2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Microbiology

Specific title of research project

Characterizing the antifungal activity of symbiotic squid bacteria

Faculty mentor supervising research

Name: Andrea Suria

Department: Biological Sciences

Email address: amsuria@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

The student researcher should be comfortable learning how to safely culture bacteria and fungi at biosafety-level 2 (BSL-2), indicating a moderate risk for human infection. Students will be trained in the proper biosafety techniques, including working in a biosafety cabinet, to ensure safety to themselves and the environment. Attention to detail and organized note taking will be important for maintaining multiple treatments in the same experiment. Familiarity with basic molecular biology topics (such as from the BIOL 120 or BIOL 125 courses) is recommended.

Description of the research project (one page maximum)

All animals establish life-long symbiotic relationships with bacteria, which play crucial roles in the animal's health. While pathogenic bacteria can cause disease, beneficial bacteria can aid in digestion, foster development of the immune system, or prevent infections. In defensive symbiosis,

the bacterial partner protects its animal host from infection and predation, such as through production of inhibitory molecules. Many examples of defensive symbiosis exist across the animal kingdom, including on salamander skin, sponges, bird eggs, and in the mammalian gut. Despite the prevalence of these symbioses, it is often not well understood how these bacteria provide protection.

In the Suria lab, we use symbiotic bacteria isolated from the Hawaiian bobtail squid, Euprymna scolopes, as a model to study the mechanisms of host defense. Female squid deposit bacteria into a jelly layer that surrounds the embryos of their eggs, which protects them from lethal fungal infections. In this project, we will create synthetic egg models from alginate and inoculate them with defined mixes of symbiotic bacteria. These egg models will then be exposed to a squid fungal pathogen to observe the antifungal activity of each symbiotic strain under host-like conditions. For bacterial strains that have high antifungal activity, the student will generate random mutations and screen for the loss of antifungal activity. This will allow us to determine which genes are necessary for production of antifungal compounds.

The student researcher will be taught a combination of culture-based microbiology and molecular biology techniques (PCR, cloning, and DNA sequencing) to determine the genes involved in host defense. Students will also use fluorescent microscopy to monitor growth of fluorescent bacteria in the egg models over time and screen for changes in antifungal activity.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Geography

Specific title of research project

Mapping the media

Faculty mentor supervising research

Name: Ashley Toenjes

Department: ENVS / Geography

Email address: amtoenjes@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/26/2025

Ending: 8/1/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Most important: interest in social inequality and global justice issues.

Old gen ed system: completed at least two social science courses by end of spring semester with a B+ or higher;

New gen ed: completed Examine Power and Inequities or Listen, Imagine, Understand competency by end of spring semester with a B+ or higher.

Basic knowledge of how to work with image files (GIS, graphic design, photography, or similar).

Ability to catalogue and organize large sets of visual data.

Description of the research project (one page maximum)

Rationale: What role do maps play in shaping media narratives and media bias? Maps are often understood to be objective representations of the world, but everything from framing, scale, and place names used are choices made by a mapmaker, and their own cultural bias. Geographers have long noted the power (Wood 1992) maps hold in shaping our worldview (Culcasi 2011). Media firms invest in eyecatching maps to accompany print, televised, and social formats, yet studies on media bias neglect the role of maps in media bias. In this project, I analyze media reporting of global events from 2022-2025, analyzing the power of maps in the media.

Design: This qualitative project uses visual, archival, and grounded theory methods to collect data. The data includes digitally collecting maps from major US media networks and physical archives at Oberlin College. Maps will be catalogued according to global event, world region, and publication, then coded using thematic and inductive coding, aided by NVivo qualitative coding software. After coding the maps, map collages will be produced to visually and analytically summarize the analysis.

Mentorship structure: The first 5 weeks of the project focus on data collection, and the last 5 weeks focus on data analysis. During the first 5 weeks, the mentorship focus will be on methods training, field work, and digital research. The methods training is organized around a series of ½ day “labs”, with hands-on training and best practices of the 3 methods this project uses. I would be interested in collaborating with other social science mentor/mentees for qualitative methods training. The field work includes 3-4 day trips to physical archives at Oberlin College. The digital research is the least interactive phase, and mentorship would include daily co-working time, and daily check-ins on the data collection process.

During the final 5 weeks, the mentorship structure focuses on data analysis. Thematic and deductive coding is an iterative and time consuming process. Mentorship in this phase includes daily interactive sessions, about 2-3 hours, where the student and I co-analyze the maps, identify themes and sort maps accordingly. I will train the student on how to use the qualitative analysis software, NVivo. In the final weeks of the program, the student will produce several map collages, summarizing the findings of our coding analyses. I will provide feedback for revisions on the collages until they produce a visually and analytically balanced representation of our data analysis.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Education/Sociology

Specific title of research project

Case study of K-12 students' access to third places in Delaware Ohio

Faculty mentor supervising research

Name: Bona Kang

Department: Education

Email address: bkang@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/26/2025

Ending: 8/1/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

(1) Successful completion (B- or higher) of an education course that satisfies the 'examining power and inequities' core competency. (EDUC 110 or EDUC 115)
(2) Successful completion (B- or higher) of a humanities or social science course that examines a particular society/civilization/community.
(3) Has an established relationship with the faculty mentor through at least two experiences (through courses, co-curricular experiences, advising, or other forms of direct mentorship/contact).
(4) Successful completion (B- or higher) of a research methods course (e.g., PSYC 310).
(5) Knowledge of how to search for literature using library databases (demonstrated in interview or via recommendation by a campus librarian)
(6) Has the physical means to directly survey and drive to observe field sites.
(7) 2 additional positive faculty recommendation for a productive disposition towards in-person and online communication, collaboration, mentorship, and independent learning.
(8) Successful interview with faculty mentor to demonstrate interest, initiative, and skills for the project.

Description of the research project (one page maximum)

This mentored independent project will consist of training an OWU student on case study research design and methods. Specifically, they will conduct a single-case study which will examine how K-12 students use third places in Delaware, Ohio. This project will allow the mentee to apply what they learn about the case study research method and present findings about access to third places in Delaware and their impacts on students. The following questions will guide the investigation: What third places are available, how are they being used, and what other places could be created? Through these questions, the study will collect previously unknown information on Delaware's students' use of third places. The main benefit of this project is for the mentee conducting the project over three phases so that they learn to apply research methods through a specific topic.

First phase: The mentee will review existing literature on third places, examining what scholars are classifying as a third place. Existing literature focuses primarily on how adults create and use third places. This study will examine third places with an educational lens by specifically seeking information on how students use these places. This phase will guide the mentee to establish what research already exists, refine the research question, and decide which Delaware sites to survey.

Second phase: The mentee will plan for and collect relevant data. This may include a survey of the existing third places in Delaware, observations of sites, and informal interviews with community organizers to learn about how and why students access and use these places. The mentee will also learn about the ethics of protecting human subjects in research, and determine whether a follow-up study with IRB approval would be necessary.

