Sophomore Early Research Program 2020-2021
Natural Science Faculty Projects

Natural Sciences: Projects in Biological Sciences, Biochemistry, Chemistry, Computer Science, Geosciences, Mathematics, Neuroscience, and Interdisciplinary Collaborations

Biological Sciences, Biological Sciences/Biochemistry

Louise Darling
Mechanisms of cellular resistance to the chemotherapeutic agent methotrexate

Methotrexate (MTX) is a commonly used chemotherapeutic agent that kills cancer cells by binding dihydrofolate reductase (DHFR) and negatively affecting the biosynthesis pathways involved in the production certain nucleosides and amino acids. Interestingly, some precursor and stem cell types appear resistant to MTX treatment. The mechanisms by which these cells resist the drug remain unclear but could be useful in developing rescue therapies to help both stem cells and normal, differentiated cells survive while cancerous cell types are affected and eliminated during MTX treatment.
Students will work in a team with their labmates and use mammalian cell culture, fluorescence microscopy, and biochemical approaches to investigate these mechanisms. Students will gain exposure to a variety of techniques potentially including, PCR, DNA cloning, gel electrophoresis, SDS-PAGE and immunoblotting, mammalian cell culture, and fluorescence-based proliferation and viability assays. Qualified students have generally completed and introductory course in Biology (BISC 110/110P/112/116) and Chemistry (CHEM 105/120/116).

John Goss
Characterizing cellular signaling pathways that regulate contractile ring constriction in fission yeast

The constriction of the actin-myosin contractile ring is an essential part of cytokinesis, the final stage of the cell division cycle. Following assembly of the ring during mitosis, a signaling pathway in fission yeast initiates constriction to separate the cell into two daughters cell leading to successful completion of division. Four scaffold proteins contribute to recruitment of the cytokinesis kinase complex to the contractile ring in order to initiate ring constriction. The goal of this project is to investigate the relative contributions of the four scaffold proteins in kinase recruitment using real-time quantitative fluorescence microscopy and computational analysis. Students involved in this research project will gain experience in critical reading and evaluation of primary scientific literature, discussing research with peers during lab meetings, and writing about and presenting their work.

Vanja Klepac-Ceraj
Microbes of the Global Flora

The soil microbiome is the collection of bacteria, fungi, and viruses associated with plant roots and soil. The composition of this microbial community can have a large effect on plants and on the ecosystem as a whole. I am interested in characterizing individual soil microbes in the New Global Flora Greenhouse and how they differ between wet and dry biomes. I look forward to working with a SERP student to explore the microbes in our new Global Flora Greenhouse. We will build a portfolio of Global Flora Microbes with pictures and identifications for the Wellesley College community.

Heather Mattila
Behavioral defenses of Asian honey bees (Apis cerana) against attack by giant Asian hornets (Vespa soror)

The SERP student would contribute to an ongoing project in the lab that examines acoustic and chemical communication between Asian honey bees (*Apis cerana*) and giant Asian hornets (*Vespa soror*), which slaughter bee colonies during mass attacks. By analyzing colony recordings made during attacks and samples of attacking hornets, we are gaining insight into the behavioral interactions between these predator and prey species. The SERP student will work on a lab team that is building a literature review and contributing to data collection, including analysis of acoustic signaling by bees and pheromone signaling by hornets. This effort is in support of two senior thesis, both of which are anticipated to result in a publication for the lab, so the SERP student will observe this process throughout the academic year. All work will be remote (colony recordings and histology images are digitized).

Becca Selden
Warming impacts on rocky intertidal food webs

The project will examine how warming affects species interactions within rocky intertidal food webs. The student will conduct both short-term behavioral observations of foraging by green crabs, whelks, and periwinkles and long-term growth studies to evaluate the effect of warming on these interactions. The student will need a background in animal behavior and an interest in marine food webs. The project will culminate in a science communication project.

Andrea Sequeira
Wetlands invaded: Exploring the colonization of Wellesley College's wetlands by invasive Phragmites grasses

This project seeks to unravel the genetic and physiological reasons for the ecological success of species introductions. Through two interconnected avenues of inquiry we will explore the origins of that success; is it imprinted in the genetic patterns of introduced populations or could introduced populations have physiological advantages or limitations that impact their success? These questions are framed in the light of the conservation concern raised by the expansion of

the common reed *Phragmites australis in* western Atlantic salt marshes and its prevalence in the wetlands in the Wellesley College campus. Students participating in the project will be trained in molecular biology and physiology techniques and data analysis. Students with interest in evolution, ecology and conservation would be good candidates for this project.

Yui Suzuki
Exploring phenotypic plasticity in insects

The Suzuki lab is interested in understanding phenotypic plasticity, the ability of organisms' appearance or behavior to respond to different environmental conditions. During T2, the SERP student will have an opportunity to work on a project examining a phenotypically plastic trait. During T3 and T4, we will conduct a literature review on the trait and analyze any data that were collected during T2. Possible projects include examining the mechanisms controlling insect flight behavior, the plasticity of caterpillar coloration and/or the growth of insects under varied environmental conditions.

Chemistry, Chemistry/Biochemistry

Megan Nunez (2 projects)
Removal of damaged DNA from nucleosomes

We want to know whether damaged DNA can be properly repaired when it is packaged in chromatin. While working on campus, a student will learn a variety of fundamental biochemical techniques for synthesizing and characterizing DNA-protein complexes. While working remotely, a student will process data and participate in weekly group meetings at which she will read and present papers from the scientific literature. A willingness to collaborate with other student and alumnae researchers is required.

