Penn Undergraduate Research Mentoring Program
Project Descriptions
Summer 2023

Please read this before proceeding to project listings!

Application and instructions at https://www.curf.upenn.edu/purm

Unless otherwise noted, current first- and second-year undergraduates may apply for any listed project.

Students are encouraged to learn more about faculty interests by reviewing faculty webpages and recent publications to determine your interest level in particular projects.

You never know where you might find a project that interests you! While projects are listed by primary department, many of them are interdisciplinary in nature. **We suggest that you use keyword searches in this document to identify additional projects that would be of interest to you.**

Students should **NOT** contact faculty about their projects unless invited to do so (ie responding to a faculty member's email/request, when asked to arrange an interview, etc.) or the PURM selection process has been completed.

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Annenberg

Claire Finkelstein

Forestalling the Use of Nuclear Weapons in Ukraine

Second-year only

My project can be modified to accommodate remote activities if made necessary by University policy.

The Center for Ethics and the Rule of Law (CERL), affiliated with the Annenberg Public Policy Center at Penn, is a non-partisan interdisciplinary institute dedicated to preserving and promoting ethics and the rule of law in national security, warfare, and democratic governance. CERL draws from the study of law, philosophy, and ethics to answer the difficult questions that arise in domestic and transnational crises and conflicts.

The center offers undergraduate students the opportunity to join CERL's team in timely research and programming on the vitally important question of how to forestall the use of nuclear weapons on the part of Russia in the current Ukraine crisis and how the United States and the rest of NATO should respond if Russia nevertheless proceeds. President Biden recently warned the world would face "Armageddon" if Putin uses a tactical nuclear weapon in Ukraine. The President further stated that the risk of nuclear war is the highest it has been since the Cuban Missile Crisis of 1962. Vladimir Putin insists he is "not bluffing" about the use of nuclear weapons, from which many have inferred he is signaling the intent to use tactical nuclear weapons in Ukraine. In light of this emergent national security crisis, CERL has formed an interdisciplinary working group to try to attempt to develop recommendations to address the current situation. The first in a series of working group meetings was held on November 16, 2022.

Students will work under the supervision of Professor Claire Finkelstein and participate in CERL's activities around this topic to augment their research skills and learn from real-world perspectives.Students will have unique opportunities to research critical ethical and rule of law issues; help plan CERL's follow-on conferences, workshops, and public programs; publish original works for CERL's blog, The Rule of Law Post; help prepare CERL policy briefings and contribute to CERL academic publications; and make critical professional contacts, which may serve to open doors to future academic and professional networks.

David Joanson, CERL Executive Director, will also be involved in mentoring the students.

Juan Llamas Rodriguez

Netflix in Mexico: A 10-Year Assessment

My project can be completed entirely remotely.

This project examines the development and expansion of Netflix and other streaming platforms in Mexico over the past decade. We consider the changes in cultural practices, regulation, and markets that have contributed to the growth of streaming content in the country. We also analyze how Netflix

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positioned itself as an alternative to traditional television networks with "quality" content and evaluate to what extent its original series offer new or recycle old types of narratives.

The two outcomes of the project are an academic article on the socio-cultural significance of Netflix original series in Mexico and a white paper detailing the current market for streaming media in the country. Students can work on supporting either of these two. The project would be a good opportunity for students interested in learning about cultural analysis of new media or the economics of media production and distribution.

Activities and skills students will develop in this project:
-- Watching Netflix shows and analyzing their main themes, narratives, and characters.
-- Reading, summarizing, and evaluating press coverage about streaming services in Mexico.
-- Reading, summarizing, and evaluating academic scholarship.
-- Compiling and updating a list of Mexican TV shows.
-- Analyzing the decisions taken by Netflix executives from a business and cultural perspective.

Arts & Sciences

ART HISTORY

Mantha Zarmakoupi

The Multivalent Meaning and Function of Public Buildings in Greek and Roman Cities. The Bouleuterion at Teos (Turkey)

My project can be modified to accommodate remote activities if made necessary by University policy.

This project will offer a new understanding of public buildings in Classical cities of the Mediterranean and its implications (economic, political, and cultural) for studies of ancient urbanism. The project focuses on the Western Asia Minor city of Teos in the Hellenistic and Roman periods and involves a targeted excavation and full study of its bouleuterion, or city council, to reveal and challenge the limits of traditional categorizations of building types in the study of Greek and Roman architecture. In so doing, the project aims to explore the ways in which ancient buildings were multifunctional and puncture our long-held idea that each designated building type must relate to a different function.

The bouleuterion was a roofed meeting space that housed the council of a Greek city-state, or polis. Earlier city councils may have met in open spaces, such as porticoed enclosures, and construction of dedicated bouleuteria buildings began in the archaic period (7th–6th c. BCE). In the Hellenistic period, the bouleuterion had become one of the city's most characteristic and most monumental secular buildings.