Final phase: The mentee will analyze data to determine the existence of third places and see what the community is using and how. These findings will lead to implications for the intentions of the places and their accessibility to Delaware students.

This case study is relevant to the Ohio Wesleyan community because it will provide insights to OWU Education faculty and students who are volunteering, working, and completing their OWU Connection Experiences within Delaware. Understanding the context in which these students live can provide valuable information to OWU students who wish to complete any of the aforementioned experiences. The case study's findings will be presented at the SSRP Symposium, OWU Connection Conference, and other related campus opportunities.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

physics

Specific title of research project

Dynamics of DC SQUID Arrays

Faculty mentor supervising research

Name: Brad Trees

Department: Physics and Astronomy

Email address: brtrees@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/2025

Ending: 7/25/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Completion of Physics 111 and Math 111 by the beginning of the project.

Description of the research project (one page maximum)

My research concerns superconductive devices known as the Josephson junction (JJ) and the superconducting quantum interference device (SQUID). A JJ is a tunnel junction formed from two bulk superconductors with a narrow non-superconducting material sandwiched between them. The physics of a JJ has been well studied since it was first proposed in 1963. It is, in effect, a nonlinear, electromagnetic oscillator whose behavior in the classical regime is well described by a model called the resistively and capacitively-shunted junction model. Two JJs combined in parallel constitute a so-called DC SQUID. The behavior of a DC SQUID is more challenging to describe than that of a JJ, because it is a more complicated structure, but such SQUIDS have been fabricated and studied (both

experimentally and theoretically) since the late 1960s. For example, it is well established that DC SQUIDs are the most sensitive detectors of magnetic fields currently known. More recently, researchers have been studying multiple DC SQUIDs combined in particular geometries (SQUID arrays) in the hope of obtaining even more sensitive field measurements. Our project would study such SQUID arrays theoretically in a combination of analytic and numerical work. We will first study the underlying physics of a SQUID array so as to write down the system of coupled differential equations that should describe the array's behavior. We will then solve the system of equations numerically (coding in Python and Mathematica) to study the behavior of the model. This project is ideal for any student interested in learning about condensed matter physics (which includes the physics of the solid state). It is preferred that the student working on this project has completed physics through the level of at least PHYS 280 (Contemporary Physics) and math through the level of MATH 280 (Differential Equations), as well as having had a course in computer science. Strong students who have completed both PHYS 111 and MATH 111 will also be considered.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Organismal Biology (ecology, evolution, physiology, etc.)

Specific title of research project

The biogeography and invasion ecology of common wall lizards (Podarcis muralis)

Faculty mentor supervising research

Name: Bryan Juarez

Department: Biological Sciences

Email address: bhjuarez@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Three

Minimum qualifications of student researcher (be as specific as possible)

1. Motivation to learn scientific principles, techniques for reliable data collection and analysis, presentation skills, and skills for publishing of scientific results. We encourage students of all backgrounds and abilities to apply.
2. Students with an interest in organismal biology, ecology, evolution, and/or physiology are preferred.
3. Where applicable, willingness to learn to handle live animals.
4. Where applicable, ability and willingness to work flexible hours, sometimes including uncomfortable conditions such as long and consecutive days in the field.
5. Where applicable, willingness to travel for 3–4 days at a time to Cincinnati, OH.
6. Where applicable, willingness to work half or full days on the computer.

Description of the research project (one page maximum)

The purpose of this research is to determine the importance of historical context and physiological mechanisms by which the common wall lizard (Podarcis muralis) has invaded urban habitats in Ohio. Previous research in the lab has revealed the importance of behavior, movement, and thermal ecology in driving the invasion of the common wall lizard. However, few studies have investigated the roles of short-term physiological change and climate in the continued success of the common wall lizard in Ohio and in the United States. We will determine the physiological underpinnings of the invasion ecology of Podarcis muralis by 1) measuring year-over-year (2024–2025) ecophysiological and ecomorphological changes and 2) measuring habitat suitability using geographical occurrence and climate data to identify the factors enabling common wall lizards to thrive. This research leverages data collected in previous years by students in the SSRP program and global databases that include Podarcis lizards. Specific products of this research will give insights on how and how quickly Podarcis muralis can adapt. Additionally, students will develop models to determine: 1) how Podarcis muralis might spread throughout Ohio and the Midwest into the future, and 2) how different environmental factors (e.g., temperature, UV light, rain) can create favorable habitat conditions ideal for establishing new populations.

We are excited to support students of all backgrounds and abilities. We seek to work with two students interested primarily in the field aspect of the proposed work and one additional student primarily interested in computational modeling for which field work is optional. All students will receive 1–1 mentoring covering all areas of the scientific process from forming research plans to publishing scientific results. While the general framework is established for these studies, the specifics of the work will be determined by student interest. Students will also be generally expected to assist with care of captive animals. For field work, we will conduct standardized surveys at established sites in Cincinnati throughout the summer where we will safely hand capture each lizard with a lasso, collect a variety of data (including blood samples) from each lizard, and mark them with a permanent mark. For lab work, we will measure each lizard’s thermal biology, physiology, and performance (sprinting, climbing). One student will also access, download, clean, and analyze occurrence and climate data from various free and online sources.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

behavioral neuroscience

Specific title of research project

Determining the effects of adolescent stress on the behavior of adult mice

Faculty mentor supervising research

Name: Chelsea Vadnie

Department: Psychology, Neuroscience

Email address: cavadnie@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

The student researcher must be accepting of neuroscience research using animal models. The student will ideally have some experience handling mice, but at a minimum willingness to learn to handle rodents (training will be provided). The ability to work flexible hours, including some weekend work, is needed since the project involves daily monitoring of animals and some weekend testing. The student will need to be detail-oriented and reliable. Preference will be given for students who have completed Behavioral Neuroscience lecture and lab (NEUR 343).

Description of the research project (one page maximum)

Mood and anxiety disorders are highly prevalent and often develop during late adolescence or early adulthood. Stress and circadian rhythm disturbances are risk factors for mood and/or anxiety disorders. Rodent research has shown that stress and circadian rhythm disruptions can cause

behaviors relevant to psychiatric disorders. However, there are remaining questions about the factors that affect vulnerability to these effects and the possible underlying neurobiological mechanisms.