Bacterial recognition and adhesion

We study the molecular characteristics of recognition and adhesion by the bacterial predator, *Bdellovibrio bacteriovorus,* using atomic force microscopy (AFM). While on campus, a student working on this project would learn how to culture bacteria and would then attach the bacteria to AFM cantilevers. The cantilevers will be used to probe a variety of surfaces to see what sticks. While working remotely, a student on this project will learn to process AFM data and will also participate in weekly group meetings at which she will read papers and interact with other students and alumnae researchers.

Rachel Stanley
The coastal carbon cycle: Insights from gas tracers

Photosynthesis in the coastal water sequesters carbon dioxide from the atmosphere and thus plays an important role in the carbon cycle. In this interdisciplinary project, a student will analyze records of the gases O2 and Ar, already collected from oceanographic ships in coastal

New England waters and use the data to calculate rates of photosynthesis and respiration and to start untangling on which factors these rates depend on and how they may change as climate changes. The research is a combination of chemistry (which is how the measurements were made), physics (because water and gases are transported in the ocean so physical transport is important) and biology (since phytoplankton and other organisms are the ones doing the photosynthesis and respiration) and thus the student will learn about all of these fields. In addition, the student will become part of a multi-institutional team since this work is highly collaborative. Most of the work will consist of using Matlab to compare the gas data to other variables measured, reading papers in the scientific literature, and thinking about the system as a whole is functioning. No coding experience is necessary but this project would be best for a student who is happy working with lots of numbers and is eager to learn about data analysis. Previous members of the lab have said that the data analysis skills they learned have been enormously useful in the fields they have ultimately pursued – public health, atmospheric chemistry, management consulting, etc. There may be some opportunity to learn mass spectrometer skills as well and to improve measurement capability in the Stanley Lab.

Mathew Tantama
Protein engineering biosensors to study brain injury & disease

Students will engage in the design, production, and characterization of fluorescent protein-based biosensor that will be used to study inflammation and cell death processes in the brain, such as in models of Parkinson's disease. Techniques include molecular biology, protein biochemistry, spectroscopy, and cell biology methods. The research projects are interdisciplinary in nature and students with a wide range of interests from biology to chemistry to neuroscience and beyond are welcome.

Computer Science, Computer Science/Media Arts & Sciences

Peter Mawhorter

VR environments for studying the psychology of memory

This project investigates how virtual reality or other immersive environments can be used to study the psychology of memory. Work will focus on learning to use software to construct a VR environment and designing an environment suitable for use in a psychology study. This project is open to students from either the natural or social sciences as long as they've taken a few computer science courses.

Ben Wood
Program analysis tools for bug-finding

Writing correct and reliable programs is hard, but crucial in a world powered by software. This project develops new program analysis tools that automatically check critical safety and correctness properties and catch bugs in programs. Student researchers will assist with

experiments to evaluate the effectiveness of these tools for finding and preventing software bugs in new and existing software. The benefits of working on this project include: (1) growing your programming skills; (2) learning software development skills including scripting, testing, version control, build systems, and command-line tools; (3) learning to read technical computer science literature; practice problem-solving and critical thinking. The requirements include: (1) love of programming and curiosity for how things work, (2) successful completion of CS 230 or equivalent, (3) confident programming skills in Java or C.

Geosciences

Dan Brabander
GeoHealth: Soils, metals, and public health

Explore the interface between Geosciences and Public Health. Our lab has several ongoing projects including geochemical fingerprinting of compost source streams, examining the fate and transport of mine waste on floodplains in Oklahoma, and examining the global threats link with lead acid battery recycling. Students must have had GEOS 102 or GEOS 101. Work in T2 will include lab bench work while T3/T4 will be data and literature focused.

Mathematics

Ismar Volic
The mathematics of voting methods

This project will examine the mathematics behind various voting systems. We will try to correlate the usage of different voting methods to more equitable candidate selection using some cutting edge methodologies that combine mathematics with data analysis. In addition to looking at the mathematical properties of various voting methods, this project will require learning about the history and politics of voting in the U.S. and will thus be highly interdisciplinary. The only mathematical prerequisite for this project is good command of algebra. Some coding and data analysis experience is welcome, but not necessary. No political science background is needed.

Neuroscience

Sara Wasserman
Fly on the wall: Communicating the importance of fruit fly research to the general public

This project will focus on choosing a method for conveying the importance of fruit fly research to the general public. Students (up to two) who participate will work with Prof. Wasserman to determine the format (i.e. podcast, children's book, comic, etc...) and will get experience researching and reading primary literature and communicating that for a general audience.

Interdisciplinary Project

Suzanne Langridge
Paulson Place Challenge

The Paulson Place Challenge project in Fall 2020 will use the campus as a “living laboratory”, including investigating history, management, and ecological processes of campus landscapes such as Paramecium Pond and the Science Meadows, researching and communicating information on animal monitoring or tree diversity and value, developing water monitoring methods, or other projects connected to the understanding of place and environment. The student is also welcome to explore and build upon questions from this summer's research on air quality, biodiversity, and water management. The student will be part of an interdisciplinary faculty/staff/student team working together to develop research questions, methods and project outcomes.