Increasing evidence shows that bouleuteria were multifunctional buildings. My argument is that the study of the bouleuterion as a building type has impeded its interpretation as a building housing a wider variety of functions that reflect the evolving identity of Greek and Roman cities and that the typological study of public monuments in the classical world at large has hindered our understanding of their design, meaning, and function. By focusing on the bouleuterion at Teos, my aim is to shed light on the

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variegated functions it fulfilled over time, on the one hand, and initiate a discussion on the ways in which the study of classical monuments may be enriched by contemporary discussions in architectural history and theory, on the other. To this end, I conduct a targeted excavation of the building in order to clarify its chronology and function.

The project will engage an undergraduate research assistant during the summer fieldwork season (2 months). The student will assist in the documentation of the fieldwork season. The student will be trained to use the digital platform of the project in order to record and organize the data of the excavation of the project. In addition, the student will be trained to record the architectural features of the building via hand and digital drawings (in AutoCAD and Illustrator).

BIOLOGY

Katie Barott

Physiological Mechanisms of Climate Change Resilience in Reef-building Corals

My project is entirely in-person.

Overview: The ability to detect and regulate changes in pH is critical for reef-building corals experiencing ocean warming and acidification stress due to climate change. Our research is investigating how seawater temperature and pH dynamics on the reef influence internal pH regulation pathways in corals and sea anemones. We are interested in understanding how these dynamics affect coral resilience to climate change stressors across biological scales, from the pH-dependence of sperm motility and symbiont photosynthesis to the effect of pH on organism metabolism and fitness. These studies will help determine the capacity of corals to persist in the ongoing climate crisis.

Planned and ongoing projects:

Laboratory mentors will provide daily training and support for each student working on one of the projects listed below.

Project 1 will investigate the role of coral-associated bacteria in corals' ability to tolerate environmental stress. Corals will be exposed to experimental heat stress and physiological and microbiome assays will be conducted to quantify the coral's response to this stress.
a. Mentor: Marcelina Martynek
b. Skills: physiological assays, DNA extractions.

Project 2 will investigate if and how sea anemones (a close relative of corals) can acclimatize and adapt to heat stress over multiple generations. We plan to subject sea anemones to heat stress in lab aquaria over multiple generations to track intra- and intergenerational effects on reproduction and development.
a. Mentor: Benjamin Glass
b. Skills: microscopy, flow cytometry, image analysis, use of temperature loggers, respirometry.

Project 3 will investigate the role of the enzyme carbonic anhydrase in cellular pH regulation in stony corals using a pharmacological inhibitor and fluorescent pH-sensitive cell dye.
a. Mentor: Luella Allen-Waller

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b. Project-specific skills: confocal microscopy, image analysis.

Skills to be developed by all participating students:

- Animal husbandry: feeding and assessing health of corals and sea anemones
- Aquarium maintenance: water quality testing (pH, salinity, nutrients), preparation of artificial seawater, cleaning tanks
- Laboratory safety: use of personal protective equipment, hazardous chemicals, fume hoods, sharps, laboratory waste disposal.
- Scientific integrity and reproducibility: use of hard-copy and electronic laboratory notebooks
- Experimental design
- Preparation of laboratory reagents: use of microbalances, pipets, pH meters, autoclaves.
- Scientific communication: presentation of research and discussion of scientific literature at group meetings
- Data analysis and visualization using the programming language R

Michael Lampson

Studies of Intragenomic Conflict and Telomere Regulation in Embryos

My project is entirely in-person.

We are interested in working with students on two projects using mouse embryos as cell biological model systems.

The first project focuses on intragenomic conflicts, which occur when the strategies used by one genetic element to increase its fitness are at odds with others in the same genome. Specifically, we study how such conflicts might impact the functional evolution of the centromere, the chromatin that facilitates chromosome segregation. Despite the centromere's conserved role in chromosome segregation, both centromeric DNA and proteins evolve rapidly across a broad range of species. This rapid evolution is surprising, as one would expect optimal centromeric DNA and protein sequences for centromere function. Our hypothesis is that the rapid evolution results from conflict between centromere DNA and genes encoding centromere proteins. Specifically, centromeric DNA benefits from recruiting higher levels of centromere proteins and therefore evolves higher binding affinity for these proteins, whereas the rest of the genome benefits from lower levels and therefore evolves to reduce this binding. We are testing this co-evolutionary hypothesis using a combination of evolutionary, molecular and cell biology methods.

Telomeres consist of repeated DNA sequences that protect the chromosome ends from a DNA damage response. The second project focuses on telomere regulation in the embryo, immediately after fertilization. Telomeres are typically short in the egg and long in the sperm due to differences in gamete development, so that maternal and paternal telomeres have different lengths in the zygote. We are testing models for how telomeres become symmetric during early embryonic cell cycles.