This summer we will focus on expanding upon our study centered on determining the effects of adolescent stress on behavior and brain function in adult mice. In both humans and rodents, there is a heightened response to stress during adolescence. It's challenging to study the effects of stress during adolescence only in humans. Thus, rodent models are especially valuable for this work. Studies indicate that rodent adolescent stress can regulate behaviors relevant to psychiatric disorders, such as anxiety-like behavior in the elevated plus maze (Albrecht et al., 2017). Similarly, we found that just three days of stress during early adolescence (postnatal days 25-27) in C57BL/6J mice increased anxiety-like behavior in the open field in adulthood. We next looked at the brains of these animals to begin to understand why this paradigm had a long-lasting effect on behavior. Previous work suggested that adolescent stress may change the expression of GABAergic genes in specific brain regions (Albrecht et al., 2017). Through quantitative real-time PCR, we measured the relative expression of GABAA receptor subunits in the prefrontal cortex (PFC), hippocampus, and nucleus accumbens. So far, we found that adolescent stress decreased the expression of the GABAA α3 subunit in the PFC, as also found by Jacobson-Pick et al. (2012). Although our findings align with prior studies, overall, our three-day stress paradigm produced weak effects. We hypothesize that a longer stress paradigm during early adolescence will have more pronounced effects.

This summer we will investigate the behavioral effects of an extended stress paradigm during adolescence on a battery of translationally relevant behaviors in adult mice. The individual selected for the SSRP will work with the student currently involved in the project. Each student will be focused on assessing different behaviors. There is some flexibility with the behaviors selected depending on the student's interest.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Animal Behavior, Evolution, Behavioral Endocrinology

Specific title of research project

Behavior, physiology, and reproductive success in two species of North American wrens

Faculty mentor supervising research

Name: Dustin Reichard

Department: Biological Sciences

Email address: dgreicha@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/25/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

1. Must be able to wake up early (pre-dawn) and hike on uneven terrain in hot, humid conditions in the presence of biting insects such as ticks, mosquitos, and flies.
2. Must be able to use binoculars to observe small birds and identify individuals based on combinations of colored leg bands (no previous experience necessary, training will be provided!).
3. Must be willing to handle live birds (adults and nestlings) and collect blood samples (no previous experience necessary, training will be provided!).
4. Completed BIOL 122 (preferred) or BIOL 120.

Description of the research project (one page maximum)

Research in my lab focuses broadly on the evolution of animal behavior and the hormonal mechanisms of behavior. We investigate these topics in free-living (wild) songbird species, but our

primary focus is two closely related species of wrens that nest in bird boxes. House and Carolina Wrens differ in multiple life history characteristics, which makes them a compelling comparative study system. House wrens are migratory, experience a shorter breeding season, and coexist at much higher densities than Carolina Wrens, which are sedentary and found in central Ohio year-round. My lab studies both species using a collection of 200 nest boxes in the Delaware area. Students that work in the lab gain skills in handling and extracting birds from mist nets, bird banding, blood sampling and processing, behavioral observation, audio recording, and field data collection and management. For the summer of 2025, there are no continuing projects in the lab, which means that student research projects will be catered to their individual interests. Projects could involve investigating territorial and/or antipredator behavior, parental care, circulating hormone levels, song structure and function, or nest architecture in either wren species. Although not required or expected, I am hoping to recruit students that are interested in continuing their research as an independent study during the next academic year. The independent study would likely focus on data analysis and writing a manuscript for publication.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Neurobiology/Ecotoxicology

Specific title of research project

Lizard Neurogenesis in Response to Lead Toxicity

Faculty mentor supervising research

Name: Eric Gangloff

Department: Biological Sciences

Email address: ejgangloff@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Students should have the following qualifications:
(1) Willingness to perform manipulative experiments with live animals, including terminal experiments (where the animal is euthanized at the end of the experiment);
(2) Willingness to perform dissections on dead animals;
(3) Experience with meticulous record keeping and/or data collection;
(4) Interest and experience in neurobiology and/or cellular physiology and a willingness to learn associated techniques;
(5) Comfort traveling for 2-3 days at a time to Cincinnati and performing fieldwork (optional)

Description of the research project (one page maximum)

Pollution from heavy metals – such as lead – pose serious threats to organisms, including humans.

Yet recent work suggests that some animals, including lizards, are resilient to lead toxicity. The study described here will be the first to examine lizard neurogenesis (brain cell proliferation) as a potential mechanism to mitigate the negative effects of lead toxicity. To characterize the response of brain cells affected by lead toxicity, we will dose common wall lizards (Podarcis muralis) with different levels of lead. We will then quantify the neural response through staining and microscopy techniques.

The student researcher will be expected to participate in various aspects of the project including (1) experimental protocols with live lizards, including dosing and conducting physiological tests, (2) collecting brain tissue via dissection, staining tissue, and preparing slides of tissue, (3) quantifying neuronal regeneration through microscopy, (4) organizing and analyzing data, and (5) presenting results in conference presentations and/or manuscripts submitted to peer-reviewed journals. Additionally, students will have the opportunity to travel to Cincinnati for 2-4 days at a time to conduct fieldwork and collect animals.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Political Science

Specific title of research project

The Politics of Food Allergy

Faculty mentor supervising research

Name: Franchesca Nestor

Department: Politics and Government

Email address: fvnestor@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Three

Minimum qualifications of student researcher (be as specific as possible)

Strong applicants will have taken at least one OWU PG class in American politics and at least one social science research methods course. Having taken Food Politics and Policy at OWU (formerly PG 300.38, now PG 281), or having experience with food allergy or intolerance or chronic illness, either directly or indirectly, is not required but is a plus.

Description of the research project (one page maximum)

This project entails collaborative research assistance work alongside PG Professor Franchesca Nestor on multiple related research questions which consider the impact of food allergy in electoral politics. The new research questions build on Dr. Nestor's existing research on food policy regulation and her food policy course, and they include:

-An exploration of the public's perception of food allergy as it relates to individuals in government—would they be hesitant to elect an individual with severe food allergy? What factors might relate to any hesitance?

-An investigation of the level of partisan sorting (or the lack of it) around food allergy—are there clear differences in preferences when it comes to Republicans and Democrats on this issue?

-A study of the willingness (or lack of willingness) of elected representatives to share food allergy or similar diagnoses—if they were diagnosed, would they share this information with their constituents? Why or why not?

This project and related questions fit within the political science literature on representation, legislative politics, and the politics of disability.

Student researchers will have the opportunity to contribute collaboratively to multiple future papers in development from a variety of angles, from literature review, including searching for relevant sources and literature review writing; to survey design, from question development to sampling approach considerations; to data analysis. They will work closely alongside the faculty mentor and other student researchers, developing research skills and writing skills, building and running a survey using survey software, and using R. The project includes both quantitative and qualitative elements in the research designs, so participants will gain a background in both empirical approaches. There is also the potential for interview-style data gathering. The mentorship approach will be team-based and collaborative, providing guidance alongside independent work, but with all team members contributing to and building capabilities in all project elements. The group will meet together most days, with regular time for independent work and follow-up feedback to ensure continual individual growth on research skills.

