These proteins are called reaction centers. A remarkable aspect of the reaction center is that efficiency of energy conversion is nearly 100%, much higher than the best commercially available photocells. How did they successfully develop such a mechanism in their course of evolution? Recent experimental and theoretical studies indicate that the quantum mechanics is playing a key role in keeping the efficiency.

In this project, we will run computer simulations to investigate how quantum mechanics is working in the photosynthetic reaction centers and other proteins. We will particularly focus on building a physical model of photo-induced charge transfer dynamics in photosystem II reaction centers, which are commonly found in oxigenic photosynthetic organisms such as plants and cyanobacteria. The simulations will be performed using a GPU-accelerated high-performance computing cluster located in Masters 202.

The student will be expected to do the following:

1) Running simulations and analyzing the results to extract properties of energy and charge transfer dynamics in photosynthetic proteins.
2) Developing a method for molecular dynamics and quantum chemical simulations on energetic properties of biomolecules including chlorophylls and carotenoid.

In both of the projects, the student will be much involved in data analysis using their knowledge about quantum physics and/or chemistry.

Prof. Kathy Berenson
Department: Psychology

Pre-requisite for a Summer Position: Applicants should have completed Psych 205 (statistics). If there are more applicants than available positions, preference will be for students who show stronger preparation/motivation to focus on this particular project (which the students should describe in their application). For example, evidence of preparation/motivation might include completion of courses related to personality/clinical psychology, completion of research methods and advanced lab courses in psychology, experience assisting faculty in a research lab, or other applied/lived experience and goals relevant to the topic of this research.

Description of Research:
Personality Lab Young adults in the US today receive a lot of cultural messages about the importance of being 'positive' (e.g., self-confident, easy-going, happy, high-vibration, etc.). My lab has been examining how an emphasis on 'positivity' may be beneficial for some individuals/contexts and yet harmful for many others. So far, the data we have collected from student volunteers (including experiments, qualitative interviews, surveys, experience sampling, and measures of heart rate variability) suggest that strongly valuing a 'positive' self-presentation increases risk for maladaptive coping, because it is associated with an inflexibly fragile self-image and less compassion for ourselves and others experiencing suffering.

During the summer of 2023 we will be continuing our work on this project, spending much of our time managing, analyzing, interpreting, and writing/editing papers about data that we have previously collected. We will also extend this work by developing and pilot testing interventions to help counteract societal pressures to be 'positive.' Specifically, we will draw upon the literature on psychological flexibility and related concepts in acceptance-based therapies to create and empirically examine experiential exercises (to be completed in person or on-line) for participants who self-identify as aspiring to work as mental health counselors/clinicians and/or social justice allies/advocates. Because these are fields in which it is crucial to be able to attend to negative aspects of life including one's own negative impact on others without letting the discomfort this evokes interfere with doing the work, individuals committed to these fields are likely to be motivated, thoughtful participants for our research.

Two X-SIG students will be hired during the summer of 2023. The students will assist with analyzing/interpreting previously collected data as well as developing/conducting new studies. The students will gain skills using SPSS syntax and APA-style, while becoming familiar with relevant theoretical and empirical work in this area of personality/clinical psychology. They will manage, analyze, and interpret data, code open-ended responses, create research materials (including Qualtrics surveys and IRB documentation), conduct literature searches and write/edit research papers. The students will spend much of their time working together, but one will develop a new study of aspiring mental health counselors/clinicians, while the other will develop a new study of aspiring social justice allies/advocates.

Prof. Nathalie Goubet
Department: Psychology

Pre-requisite for a Summer Position: Interested students should be psychology majors and have completed Psych 205.

Description of Research:

***Project 1* - The cost of Adversity – Perceptions and Realities**

A solid body of research points to the potential negative effects of childhood trauma on long-term mental, physical, and social health. Despite these scientific findings, information has been slow to trickle down to the general population. Results from our lab show that college student seem relatively aware of the long-term costs on mental and social health but do not know the effects on physical health. In a previous project on the perception of resilience skills, we found some mismatch between the factors empirical research has identified as important and people's beliefs. We also found the importance of some factors (i.e., family, school, community, personality) varied depending on the race/ethnicity of our participants. The overarching goals for the summer project are to follow-up on these results by 1) investigating how people's awareness of the cost of early trauma may be related to their own life stories (i.e., their own childhood adversity) as well as personal characteristics (age, gender, race/ethnicity, SES); and 2) exploring how people's beliefs about resilience may shape how they perceive their responses to other people's adversity. This project will be focused on a sample of 200 adults (of all ages) and data will be collected via an online data collection system.

***Project 2* - Food perception in Elementary school children**

Childhood obesity is a great concern in the US because it is associated with short-term and long-term consequences on physical and psychological health. Part of the problem is a lack of balance in the foods offered to children, and the biological attraction for unhealthy foods (sweet and salty foods). Past research indicates that visual cues are key factors in children's decision to eat or not specific foods, in addition to various personality and contextual factors.

In previous research in our lab, we asked 3- to 11-year-old children to judge food plates when foods were mixed or not touching at all. Children's liking of the foods and willingness to eat depended on the type of food and was correlated with their liking of these foods.

The general goal of this research project is to better understand what guides elementary-school children in their food preferences and judgments. In this new project, we will investigate the various factors that may drive these responses. Children's preference for no-contact plating may be linked to an understanding of contamination and the development of disgust sensitivity. Other factors may drive children's food choices and preferences. For example, personality characteristics, perceptual sensitivity, and/or family context. We will conduct an experiment to explore these factors, and test elementary-school children (from 5 to 10 years of age) from Gettysburg and towns around. Data collection (children and their parents) will proceed on campus at the Flavor and Olfaction lab (McCreary).

X-SIG summer fellows will gain knowledge and experience in literature searches and science writing in APA style; data management and analysis using SPSS; using Qualtrics; Research on resilience/adversity; research on child food acceptance/perception.

Prof. Daniel McCall
Department: Psychology

Pre-requisite for a Summer Position: Completion of Psych 205 or equivalent statistics class (required) and Psych 305 (preferred).

Description of Research:
Our perception of a food's flavor primarily arises from a combination of aroma as signaled by olfactory receptors in the nose, with taste sensations (sweet, sour, salty, bitter, and umami) detected on the tongue. However, our total experience of flavor is affected by so much more than that. In our lab we study the psychological, 'top-down' mechanisms that influence flavor perception. These include information from other sensory systems such as a food's color or texture, as well as cognitive, cultural, and emotional factors that bias our flavor sensitivity and preference.

In a recent study we found that the perception of an odor's pleasantness and intensity varied depending on the verbal label assigned to that odor. When odors were mislabeled, participants' perceptions changed, even when they were aware that the labels were incorrect. We will continue work in this domain in the summer of 2023, examining how verbal labels and emotional primes influence flavor perception and memory. The primary focus of the summer experience will be to design, conduct, analyze and write up the results of this study. Students will read and summarize background literature, design the experiment, collect data with human participants, analyze the data, and write up their findings. Students will learn to use the Superlab and Qualtrics software packages to implement the experiment. They will also learn lab techniques relevant for this work, including pipetting, serial dilution, and psychophysical testing of taste and olfactory thresholds using standardized clinical tools. Students may also conduct coding of open-ended responses and complete data analyses with existing data sets related to this work.