Both projects will involve in vitro culture of mouse embryos, staining, and fluorescence microscopy to examine localization of centromere and telomere proteins. Students will work closely with a postdoctoral fellow: Piero Lamelza for the first project or Hyuk-Joon Jeon for the second project.

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Marc Schmidt

Analysis of Courtship Behavior and Its Neural Substrates in a Socially Gregarious Songbird

My project is entirely in-person.

Our laboratory takes a highly integrative approach to studying the neural bases of social displays and interactions in animals. We developed (in collaboration with the Daniilidis group in CIS) a unique "smart aviary" that allows real-time monitoring and classification (over the entire 3-month breeding season) of visual and acoustic displays within a defined social group of songbirds. Much of the behavioral analysis combines manual annotation with machine learning approaches to generate large datasets of behavioral interactions within this social network. These data are then analyzed, in collaboration with our colleagues in Physics (Balasubramanian lab), to generate predictive models of individual behaviors within the social group. Our aim is to eventually record wireless brain neural activity from each bird in the aviary using technologies we are developing together with the Aflatouni group (EE). While these technologies are being implemented, we are piloting various prototypes by recording neural dynamics in birds performing song courtship displays in smaller enclosures.

We are looking for students interested in applying quantitative methods to the study of animal social behavior. Necessary skills include programming competence, strong mathematical skills, and a deep interest in animal behavior. Some knowledge of systems engineering, or a willingness to learn, would be ideal. Skills learned during the summer could include behavioral annotation, systems engineering, neurophysiological techniques, mathematical modeling of social networks, as well as deep learning of animal pose estimation and classification.

All interested students are welcome to apply. Engineering students would be a particularly good fit.

Paul Schmidt

Rapid Adaptation in Natural and Experimental Populations

My project is entirely in-person.

We will be conducting a series of experiments to understand mechanisms by which extremely rapid (5-10 generations) adaptive evolution occurs. This project is in collaboration with the laboratories of Dmitri Petrov (Stanford University), Lauren McIntyre (University of Florida), and Brandon Cooper (University of Montana). The work will involve manipulative field experiments at our experimental orchard at Pennovation and complementary work conducted in the laboratory. A particular focus will be on the effects of host microbes and endosymbionts in driving patterns of evolution. Students will gain exposure to field oriented biology, experimental design, genomic analysis, quantitative genetics, and molecular genetics. No prior experience needed.

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CHEMISTRY

Ivan Dmochowski

Building Small Molecules or Proteins as Xenon-Based, Next-Generation MRI Contrast Agents

My project can be modified to accommodate remote activities if made necessary by University policy.

The student working on this project will employ techniques of organic chemistry or protein chemistry to develop molecules that interact with the noble gas xenon to produce unique signals for magnetic resonance imaging (MRI). One long-range goal of this project is to advance the field of molecular imaging, to enable early and accurate disease detection using common imaging modalities such as MRI. The isotope xenon-129 has a spin-1/2 nucleus that is readily manipulated for ultrasensitive detection using conventional scanners. The student will employ various analytical techniques to confirm that they have generated the desired small-molecule or protein capsule. X-ray crystallography is the gold standard for confirming xenon binding in the site(s) of interest, but other chemistry analytical methods will be performed as well. There are several graduate students who will serve as day-to-day mentors in these different project areas.

Marisa Kozlowski

Development of New Synthetic Methods

Second-year only

My project is entirely in-person.

Project 1: Development of catalytic, oxidative fragment coupling processes. There is significant interest in these methods due to their use in the pharmaceutical industry both for the synthesis of medicinal chemistry leads and in process development. In addition to conventional approaches to reaction optimization, high throughput experimentation techniques are utilized to identify leads and optimize processes. Requirements: Chem 2410, Chem 2411 or 2412, Chem 2420, Chem 2421 or 2422. Responsibilities: Synthesis and testing of new substrates and catalysts in oxidative bond forming processes. Must be able to keep a good lab notebook, follow safety protocols, and respond to feedback. Benefits: Will develop skills to work independently in a laboratory environment that are useful in the broad context of laboratory research, and specifically useful for careers or PhD programs in chemistry and related fields.

Project 2: Development of new computational models for reaction optimization based on statistical modeling. Electronic structure and quantitative structure activity relationship calculations are used. The results establish mechanistic pathways and the determinants for selectivity. This information in turn is used to predict the outcomes of modified systems with the aim of improving yield, selectivity, or scope. Requirements: Chem 2410, Chem 2420, Statistics Class, ability to use R or python, familiarity with multivariate multiple regression a plus. Responsibilities: Identify new parameters for fitting reaction

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data (rate, selectivity, etc.) to catalyst structure. Design new catalysts based on model predictions. Understand statistical models by exploring fundamental reaction steps computationally with Gaussian. Benefits: Will develop skills computation that are useful to broad range of careers, and especially useful for careers or PhD programs in scientific and engineering fields.