Progress on all projects in development is the goal for the summer, with longer term goals including the presenting at the Student Symposium, co-authorship on multiple manuscripts, and, potentially, conference attendance.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Organic Chemistry

Specific title of research project

Synthesis of Bioactive Small Molecules for Protein Tyrosine Phosphatase Inhibition

Faculty mentor supervising research

Name: Grant Walby

Department: Chemistry

Email address: gdwalby@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

Ideally students will have completed both semesters of Organic Chemistry by the time of starting SSRP. I am willing to make something work if the student is strong and has only had one semester of organic chemistry.

Description of the research project (one page maximum)

Students have a option between two research projects.

The first project is to synthesize small organic molecules that we hypothesize to be bioactive, particularly related to a collection of enzymes called Protein Tyrosine Phosphatase (PTPs) which have ties to diabetic diseases and cancer. This project will involve designing the molecule supported by computational programing, developing a synthetic route and, in the long-term, testing these

molecules against PTPs using reported assays. Students will work to design their own molecule, learn how to utilize resources to plan synthetic routes and how to design synthetic organic chemistry experiments.

The second project focuses on developing a new synthetic method to prepare non-canonical amino acids, which have heavy application in protein engineering and medicine. Students will use a common chemical called mandelic acid to help promote a reaction called Multi-Component Assembly Process (MCAP). We will start by exploring the baseline conditions of the reaction before exploring what starting materials are able to do this reaction. Students will explore how to design synthetic organic chemistry experiments as well as explore how to do structure determination and utilize modern synthetic techniques. In the long term we will investigate ways to apply this methodology towards interesting natural products for synthesis.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

mathematics, physics

Specific title of research project

Swimming at micron scale: a numerical study

Faculty mentor supervising research

Name: Han Guo

Department: Math/CS

Email address: hguo@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

The successful candidate should
1. has taken MATH 210, 280, CS 110 by the end of the Spring semester;
2. has basic knowledge of matrix algebra;
3. not be afraid of programming;
4. be curious about biophysics;
5. be hardworking and embrace challenges.

Description of the research project (one page maximum)

When we think about better swimming, we usually think about three things: increasing thrust, reducing drag (or viscous force), and making use of inertia. While the thrust is generated when the swimmer pushes water, the latter two are important at all stages of swimming. We want to reduce

drag to limit the “friction” working against our motion, and make use of inertia to “coast” after each stroke (this is especially true for long-distance swimmers).

The ratio between the inertial forces and the viscous forces, Reynolds number, is arguably the most important dimensionless quantity in the field of fluid dynamics, which was named after Osborne Reynolds more than 100 years ago. Mathematically, the Reynolds number is computed as velocity times length divided by the fluid viscosity. For a human swimming in water with a reasonable speed, the Reynolds number is typically in the order of 10,000 ~100,000. The Reynolds number decreases fast as we turn our eyes to smaller animals. For example, the Reynolds number of E. coli swimming could be as low as 0.00001 ~ 0.0001. That is to say, microswimmers like E. coli live in an environment which is dominated by viscosity and inertia becomes irrelevant. Strokes useful for human are very ineffective for microswimmers.

In this project, we are going to dive into the counter-intuitive world of microswimmers. We will model different types of cilia/flagella driven microswimmers using various reduced order models, and apply/design novel numerical methods to simulate their swimming. Successful completion of the project will likely lead to presentation(s) at international conference(s).

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Political science

Specific title of research project

Political and Nonpolitical Human Rights Violations: Developing Global Indicators

Faculty mentor supervising research

Name: Jim Franklin

Department: Politics and Government

Email address: jcfrankl@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/27/2025

Ending: 8/5/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

Major in Politics and Government or related field, such as Sociology/Anthropology, International Studies, Economics, or Data Analytics. Preferably will have completed a course in research methods such as PG 279 or DATA 100.1.

Description of the research project (one page maximum)

The quantitative study of human rights violations has expanded greatly. This has been made possible by quantitative indicators such as the Political Terror Scale (PTS) that measures the severity of physical integrity rights violations (i.e. killing, torture, disappearances, and arbitrary imprisonment) using annual human rights reports produced by Amnesty International and the U.S. State Department. This has led to the development of a fairly consistent model explaining these violations. However, several recent publications have argued that the targeting of human rights

violations can differ. In political repression, human rights violations target political opposition, which is prevalent in autocracies but not democracies. In oppression, abuses tend to target socially marginalized individuals, which can occur in democracies as well as autocracies. In a 2020 article, I applied the PTS methodology to code (1) abuses targeting political opponents and (2) abuses that are not politically targeted. This article covered seven Latin American countries, and I did find that democracies have significantly lower levels of political abuses, but not nonpolitical abuses, compared to autocracies. One issue that is still not clear is why some democracies have more nonpolitical abuses than others. Answering this question requires new indicators for a broader range of countries.

For the SSRP, I propose to work with students to create political and nonpolitical human rights violation variables for all countries included in human rights reports for as many years as possible. This will allow original analyses of the causes of nonpolitical abuses. Fortunately, the PTS methodology is already established, and I have already developed methods for coding the targets of abuses. I plan to work very closely with the student coders, especially at first as we refine our coding decisions. Having two student coders will facilitate coding the large number of cases and allow us to estimate inter-coder reliability. A third student coder would allow more coverage of cases, so that would be useful if feasible, but I did not want to ask for too much in my first SSRP proposal!

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Biochemistry, surface chemistry

Specific title of research project

Interactions between monolayer membrane mimics and cell-penetrating peptides

Faculty mentor supervising research

Name: Kayce Tomcho

Department: Chemistry

Email address: katomcho@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

The student should have successfully completed the organic chemistry sequence. Ideal candidates have proficiency in basic laboratory skills such as solution preparation. This project will also involve data analysis using graphing software and a large amount of literature review.

Description of the research project (one page maximum)

Biological membranes are significant contributors to transmembrane protein function and localization. Additionally, membrane fluidity and dynamics is influenced directly by its composition. In this project, students will study Langmuir monolayers of sphingolipids, phospholipids and cholesterol as simple model systems representing human biological membranes. Two-dimensional Langmuir monolayers have long been used as simplified model systems to study the interactions that occur within cell membranes (bilayers). Using simple Langmuir model systems allows us to obtain molecular-level

information on the interactions between these lipids and various small molecules (i.e. drugs, hormones, peptides, etc.) which can be correlated to their physiological activity. The glycine receptor (GlyR), a pentameric ligand gated ion channel (pLGIC) protein, is responsible for inhibitory neurotransmission by facilitating the influx of chloride ions. GlyR is a therapeutic target as it is linked to chronic pain and hereditary hyperekplexia. A large intracellular loop within GlyR, the M3-M4 loop, is not well characterized structurally, though it is known that receptors that have truncated or missing loops do not function. Crosslinking-mass spectrometry (CXMS) studies have shown that attaching a crosslinker to mutated Cys residues in the extracellular domain of GlyR can crosslink to residues in the M3-M4 loop region, though these residues are located beyond the reach of the crosslinker. One explanation of the results could be due to poly-Arg/Lys regions, located in the M3-M4 loop. Studies have shown that peptides containing Arg and Lys residues have the ability to penetrate the membrane and act as cell-penetrating peptides (CPPs). By studying the effects CPPs have on the structural organization of various Langmuir monolayers, the M3-M4 loop can be better understood. Through this project, students will get a unique opportunity to use specialized surface-science instrumentation. Students will utilize a Langmuir trough to collect surface pressure-area isotherms and Brewster angle microscopy to image the aqueous interfaces of interest.

