Sophomore Early Research Program 2016-2017
Natural Science Faculty Projects

Natural Sciences: Projects in Astronomy, Biological Sciences, Chemistry, Computer Science, Geosciences, and Neuroscience.

Astronomy

Kim McLeod
Hunting Planets

My SERP student will use Wellesley's 24" telescope to conduct observations for the KELT exoplanet search project. She will also help to train other observers. My expectation is that the student will commit to three evenings of observing per week, with the understanding that she will in reality work on average only 2 nights per week due to weather, and likely more in Fall than in Spring.

Biological Sciences

John Goss
Characterizing the recruitment of regulatory kinases to the division plane during cytokinesis

Cytokinesis is the final stage of cell division, when an actin-myosin contractile ring constricts to separate the two daughter cells. The cellular localization of this ring and the timing of its constriction are tightly controlled to ensure proper cell division. Errors in this spatio-temporal regulation can lead to asymmetric cell division, a hallmark of various forms of cancer and neurodegenerative diseases. The Ndr family kinases Mob1p and Sid2p are highly conserved signaling proteins that are recruited to the fully formed contractile ring, where they phosphorylate downstream targets to initiate ring constriction. Delays in recruitment of these kinases result in delayed ring constriction and increased errors in cytokinesis. However, the mechanism by which Sid2p and Mob1p are recruited to the contractile ring is poorly characterized. This project will utilize molecular, cellular, and biochemical approaches to characterize the role of several key proteins in the recruitment of these kinases to the division site.

Heather Mattila
Does food stress affect the ability of honey bees to learn?

A SERP student will join a team of students in Professor Mattila's lab whose goal is to investigate the social behavior of honey bees. Our work during the 2016-17 academic year will extend the findings of an ongoing lab project (see the following 2015 PLOS ONE publication: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0121731). The project will involve an exploration of the effects of poor nutrition on the learning and orientation performance of European honey bees (Apis mellifera). During the academic year, the Mattila lab will focus on analyzing raw field data that will collected during Summer 2016 to address this question. No previous experience with lab research or honey bees is necessary.

Chemistry

Chris Arumainayagam
Electron-Induced Reactions Relevant to Water Radiolysis

We propose to study the low-energy (0-100 eV) electron-induced decomposition of water under ultrahigh vacuum conditions (p ~ 5 ´ 10-10 Torr) using post-irradiation temperature programmed desorption (TPD), a well-established surface science technique, isothermal electron-stimulated desorption (ESD) experiments, and infrared reflectance absorption spectroscopy (IRAS). These studies will allow us to examine the hypothesis that dissociative electron attachment is the primary mechanism leading to radiolysis of water. The radiation chemistry of water is of fundamental importance to fields as diverse as interstellar chemistry, waste remediation, radiation processing of food, nuclear reactors, medical diagnosis, and radiation treatment of cancer.

Don Elmore
Characterization of Antimicrobial Peptides

A SERP Project in the Elmore Lab would involve studies antimicrobial peptides, which are small proteins that kill bacteria and other microorganisms and represent a potential alternative to conventional antibiotics. Projects would aim to determine why different peptides kill bacteria via different mechanisms. Students joining the lab as part of the SERP program would participate in this projects by learning experimental methods, such as fluorescence and circular dichroism spectroscopy, lipid vesicle preparation, bacterial culture or confocal microscopy, or computational methods, such as homology modeling or molecular dynamics simulations. Qualified students will generally have completed at least two courses in either chemistry and/or biology during their first year of Wellesley.

Adrian Huang
Regio-controlled N-Substitution of Pyrazoles and Its Application to the Synthesis of Celecoxib

N-Substituted pyrazoles have received increasing attention in agrochemical, pharmaceutical, and material science. The project will investigate new methods to prepare N-substituted pyrazoles quickly and environmentally friendly. The research will provide undergraduate students with valuable training in organic synthetic techniques.

Megan Núñez
Biophysical Chemistry of Bacterial Predation

In this project, we combine biology, chemistry, physics, and computer science to explore how bacteria adhere to surfaces. A student working on this project will learn to image and probe bacteria using our new atomic force microscope. She should be good with computers and technology and be willing to learn some complex data analysis in Igor. She must be a self-starter who can work independently.

Mala Radhakrishnan
Molecular Matchmaking: Using Computation to Understand how BIologically-Relevant Molecules Recognize Their Binding Partners

The Radhakrishnan Lab develops and applies computational methods to analyze and design molecular interactions in biomolecular systems. We want to understand how molecules utilize their chemical and physics properties to "recognize" their intended binding partners while avoiding unwanted interactions. We also apply computational methods to suggest ways to improve interactions between drug molecules and their targets. Students in our group get a very interdisciplinary exposure to chemistry, physics, biology, math, and computer science. They also learn valuable computer programming skills, which are highly transferable to any future discipline. No previous computer programming experience is necessary, nor are any particular courses, although a successful student must have a strong interest in analytical and quantitative thinking and in interdisciplinary learning.