Monica McCallum

Exploring Microbial Chemistry

My project can be modified to accommodate remote activities if made necessary by University policy.

The McCallum laboratory seeks two undergraduate students interested in understanding the origins and functions of the small molecules (natural products) produced by microorganisms. The interdisciplinary research projects available will provide the successful applicants with the opportunity to experience modern laboratory techniques in synthetic organic chemistry, microbiology, molecular biology, mass spectrometry, and biocatalysis. Our lab is particularly interested in studying the complex microbial chemistry within living sponges, which are known to produce natural products used to combat human diseases.

[Basic Qualifications] We seek candidates who are curious, conscientious, careful, and kind, with a demonstrated capability to work collaboratively in a team setting, problem-solve, organize information, and work diligently. Previous experience in the service sector (e.g. restaurant, retail, etc.) is a plus. No previous lab experience required.

[Basic Responsibilities] Strict adherence to laboratory safety protocols and regulations. Maintenance of a laboratory notebook in keeping with lab standards. Regular reporting to supervisor. Participation in laboratory events, including weekly lab meetings. Assistance with basic laboratory maintenance (cleaning and maintaining laboratory equipment, organizing supplies, preparation of common supplies, etc.). Carrying out approved experiments under the direct mentorship of Dr. McCallum and a current graduate student in the lab. Available skills to learn: basic molecular biology (PCR, molecular cloning, gel electrophoresis), protein expression, protein purification, biochemical assays, synthetic organic chemistry, microbiology.

Sergei Vinogradov

Synthesis of Pi-extended Porphyrins for Imaging Applications

My project is entirely in-person.

Please check our group website to get an idea of the synthetic projects that we are working on. You will be a part of such projects.

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CLASSICAL STUDIES

Thomas Tartaron

Russell House (Charleston, SC) Labor, Craft, and Fashion Project

My project can be modified to accommodate remote activities if made necessary by University policy.

This project is part of the on-going Kitchen House Project in the Center for Analysis of Archaeological Materials at the Penn Museum The Russell Kitchen house is a key site for understanding the lived experience of enslaved workers in Charleston, SC, the main urban port city of the southeast U.S. before the Civil War. An interdisciplinary team of archaeologists is analyzing materials found between wall spaces of this house, addressing issues of food choice and preparation, craft production, ecology, and evidence for the changes in outdoor spaces and work yards. This data set includes hundreds of scraps of fabric and related organic material sorted from wall cavities within the kitchen house. We seek a student who will organize the cleaning, mounting, examination, and description of these small scraps. They will work under magnification to look at evidence for manufacture and use. The student will use historical and archival sources to understand access to cloth and clothing by the enslaved, and they may relate these findings to the literature on the production of cloth in New England for the slave market and cloth for the luxury market from New England and Europe.

The ideal student for this project will be interested in archaeology and material culture, in fashion and craft, and in the economic and social history of the U.S. in the 19th Century. We seek a curious person who is good with visual details and interested in unexplored parts of the past. Mentors will include staff members and students in the Center for the Analysis of Materials and the Penn Museum. These include teaching specialists Katherine Moore, Chantel White, and staff from the Museum's Academic Departments of Conservation and Academic Engagement.

CRIMINOLOGY

John Macdonald

The Effects of Clean Streets on Gun Violence

My project can be modified to accommodate remote activities if made necessary by University policy.

The study will consist of mixed-methods examination of the effects of street cleaning on gun violence outcomes. A randomized controlled trial will test whether street cleaning reduces gun violence, and if so, what intensity of cleanup is most effective and/or cost-effective. The research will answer the following questions:

- Does basic street cleaning (such as trash removal, weed trimming, leaf blowing, and sidewalk sweeping) impact rates of gun violence?
- Does the effect of street cleaning on gun violence vary by frequency of cleanups?

An undergraduate student can work with one faculty member and two research staff members on this project. The undergraduate should have some familiarity with ArcGIS, R, or STATA to map data and

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assist the project team with developing a visual depiction of the implementation of the street cleaning intervention. Some in-person meetings will be necessary on campus and in Philadelphia neighborhoods. The undergraduate can also assist in building a literature of previous studies that examine the link between litter/trash and gun violence.

EARTH AND ENVIRONMENTAL SCIENCE

Jon Hawkings

Trickle or Treat - Is the Greenland Ice Sheet a Source of Nutrients to Coastal Ecosystems?

Second-year only

My project is entirely in-person.