This is an ongoing continuation of a project started in 2024. Two students will work on the following parallel projects:

1) Interaction of Sphingomyelin-dipalmitoylphosphatidylcholine-cholesterol monolayers with the following potential CPPs in the M3-M4 loop: 310QHKELLR316 and 317FRRKRRHHK325

2) Interaction of Sphingomyelin-dipalmitoylphosphatidylcholine-cholesterol monolayers with the following potential CPPs in the M3-M4 loop: 372SPEEMR377, 378KLFIQRAK385 and 386KIDKISR392

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

neuroscience, psychology

Specific title of research project

Examining Effects of Video Games on Cognition & Brain Function

Faculty mentor supervising research

Name: Kira Bailey

Department: Psychology & Neuroscience

Email address: kmbailey@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

For this project, students should have an interest in understanding human cognition and/or brain function. A motivation to study video games and their effects on players is also encouraged. Prior coursework or experience with the coding and/or electroencephalography (measurement of human brain waves) is preferred, but students willing to learn these skills are encouraged to apply. Students must be comfortable learning new computer software and interacting with human research participants.

Completion of any of the following courses is strongly recommended, but not necessarily required: Introduction to Neuroscience (NEUR 110 or 250), Cognitive Psychology (PSYC 266 or 364), Cognitive Neuroscience (PSYC 342). Experience in CS and/or Data Analytics courses may also be useful.

Description of the research project (one page maximum)

A growing body of evidence suggests that action video game (AVG) experience is associated with improvements in visual/spatial attention and executive functioning (Feng, Spence, & Pratt, 2007; Green & Bavelier, 2003, 2006, 2007; Green, Pouget, & Bavelier, 2010; West, Stevens, Pun, & Pratt, 2008) and changes in brain function (Knols et al., 2017). The significance of this finding lies in the implication that the skills acquired in an AVG might be transferred to other contexts (Green & Bavelier, 2003; Boot, Blakely, & Simons, 2011), which contrasts with findings from a wealth of training paradigms wherein improvements in performance transfer very narrowly (to highly similar tasks) or not at all (Ball et al., 2002; Hertzog et al., 2009; Owen et al., 2010).

The seemingly broad transfer of skills from AVGs after little to moderate amounts of training (10 to 50 hours) has led some researchers (Bavelier et al., 2012; Green & Bavelier, 2008) to recommend the use of AVGs in training protocols among populations that would benefit from enhanced visual attention and cognition (e.g., older adults, pilots, military personnel, surgeons). These recommendations may be premature, however, as there are important methodological limitations of the past research (Bisoglio et al., 2014; Boot, Blakely, & Simons, 2011) as well as negative effects of AVGs on some forms of attention and cognition (Bailey et al., 2010; Cudo et al., 2024; Rice et al., 2021).

Several ongoing studies in my lab are designed to address these limitations and students will have the option of working on one or more of these projects. Potential research activities include: developing new video games and research protocols for testing the causal impact of games on cognition, collecting and analyzing brain and behavioral data to assess commercial video game effects in the lab, and conducting survey research to examine existing patterns of player behavior and cognition in the real world. Students will have the opportunity to engage with projects at various stages of the research process from conception and experimental design to manuscript preparation.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Developmental Psychology

Specific title of research project

LGBTQ+ Family Socialization and Developmental Outcomes in Emerging Adulthood

Faculty mentor supervising research

Name: Krystal Cashen

Department: Psychology

Email address: kkcashen@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Required:
Successful completion of PSYC 110
Interpersonal skills necessary for interacting with potential human participants
Sensitivity to LGBTQ+ identities and openness to continued learning in this area
Detail-oriented and reliable
Preferred:
Successful completion of either PSYC 285 or a Group C: Psychology Across the Lifespan Course
Familiarity with statistical and survey software

Description of the research project (one page maximum)

My previous work has shown that people with LGBTQ+ parents develop unique

community connections and identities (Cashen, 2022) and attribute increased feelings of openness and acceptance to their upbringings (Burand et al., 2023). However, we still do not understand which specific processes contribute to these developmental outcomes. One potential parenting practice that may contribute to these outcomes is LGBTQ+ family socialization or the ways in which LGBTQ+ parents talk to their children about what it means to be an LGBTQ+ family (Oakley et al., 2017). This survey study will examine how LGBTQ+ family socialization is associated with important developmental outcomes in emerging adults with LGBTQ+ parents. The SSRP student will be able to contribute to designing and piloting study measures in preparation for data collection this fall.

Although the primary focus for this summer will be on the socialization project described above, there may be opportunities for the student to contribute to secondary data analysis on the project described below depending on the student's interests and training goals.

Impact of Political Context on Family Formation Decision Making among LGBTQ+ Individuals

In recent decades, scientific advances in assisted reproduction technologies (ART) and changes in legal access to adoption have resulted in greater access to multiple pathways to family formation for LGBTQ+ individuals. However, each family formation pathway carries unique benefits, risks, and considerations for family functioning and child development (Goldberg, 2023). Previous research has shown that LGBTQ+ individuals often report distinct reasons for choosing a specific family formation pathway in comparison to cisgender heterosexual individuals. However, recent changes in the political and legal landscape within the United States (e.g., the overturning of Roe v. Wade, increasing anti-LGBTQ+ legislation) may shift how LGBTQ+ individuals make decisions about family planning. For example, a recent study of current LGBTQ+ parents in Florida found that many parents had considered or were actively undertaking changes to their own behavior (e.g., not disclosing their LGBTQ+ identity) and/or changes to their family context (e.g., changing their child's school, moving out the state) to cope with growing concerns about the safety of their families following the passage of HB 1557 (Goldberg, 2022).

Using a survey design, this study examines whether LGBTQ+ individuals are similarly making adjustments to their plans for future parenthood (e.g., whether to become a parent, choice of family formation pathway, parenting contexts). Data for this study was collected during SSRP 2023.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Health Science

Specific title of research project

Pilot study of the "Whole Athlete" program

Faculty mentor supervising research

Name: Liz Nix and Liz Starns (we will conduct the study together and share the stipend)

Department: Health and Human Kinetics

Email address: eanix@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/11/2025

Ending: 7/22/2025

Requested number of students

Three

Minimum qualifications of student researcher (be as specific as possible)

We would require 2-3 student researchers. All researchers should be trained in human research participation with certification. Students should be from Nutrition, Health and Human Kinetics, Psychology or a related field. The student should have taken at least 1-2 courses in these topics. Students who have previous teaching and group leadership skills preferred. The best option would be to have 1 student each who is interested in nutrition, conditioning, and mental aspects of sports, respectively. If only students apply, we will also elicit help from local sport psychology programs.