Computer Science

Eni Mustafaraj
Designing Visualization Experiences for Collaboration

Visualization is the preferred way for exploring large amounts of data in many scientific disciplines. However, building visualizations is usually a non-trivial process involving either dedicated software or advanced programming skills. Moreover, only one user at a time can work on a visualization. Thus, our research questions is: will engagement with data increase and understanding of a problem deepen if we design new visualization experiences where users can work collaboratively? We will investigate this question by: 1) building a prototype for the multi-

taction displays on the Wellesley's HCI lab for collaborative data visualization; 2) studying users working with the prototype. The student working on this project should ideally have some experience with Python and Javascript and then during the project will become very proficient in them. The student will learn about the iterative design process of implementing users experiences, and will explore themes from psychology such as collaboration and learning.

Geosciences

Daniel Brabander
Urban agriculture geochemistry challenge: Increasing food sovereignty minimizing lead exposure

Designing sustainable urban agricultural best practices in food deserts presents many challenges. How can produce be safely grow in urban soil that is often contaminated with lead? What cost effective amendments can be added to the soil to lower lead uptake in plants and reduce lead bioaccessibility in soils? The Brabander lab group has been fingerprinting municipal compost source streams to determine how to reduce total trace metal inventories while providing a growth matrix that reduces lead geomobility in soils. Urban forging is also on the rise in major US cities and our lab has begun to examine both the nutrient and trace element profiles of fruit (typically, cherries, pears, peaches, and apples) that is harvested from trees found in urban backyards, parkland, and along roadways. Is this fruit as safe as organic/conventional produce? Can adding this to the palette of urban agriculture lengthen season to late fall-early winter thereby increasing sovereignty throughout a longer period of the year?

Preference for those considering ES/GEOS majors and having taken one of the following courses GEOS101, GEOS102, GEOS 120, ASTR 120, ES101, or ES103.

Neuroscience

Deborah Bauer
How do glutamate transporters influence glutamate receptors?

This project will involve worm-mating, PCR, and fluorescence microscopy experiments to determine whether glutamate transporter expression influences receptor localization before and after learning paradigms. Through these experiences, you will also learn to keep a lab notebook, sterile technique, solution making, worm maintenance, experimental design, use of a dissecting microscope, worm behavioral testing, statistics, data analysis, and literature review pertinent to the field. Because I will be advising from off campus during the fall semester, students applying should have previous experience in the lab.

Sharon Gobes
Neural mechanisms underlying song learning in birds

In the Gobes lab, birds (zebra finches) are used to investigate the neural mechanisms underlying learning and memory. Research assistants will get trained on one or more of the following techniques: behavioral tests and analysis of behavioral data, histological processing of brains, light microscopy and image analysis, and/or wet-lab procedures (immunocytochemistry and other chemical procedures to highlight structures in the brain). After training, and once the student is proficient on the technique, the SERP student will become responsible for running one aspect of a larger study independently. This includes time planning of experimental procedures, purchasing and maintaining the required materials, running experiments, collecting and analyzing the data, and co-authoring an abstract / preparing a poster to present the results of the study. The fellow will work closely together with the lab-manager, which will require a high degree of responsibility and general tasks.

Marc Tetel
Progestin receptor function in brain

Our lab is studying how the progestin receptor functions in brain to regulate gene expression. We are focusing on how the progestin receptor can be activated in the absence of progesterone by the neurotransmitter, dopamine. Students will use biochemical approaches, including protein-protein interaction assays, and gain experience with neuroanatomy. Students will gain a better understanding of how steroid hormones function in brain and behavior.

Sara Wasserman (new faculty member, starting in July 2016; Interested students should contact Barb Beltz, Neuroscience Program Director)
How does internal state alter multimodal sensory integration in flying Drosophila?

A hallmark of the brain is that a singular input does not always elicit the same output; rather a given input might produce a variety of outputs depending on the internal or external state of the animal. The Wasserman Lab uses the fruit fly,*Drosophila melanogaster*, to investigate how a brain can assess and integrate external and internal states to modulate behavioral responses to sensory signals. We explore how neuronal circuits coordinate this modulation; yet remain sufficiently stereotyped to reproduce adaptive behavioral responses. Students working in the lab will utilize a multidisciplinary approach by combining computer coding (Matlab), molecular, genetic, and optogenetic techniques with 'virtual reality' electronic flight simulators (http://sarawasserman.virb.com/fly-movies) to activate or inactivate identified neurons or groups of neurons to probe the genes, neurons, neuromodulators, and circuits that coordinate context-dependent behavior. The Sophomore Early Research Fellow will focus on understanding the mechanisms by which internal physiological state (starvation and dehydration) alters both olfactory and visual modalities.