The supply of nutrients such as carbon (C), nitrogen (N), phosphorus (P), silicon (Si), and iron (Fe) is critical to maintaining the health and productivity of aquatic ecosystems. Glaciers - rivers of ice - have recently been identified as potential nutrient sources to downstream ecosystems. Glaciers host "hidden" wetlands/ecosystems beneath the ice and act as the "bulldozers" of the natural world, crushing rock as they move. The potent combination of meltwater and freshly crushed rock powder ("glacial flour") releases dissolved elements and forms highly reactive nanoparticles.

The Greenland Ice Sheet is the second largest ice mass on Earth. It is a particularly large source of freshwater - ~400 million Olympic-sized swimming pools of meltwater is discharged by the ice sheet into the ocean every year, an amount increasing with climate warming. The chemical composition of this meltwater is not well known, and therefore its impacts on ocean ecosystems are uncertain. The ice sheet also contributes ~10 % of the global annual riverine sediment load. Some of this sediment is transported as dust, but the quantity and composition of this dust, and therefore its potential impact on ecosystems, has not been studied.

This project will look to support up to two undergraduate students to study the nutrient content of Greenland Ice Sheet meltwaters and sediments. The students will participate in fieldwork to Greenland in June/July of 2023 as part of a National Science Foundation funded project awarded to Dr. Jon Hawkings.

The first position will focus on collecting and analyzing water samples from a large Greenland Ice Sheet meltwater river near the settlement of Kangerlussuaq. The second position will support a student to collect and analyze atmospheric dust/aerosols from the same study area. Water and sediment samples for nutrient analysis will be collected from several study sites near Kangerlussuaq throughout the fieldwork period. Both students will help analyze these samples in the Penn BiCycles Lab after fieldwork.

Skills/benefits/experiences acquired during project: opportunity to work in a beautiful, remote Arctic environment that is on the front line of climate change; constructing a scientific sampling plan; collecting samples for geochemical analysis; experience with advanced lab and field instrumentation; member of a close-knit group of scientific researchers; exposure to a range of Arctic research; process and synthesize complex datasets and present findings to the Penn community.

Mentors: Dr. Jon Hawkings, Dr. Eva Doting, Dr. Jack Murphy, Amina Youssef

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Hugo Ulloa

Unravelling the Fate of Droplets Falling on Sloping Fine Sediment Coats

My project is entirely in-person.

What happens when a droplet falls on a dry substrate? This basic question brings our attention to a fundamental process on Earth: rain falling, wetting and mobilizing the uppermost and finest sediment coating the continental surface. The power of rain to erode and shape the landscape morphology is beyond question. However, the processes triggered by the first meteoric droplets impacting a dry fine sediment layer on sloping terrains still need to be characterized.

As climate change amplifies the severity of drought in many regions of Earth, vast areas become prone to accumulate fine granular material. Yet, as droughts support the expansion of desertic environments, sudden and extreme rainfalls can originate complex and vigorous streams of meteoric water enriched with particles. These multiphase (fluid+solid) flows can devastate communities in regions experiencing long-lasting droughts, such as California. Nonetheless, every storm starts with a few droplets, regardless of how intense a rainfall event is.

In this project, we will investigate the processes undergone by the first droplets impacting a sloping fine sediment layer via laboratory experiments. Our main goal is to identify how the various parameters at stake affect droplets' behaviour, transformation and fate once in contact with sediment. In particular, we aim to quantify the granular material transported by droplets throughout the landscape. Utilizing an already-built laboratory setup, we will measure the evolution of droplets through a sediment layer with cameras and tracking algorithms. The mobilized sediment will be measured using a laboratory scale. Droplets' dynamics will be studied in terms of fluid and sediment properties. The experiments will be performed in our wet lab located in the David Rittenhouse Laboratory building, and data will be analyzed in the computing lab in Hayden Hall.

Summing up, this project aims to shed light on the droplet-sediment dynamics and the capacity for droplets to mobilize sediment. This project's outcomes may allow learning how early rain droplets, known as liquid marbles, carve patterns on granular surfaces relevant to characterize the early stages of streams' formation on the landscape.

This PURM project is ideal for students eager to (1) investigate a ubiquitous yet unexplored environmental flow, (2) have hands-on laboratory experience and (3) gain background in data analysis and reporting results. No specific knowledge is required. This project will be developed in collaboration between the Geophysical and Environmental Flows Laboratory, led by Prof Hugo Ulloa, and the Penn Sediment Dynamics Laboratory, led by Prof Douglas Jerolmack.

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HISTORY

Marc Flandreau

Broker Bankruptcies in the London Stock Exchange during the 1820s

My project can be completed entirely remotely.