Description of the research project (one page maximum)

Liz Starns and Liz Nix will develop a 6-week program intended to be delivered to various athletes and

athletic teams in the Delaware and surrounding communities. Students will teach tailored nutrition education, conditioning and cross-training programs, and mental aspects of sport performance, tailored to the specific sport team or athlete. Each team/athlete will meet once per week for two hours to cover one of these topics and each topic will have assessments related to knowledge, competency, behavioral change, and performance. We will work with 6-8 teams/athletes with pre and post testing, including both qualitative and quantitative data. OWU Students would be expected to meet with Starns and Nix 2-3 times per week and teach (supervised) with team sessions dispersed throughout the week.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Global French Studies

Specific title of research project

A Data-Driven Approach to Bolstering the French Curriculum at Ohio Wesleyan

Faculty mentor supervising research

Name: Mary Anne Lewis Cusato

Department: World Languages and Cultures

Email address: malewis@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/26/2025

Ending: 8/8/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

This project will entail my working with students to help me to continue to modernize the French curriculum at OWU. I have already made many changes to boost enrollment, retention, and major / minor counts and have published in Inside Higher Ed about this. See this link: https://www.insidehighered.com/views/2021/07/28/seven-ways-boost-success-very-small-departments-opinion for more information.

This project, "A Data Driven Approach to Bolstering the French Curriculum at Ohio Wesleyan University," would allow me to work with students in a focused way to collect data to put the finishing touches on this new mode of French at OWU. Students will collect data on the highest ranking French curricula in the country as well as collect data on those programs who enroll very highly. They will examine such curricular variables as course titles, scheduling, study abroad programs, program outcomes, internships, affordability of study abroad programs, special double-major tracks (medicine + French, for example), etc. We will work together to collect and analyze information so that I can finalize my curricular proposal to the French Program, with the potential outcome of creating a Global French Studies program or something similar. We will decide, based on collected data and analysis, whether to offer some upper level courses in English in order to improve enrollment and emphasize

culture. This is work that I simply cannot do as a single full-time faculty member managing an entire curriculum and all students in French and mentoring a part-timer, recruiting, etc. Having students at the heart of this process makes good sense for the curricular development, and it would be an excellent way for them to gain mentorship, practice researching, and work in detailed, careful analysis.

Thus, I am looking for students who are highly engaged in / excited about French at OWU, who are skilled analysts, who are independent workers, and who are able and willing to do thorough research to help me collect and analyze all relevant information. I also need strong communicators, both orally and in writing.

Description of the research project (one page maximum)

This project, "A Data Driven Approach to Bolstering the French Curriculum at Ohio Wesleyan University," would allow me to work with students in a focused way to collect data to put the finishing touches on this new mode of French at OWU. Students will collect data on the highest ranking French curricula in the country as well as collect data on those programs that enroll very highly. They will examine such curricular variables as course titles, scheduling, study abroad programs, program outcomes, internships, affordability of study abroad programs, special double-major tracks (medicine + French, for example), etc. We will work together to collect and analyze information so that I can finalize my curricular proposal to the French Program, with the potential outcome of creating a Global French Studies program or something similar. We will decide, based on collected data and analysis, whether to offer some upper level courses in English in order to improve enrollment and emphasize culture. This is work that I simply cannot do as a single full-time faculty member managing an entire curriculum and all students in French and mentoring a part-timer, recruiting, etc. Having students at the heart of this process makes good sense for the curricular development, and it would be an excellent way for them to gain mentorship, practice researching, and work in detailed, careful analysis.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Data Analytics

Specific title of research project

Environmental Impact of Data Centers in Ohio

Faculty mentor supervising research

Name: Mehwish Abbasi

Department: Mathematics and Computer Science/ Data Analytics Program

Email address: mabbasi@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/2025

Ending: 7/28/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Computer Science and Data Analytics major with experience in Python, Python libraries (NumPy, Pandas, Matplotlib, scikit-learn), and machine learning.

Description of the research project (one page maximum)

Title: Environmental Impact of Data Centers in Ohio
Analyzing the Carbon and Water Footprints of Data Centers – Patterns, Trends, and Impact on Climate

Abstract
Data centers drive the digital economy but significantly impact the environment, especially through carbon emissions and water usage. This study examines the environmental footprint of data centers in Ohio, focusing on energy and water consumption patterns. By correlating these patterns with

climate impact indicators, the research identifies mitigation strategies to reduce their carbon and water footprints. Outcomes include a detailed assessment of environmental impacts, insights into operational trends, and actionable recommendations for fostering sustainable digital infrastructure.

Introduction and Background

The expansion of data centers has raised sustainability concerns due to their substantial energy and water demands. Their operations contribute to climate change through greenhouse gas emissions and exacerbate local water stress. While the broad impacts are acknowledged, specific resource usage patterns and their environmental implications remain underexplored.

Ohio, with its diverse energy mix and freshwater resources, provides an ideal setting for this research. The project aims to:

Quantify the carbon and water footprints of Ohio’s data centers.
Identify patterns in their energy and water usage.
Correlate these patterns with climate impact indicators.
Develop sustainable strategies to mitigate their environmental footprint.

Objectives

Measure the carbon and water footprints of data centers in Ohio.
Identify operational patterns influencing resource consumption.
Link operational data to climate indicators, assessing contributions to global warming and water stress.
Propose strategies to reduce their environmental impact.

Methodology

Data Collection: Gather energy and water usage data from operators and utilities; use environmental databases for regional context.
Footprint Analysis: Apply carbon accounting and Water Usage Effectiveness (WUE) metrics to evaluate emissions and cooling efficiency.
Pattern Identification: Analyze data using statistical tools to uncover resource usage trends by size, operation type, and energy sources.
Climate Correlation: Relate emissions and water usage to climate models, mapping high-impact areas.
Mitigation Strategies: Explore renewable energy adoption, energy-efficient technologies, and operational changes to optimize resource use.

Expected Outcomes

A comprehensive assessment of Ohio’s data centers' carbon and water footprints.
Insights into resource usage patterns and climate impacts.
A sustainability framework for reducing environmental impacts.
Policy and business recommendations for sustainable data center operations.