The goal of the project is to assist Professor Flandreau with data collection. During the 1820s, the London stock exchange was subject to violent convulsions owing to a boom and bust in foreign debt. It left traces in stockbroker bankruptcies, which are discussed in a document which Professor Flandreau has digitised. Your mission, should you accept it, will consist in going over the pages of this document and collect information on LSE stockbrokers, both soft (mention of the submarket where they operated for instance) and hard (name, date of failure, and occasionally date of reinstatement). The skills required involve a good eye, as the source is a manuscript (though a legible one), and a rigorous work attitude. Because of the nature of the task and the fact that the source has been digitised file, it is expected that, after a couple of training sessions with Professor Flandreau, the student will be on their own and they can work from anywhere. Depending on speed of completion, there might be additional tasks such as searching online London stockbroker databases, which have been digitised by genealogists. That's about it!

Ramya Sreenivasan

Mapping and Historicizing Sovereignty in Early Modern Northern India, 1300-1700

My project can be modified to accommodate remote activities if made necessary by University policy.

I am working on a history of polities in northern India, over a vast geographical space (a thousand miles east to west) but within a single political zone. Within this zone -- extending from Kabul in the northwest to Arakan in the southeast -- I explore how the extraction of resources -- through agriculture, mining and manufacture -- established sovereignty for ambitious warlords, kings, and aspiring emperors, between 1300 and 1700. Digital mapping (ArcGIS) and data visualization tools provide powerful interpretive strategies for understanding the relationship between sovereignty and resource extraction, and for tracing the shifting frontiers of polities in northern India, all the way between Kabul (modern Afghanistan) and Arakan (modern Bangladesh), between 1300 and 1700. As I explore strategies to record and present this material digitally, I seek a research assistant who can help with different kinds of thematic maps -- making spreadsheets with the relevant data and plotting it as appropriate to produce historical maps -- as well as help with the digital presentation of this project. No prior familiarity with digital humanities tools is required, nor prior familiarity with South Asian languages. The research assistant will emerge from this project having acquired skills in data plotting, data visualization, mapping, and other such digital humanities tools relevant to social scientists and humanists. They will also develop an understanding of historical method and of the nature of historical evidence and interpretation, as well as an understanding of how political authority might have been exercised and experienced on the ground in many parts of the pre-modern world.

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Melissa Teixeira

Inflation and Hyperinflation in Brazil, 1980s-1990s

My project can be completed entirely remotely.

How did high inflation shape Brazil's transition to democracy in the 1980s and 1990s? After 20 years of military dictatorship (1964-1985), pro-democracy movements pushed for Brazil's new civilian government to not only secure political and civil rights, but also socio-economic rights: healthcare, employment, and fair prices. Democratic aspirations, however, soured with the worsening economy. Brazil faced debt defaults, slow growth, unemployment, and inflation. By 1990, prices were nearly doubling monthly as hyperinflation became a hurdle to the young democracy's ability to improve living conditions. Expanding the meaning of democracy had to contend with unfolding economic crises.

This project uses inflation to study how economic instability shaped citizen's expectations about democracy. As much as inflation conditioned everyday hardships in Brazil, we know little about the policies implemented, or how citizens navigated dramatic swings between state-decreed price freezes and inflationary spirals. Beyond macroeconomic trends, my aim is to explore how economists, bureaucrats, consumers, workers, and industrialists understood and tried to fix (or live with) inflation. I am especially interested in how businesses and consumers adjusted their economic behavior to inflation. Research will focus on popular consumer strategies to maximize purchasing power under uncertain conditions, exploring how hyperinflation coincided with a boom in consumerism. The project also explores new financial products developed by Brazilian banks in response to the public's desire to hold limited cash.

Students working on this project will be asked to read and summarize secondary literature on the topic; read and summarize official reports produced by the International Monetary Fund; survey newspapers reporting on economic events in Brazil; and help to catalogue and organize primary sources that I have digitized in Brazilian archives. Students will also be asked to compile and plug into excel spreadsheets some financial/economic data. A baseline familiarity with excel is preferred, though I can also teach students how to work with the software. There are many materials available in English, so knowledge of Portuguese is not required. However, reading abilities in Portuguese or Spanish is preferred and would enrich the research experience. Students working on this project will gain familiarity with contemporary Brazilian history and an applied knowledge of macroeconomics. Students will also gain experience in creating and managing economic databases and digital depositories of documentary evidence. Students will have autonomy in carrying out research assignments, and be encouraged to follow promising leads. This project can be done remotely or hybrid, depending on the student's availability.

Joshua Teplitsky

Mapping Books in Motion: A Global Case Study in Hebrew Books

My project can be modified to accommodate remote activities if made necessary by University policy.

This project is structured around a digital humanities enterprise called Footprints: Jewish Books through Time and Place. The project, first conceived a decade ago, is a collaboratively-produced database that is designed to study the movement of printed Hebrew books that were published in the early centuries of printing (roughly 1450-1800), and to explore the movement of those books up the present day. The goal

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of the project is to produce a tool that uses material objects (books, with their individual histories) to understand how knowledge itself moves and is transmitted across place and time. It draws upon source material from rare books and libraries around the world, including holdings at the University of Pennsylvania and other parts of Philadelphia. The project engages to Jewish materials, but its larger questions have implications for cultures of many sorts.

The project draws upon a variety of skill sets, each of which is essential to the ultimate outcome:

1. Historical research: questions involving reconstructing the context and moments in which books were bought, sold, gifted, censored, confiscated, burned, and beyond. Students will work with primary sources like auction catalogs or even with rare books themselves to glean what they can about the "life story" of books as individual objects.

2. Computer Science: students are invited to try, test, and reconceive elements of the relational database. This also includes work on mapping and GIS functions.

3. Statistical analyses: students will explore questions by working directly with a dataset of several thousand entries, posing questions and looking for patterns and trends only visible with attention to quantitative evaluations.

You do not need to be Jewish, or know Hebrew, in order to participate. For some of the tasks languages other than English are welcome, but not a requirement. This project is open to anyone interested in how ideas move from one place to another, to people interested in the relationship between digital methods and humanistic research, and/or in the meeting of large quantitative data's relationship to microscale reconstruction of ordinary, individual lives from the past.

Beth Wenger

American Jews and the Paradigm of Crisis

My project can be completed entirely remotely.

American Jewish history has been marked by ongoing uneasiness and insecurity about the American Jewish communal future. Despite the relative freedoms that the United States offered, Jews were consumed with a variety of concerns about the vitality of Jewish culture (or lack thereof). The paradigm of crisis has been a regular feature of American Jewish life—ranging from fears that American Jewish culture did not measure up to its European counterpart to preoccupation with population numbers, "disappearance," "continuity," and more.

I am looking for a student to conduct research on this topic, particularly in newspapers and periodicals. Much of this research can be conducted online and thus, will not require regular residence in Philadelphia, though some sources may need to be retrieved in person if they are not digitized. Applicants must be committed to developing the skills of historical research. They should be self-motivated, well-organized, and able to distill and concisely present research findings. The student selected must have the ability to discern key themes, carefully document sources, and present information clearly and concisely.

This experience will enhance research skills, critical thinking, and refine proficiency in organizing and presenting information.

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JEWISH STUDIES

Talya Fishman

1. Catalogue Illustrations in Digitized Medieval Hebrew Bible Codices 2. Identify & Catalogue Medieval Hebrew References to Objects used in Jewish & Christian Material Devotion

My project can be completed entirely remotely.

PROJECT ONE:
Seeking student who can read Hebrew and has an interest in Art History. Research Assistant will study the digital reproductions of around 20 medieval illuminated Hebrew Bible codices in order to identify and create a record of each full page illustration. The researcher will describe each image and record any Hebrew captions.

PROJECT TWO:
As the larger framework of this research project concerns the role of material images in medieval Jewish culture, there is an opportunity for a second student researcher with excellent reading ability in Hebrew, and, ideally, competence with rabbinic sources. This project has two parts:

1) Read though the Hebrew translation of Judah Halevi's _Cuzari_, and identify all passages that discuss the importance of material objects. (E.g., Golden Calf; Temple implements.) Select and create a record of these passages.

2) Using a database of rabbinic sources, and plugging in particular Hebrew keywords (e.g., tzelem, temunah, shiqqutz), identify and create a record of passages that refer to objects used by medieval Christians in their acts of material devotion.

For both projects, Professor Fishman will have --at least-- weekly engagement with student researchers, either in person, if on campus, or by Zoom. For both projects, Professor Fishman will involve the researchers in analyzing the retrieved data and in thinking about its broader historical and cross-cultural significance.

LINGUISTICS

Eugene Buckley

Kashaya Language Database and Dictionary

My project can be completed entirely remotely.

I am working on the documentation and analysis of Kashaya, an endangered Native American language of northern California. This project is largely organized around a computer database that connects extensive analyzed texts and sentences to lexical entries, which can be used to generate a full dictionary, specialized wordlists, and example sentences.

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Tasks related to the database might include checking the English definitions for clarity and consistency; classifying entries according to their semantic category; analyzing example sentences by means of the lexical entries; verifying that the structure of the Kashaya words is correctly encoded, with accurate links between roots and derived forms; and finding examples to illustrate the entries by looking in the texts.

In addition, I have a large collection of recordings of native speakers. These are mostly transcribed already, but the transcriptions have not been linked to the corresponding places in the recordings. A student with knowledge of Praat or similar software could help with this large undertaking, which also includes extracting sound clips to be used for language learning.

In assisting on this project, the student will learn about a complex and fascinating language, and gain experience in the documentation of languages in general. It could easily lead to a subsequent research project on any aspect of Kashaya that the student finds interesting. No prior knowledge of the language is required, but some background in linguistics is essential.