Conclusion

This research provides a critical analysis of Ohio’s data centers’ environmental footprints, offering actionable strategies for sustainable growth while minimizing climate impacts.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Neuroscience

Specific title of research project

Analyzing morphological changes in astrocytes associated with aging markers in rhesus macaque brains

Faculty mentor supervising research

Name: Miranda Horn

Department: Biological Sciences and Neuroscience

Email address: mdhorn@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/12/2025

Ending: 7/18/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

The student researcher should be comfortable looking at fluorescently stained slide images and learning how to trace astrocyte processes. They should be willing to work with fixed tissues from rhesus macaques, hazard chemicals used to stain such tissues, and a microscope to capture and analyze images of the stained slides. Attention to detail will be important for accurately tracing astrocyte processes.

Description of the research project (one page maximum)

As the population ages, neurodegenerative disorders become an ever-increasing burden on society. Understanding the cellular and molecular mechanisms that differentiate healthy brain aging from pathological brain aging is critical to the identification of targeted therapies and preventative

measures. Recently, the neuroimmune system has emerged as a key determinant in the trajectory of brain aging.

Research in the Horn lab is at the intersection of these fields, focusing on how alterations in the neuroimmune system, especially astrocytes and microglia, affect neurodegeneration in a non-human primate model of HIV infection. Astrocytes show signs of accelerated aging after infection, including increased expression of the aging marker p16INK4a even after treatment has decreased viral burden. However, further characterization of this “aged” astrocyte phenotype is necessary, including analysis of additional aging markers and morphological alterations.

The student researcher will be taught a combination of immunohistochemistry, fluorescence microscopy, and specialized morphological analysis techniques. The student will analyze previously stained tissues for correlations between expression of p16INK4a in astrocytes and morphologic alterations of those astrocytes in both aged, uninfected and young, infected rhesus macaques. Students will also perform immunohistochemistry to assess the expression of additional aging markers in astrocytes of infected and aged animals.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Math, Statistics and Computer Science

Specific title of research project

Numerical Experiments in Probabilistic Number Theory

Faculty mentor supervising research

Name: Nick Geis

Department: Math and CS

Email address: nsgeis@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/2025

Ending: 7/25/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Experience coding in C++, Julia, or another high-performance programming language; Completion of MATH 230 or possesses equivalent knowledge in statistics by end of this spring; Completion of one of either MATH 250 or CS 220 by end of this spring is helpful, but not necessary; Most importantly: be hardworking, be unafraid of learning new tools and techniques, and have a positive attitude with a willingness to propose and explore new ideas.

Description of the research project (one page maximum)

One of the most famous problems in mathematics is the Riemann Hypothesis. First conjectured by Riemann in 1859, the Riemann Hypothesis relates the zeros of a special function called the Riemann Zeta function to the distribution of prime numbers (important numbers underpinning many cryptographic schemes). Today, the Riemann Hypothesis remains unproven and

is one of the most active areas of mathematics research. One approach to study the Riemann Hypothesis is to use probability and statistics to create random models that simplify the Riemann Zeta function or other closely related functions. The focus of this project is numerically studying one such random model.

In 1944, Wintner developed “random multiplicative functions” in order to study a probabilistic variant of the Riemann Hypothesis. He showed that the Riemann Hypothesis is “almost surely” true in this model (“almost surely” does not mean “proven to be” here). In recent years, there has been much interest in the subject. For example, Aymone, Heap and Zhao (2022) showed that the partial sums of random multiplicative functions equal 0 infinitely many times with probability one. Then, in 2023, two independent groups (Geis and Hiary; Klurman, Lamzouri, and Munsch) proved a lower bound on the number of times these sums equal 0 for very large numbers. The goal of this project is to collect numerical data for when partial sums of random multiplicative functions equal 0 and other related questions.

During this project, we will generate a large dataset of special values of partial sums of random multiplicative functions and analyze it to create new mathematical conjectures. The overall structure of the 10-week investigation is as follows:

1. Learn basic number theory and probability theory. (1-2 weeks)
2. Write a computer program that quickly generates the desired data yet is flexible enough to be used to study other properties. (2-3 weeks)
3. Analyze the data using statistical techniques to make conjectures about observable patterns. Then attempt to explain why the data follows our observations, no proofs expected. (2-3 week)
4. Repeat steps 2 and 3 with new questions.

Beyond these steps, we can consider the following directions. One direction would be to make the program compatible and optimized to run on a supercomputer (Ohio’s OSC or OSU’s Unity Cluster) to create a more complete data set. Another direction would be to summarize our data and write up any proven results for an undergraduate mathematics journal.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Astrophysics

Specific title of research project

Determining How Stellar Magnetic Activity Depends on Stellar Parameters using Data from the Kepler Space Telescope

Faculty mentor supervising research

Name: Robert Harmon

Department: Physics and Astronomy

Email address: roharmon@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/2025

Ending: 7/25/2025

Requested number of students

Two

Minimum qualifications of student researcher (be as specific as possible)

Successful completion of PHYS 111. Proficiency with Python or another programming language is a plus.

Description of the research project (one page maximum)

Students selected will participate in a collaborative project of Dr. Harmon and OWU alum Dr. Rachael Roettenbacher, a research scientist at the University of Michigan. We are conducting the first large-scale systematic study of how the magnetic activity of stars depends on stellar parameters such as the star's mass, surface temperature, and rotation rate.

The Kepler space telescope was launched in 2009 as NASA's first mission to study exoplanets, which

are planets orbiting other stars, and remained operational in this mode until 2013. Kepler was designed to discover exoplanets via the transit method: When a planet passes in front of its star as seen from our perspective, it blocks some of the star's light from reaching us, resulting in a temporary dip in brightness. Kepler took repeated digital images of more that half a million stars, allowing how their brightness changed over time to very high precision, ultimately detecting almost 2800 confirmed exoplanets.

As a side effect of searching for exoplanets, Kepler detected starspots on more than 40,000 stars. Starspots, like sunspots on our own Sun, are regions on a star's surface where strong vertical magnetic fields suppress the transport of heat towards the surface, causing the spots to be cooler and thus darker than the rest of the star's surface. The star's brightness varies as the dark spots are carried into and out of view by the star's rotation, so that monitoring stars for brightness changes due to exoplanets naturally also detects starspots as well.

Because they are associated with concentrations of a star's magnetic field, studies of spots provide important insights into the physics of stellar magnetic fields and how they are generated. This in turn provides insight into magnetic processes on the Sun, which are important to understand because the Sun's magnetic field is the driver of solar storms and coronal mass ejections that can have profound consequences for electrical grids, satellites, and more.

Dr. Harmon developed a computer program that takes measured brightness variations as input and generates a map of the distribution of starspots on the star's surface. Students working on the project will assist in analyzing how the starspot distribution and the way it changes over time depends on other stellar characteristics. There is also the potential for student involvement in developing machine learning algorithms to assist in the selection and analysis of the large number of models generated.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Computer Science

Specific title of research project

Artificial Intelligence of Modern Board Games

Faculty mentor supervising research

Name: Sean McCulloch

Department: Math/CS

Email address: stmccull@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/2025

Ending: 7/25/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Successful completion of CS210. More CS classes are a bonus.

Description of the research project (one page maximum)

Much work has been done in the past on designing Artificial Intelligence (AI) programs to play "classic" board games, such as Chess, Checkers, Othello, and Go. Many of these games have programs that are sufficiently advanced that they beat the best human players. In the last ten to twenty years, however, there has been a rise in "abstract" or "European-style" board games. These differ from the board games many of us have played as children (such as Monopoly or Life) in several areas:
(1) the games are typically short, many finishing in 90 minutes or less;
(2) the games usually emphasize player interaction in some way (components such as bidding,

competing for scarce resources, or trading/negotiation are commonly seen); and (3) the games often are based around hidden information, so that nobody can know the whole state of the game.

These factors, especially the last two, make designing an AI for these games a challenge, and so much less has been done analyzing these games, and what has been done has much room for improvement. Many of these games have an underlying inherent mathematical basis (for example, in graph theory or game theory) that we can exploit to create programs that play the game well.

Previous summer students have begun work on agents for the games Pastiche (a game in which players create paintings by collecting and mixing color cards) Modern Art (a multiplayer auction game), Euro Rails (a game where players create rail lines and deliver goods), and Pandemic (a cooperative game where players work together to cure diseases before it outbreaks across the world). This summer's SSRP student can either extend the work in these programs, or begin work on an entirely new game.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Biology

Specific title of research project

Female Choice and Male Paternity in the Sailfin Molly, Poecilia latipinna

Faculty mentor supervising research

Name: Tami Panhuis, Shala Hankison

Department: Biological Sciences

Email address: sjhankis@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/19/25

Ending: 7/25/25

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Ability to work independently is a must. Completion of Animal Behavior, Genetics, or Evolution is preferred, but not required. Project includes both behavioral observations and molecular bench work, so a student interest in both areas is critical. Student will also be involved in animal care (cleaning, feeding, etc), including some weekend work.

Description of the research project (one page maximum)

An ongoing question related to mating strategies and mating behaviors is how these relate to actual reproductive success. In the sailfin molly, Poecilia latipinna, males exhibit a wide range of mating behaviors (Ptacek & Travis 1997), from performing elaborate courtship to elicit female cooperation, to sneaky copulation attempts, which females often try to avoid, along with post-copulatory sperm

competition (Schlupp and Plath 2005, Aspbury and Gabor 2004). Females, too, have a range of responses (Farr et al 1986). They may actively solicit male courtship and cooperate during sperm transfer, or may avoid certain males that lack preferred characteristics. There may also be crypic choice, in which females may preferentially use some sperm over other sperm (Pilastro et al 2004). Finally, use of stored sperm, mating order, timing of mating relative to the female's reproductive cycle, and other factors may all influence which male(s) actually fertilize the eggs.

This project seeks to combine behavioral observations of male and female P. latipinna courtship behaviors with paternity testing of offspring to determine whether certain behaviors correlate with mating success.. Previous work has suggested that at least half of all broods are sired multiply (Travis et al 1990). We will use the event recorder program, The Observer, to record mating behaviors of females and males. Work will be collaborative across the Panhuis and Hankison labs

Once we have offspring from the matings of known females with sets of males, we will determine paternity and look for patterns relating paternity to observed mating behaviors. While paternity can be influenced by the suite of circumstances detailed above, patterns that we observe may allow us to better understand the outcome of specific mating behaviors on fitness.

Aspbury AS, Gabor CR (2004) Discriminating males alter sperm production between species. PNAS 101: 15970-15973.
Farr JA, Travis J, Trexler JC (1986) Behavioural allometry and interdemic variation in sexual behaviour of the sailfin molly, Poecilia latipinna (Pisces: Poeciliidae). Animal Behaviour 34:497-509
Pilastro A, Simonato M, Bisazza, Evans JP (2004) Cryptic female preference for colorful males in guppies. Evolution 58: 665-669.
Ptacek MB, Travis J (1997) Mate choice in the sailfin molly, Poecilia latipinna. Evolution 51:1217-1231.
Schlupp I, Plath M (2005) Male mate choice and sperm allocation in a sexual/asexual mating complex of Poecilia (Poeciliidae, Teleostei). Biology Letters 11: 169-171.
Travis, J, Trexler JC, Mulvey, M (1990) Multiple paternity and its correlates in female Poecilia latipinna (Poeciliidae). Copeia, 722-729.

2025 Faculty Mentor Research Proposal

2025 OWU SSRP

General area of research (broad overall area such as genetics, biochemistry, environmental science, etc.)

Physics

Specific title of research project

Testing Lorentz and CPT Symmetries with Storage-Ring EDM Experiments

Faculty mentor supervising research

Name: Yunhua Ding

Department: Physics

Email address: yding@owu.edu

Anticipated research dates (10 weeks):

Beginning: 5/7/2025

Ending: 7/16/2025

Requested number of students

One

Minimum qualifications of student researcher (be as specific as possible)

Successful completion of PHYS 280 Contemporary Physics. Some basic skills of Mathematica coding are preferred, but not required.

Description of the research project (one page maximum)

General Relativity (GR) and the Standard Model (SM) of particle physics are the two most successful theories describing our nature so far. Among the important foundations of both theories, Lorentz and CPT symmetries play a crucial role. The former symmetry states that physical laws are unchanged when transforming between two inertial frames, while the latter is the symmetry of physical laws under the simultaneous transformations of charge conjugation (C), parity inversion (P), and time reversal (T). Although many of the predictions from GR and the SM have been verified by experiments, they remain fundamentally incompatible, leaving the unification of these two theories as

a key challenge in physics. Recent research suggests that tiny violations of Lorentz and CPT symmetries could appear as natural features of models unifying gravity with quantum physics. Such tiny deviations from these symmetries could produce interesting observable effects, such as modifications to the spin motion of particles under electromagnetic fields.

Thus, this theoretical project investigates potential signals arising from Lorentz and CPT violation in experiments searching for nonzero Electric Dipole Moments (EDMs) of charged particles in storage rings. The work begins with a review of the conventional theory that describes the spin motion of particles confined in electromagnetic fields. Building upon this, we will extend the theory with additional terms to allow for possible violations of Lorentz and CPT symmetries and determine the modified spin motion due to Lorentz and CPT violation. Next, we will develop Mathematics codes to transform the results to the standard inertial frame and study the time variations of the signals. By analyzing data from existing or proposed EDM experiments, we aim to place stringent bounds on the magnitude of Lorentz and CPT-violating effects that have not been studied before.

Through this project, students will develop key skills, including physical system modeling, analytical techniques, Mathematica, scientific presentation, and collaborative teamwork. These experiences will prepare them for successful careers in physics and related fields.