This project is well suited to remote collaboration and I am happy to work with a student via Zoom discussions and shared data in the cloud.

Jianjing Kuang

Production and Perception of Rhythm and Melody in Music and Speech

My project can be modified to accommodate remote activities if made necessary by University policy.

Music and speech are closely related, as they both involve the production and perception of sound. They share many similarities in terms of the mechanisms involved in their production and perception, yet they are distinguished auditory processes. The links between music and speech have received great interest in recent years, such as the bi-directional influences between music and speech, but the mechanisms are still remained to be further explored. In the summer, we will run production and perception experiments to probe how rhythm and melody are produced and perceived in music and speech; and how emotion and meanings are delivered in music and speech. Students are encouraged to design experiments to explore their questions as well. Students will gain substantial experience in experimental design, speech processing and analysis, and quantitative analysis. This project requires very broad interdisciplinary knowledge such as linguistics, engineering, computer science, psychology, physiology, and musicology. Students with relevant backgrounds are encouraged to apply

MATHEMATICS

Lu Lu

Physics-informed Machine Learning for Solving Differential Equations

My project can be completed entirely remotely.

Deep learning has achieved remarkable success in diverse applications; however, its use in scientific computing under the name of scientific machine learning (SciML) or AI for Science (AI4Science) has emerged only recently. In this project, we will focus on the use of deep learning in solving partial

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differential equations (PDEs). Physics-informed neural networks (PINNs) solve a PDE via embedding the PDE into the loss of the neural network using automatic differentiation. The PINN algorithm is simple, and it can be applied to different types of PDEs, including integro-differential equations, fractional PDEs, and stochastic PDEs. Moreover, from the implementation point of view, PINNs solve inverse problems as easily as forward problems.

Despite promising early results, there are still some issues in PINNs to be addressed. For example, one open problem is how to effectively solve stiff problems. In this project, we will develop new methods to improve the accuracy of PINNs for stiff problems. We will also apply PINNs to solve challenging engineering, physical, and biological problems.

To incorporate undergraduate students into the project, the students will be mentored as follows.

(1) Accessible beginning: As a start, undergraduate students will learn fundamentals of deep learning, PINNs, and programming using Python and TensorFlow/PyTorch. The student will also read the materials of my course "Deep Learning for Scientists and Engineers" in Spring 2023. I have developed a Python library, DeepXDE (https://github.com/lululxvi/deepxde), for PINNs, and the student will learn how to use DeepXDE to solve PDEs.

(2) Data collection and analysis of computational tasks: This project focuses on developing new deep learning and numerical algorithms, and thus it heavily relies on computers. The students will perform computational tasks by running different algorithms, collecting and analyzing the output data, and comparing the effects of different parameters and the performance of different algorithms. By performing numerical experiments, the student can receive feedback of the performance of the developed algorithm.

(3) Improving current algorithms (optional): After the students have a good understanding of the current algorithms, the students are encouraged to modify the algorithms to improve the performance, but this is optional.

(4) The student will have a desk in my lab and sit next to the other students. We will have a weekly one-on-one meeting, and I have an open door policy, where the student can stop in and ask questions as they arise. The student will also be co-supervised by the graduate student mentor.

NEUROSCIENCE

Matthew Hayes

Neural Correlates of Obesity

My project is entirely in-person.

The staggering prevalence of obesity presents major public health and economic consequences. Effective anti-obesity drugs are desperately needed to combat the obesity epidemic, as behavioral strategies offer limited success. Analogs of the endogenous satiety signal glucagon-like peptide-1 (GLP-1) suppress food intake and body weight and are FDA-approved for obesity treatment. However, GLP-1 analogs (e.g. semaglutide) are burdened by side effects, namely nausea and emesis. Therefore,

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increasing the therapeutic potential of GLP-1 receptor (GLP-1R) agonists requires characterization of the central mechanisms that mediate both the food intake-suppressive and nausea/emesis effects of GLP-1.

Preliminary data in the rat indicate that GLP-1Rs in the locus coeruleus (LC), a source of norepinephrine (NE) output in the brain, are pharmacologically and physiologically relevant for the food intake and illness-like effects of GLP-1. Our data suggest that IP semaglutide in rats causes LC neural activation. However, the in vivo dynamics of semaglutide signaling are unknown, yet translationally valuable. Together with a Research Associate, Dr. Samantha Fortin, PURM students will prepare rats for in vivo fiber photometry recordings of calcium signaling in LC NE neurons. Students will learn stereotaxic injection of a cre-dependent virus (pAAV. Syn.Flex.GCamp6s. WPRE.SV40) expressing GCamp6s, a genetically encoded calcium indicator, into the LC of TH-cre rats (n=16/sex). Students will also learn to implant a fiber optic for fiber photometry over the LC. Following postoperative recovery, rats will be food deprived for 2 hrs, to ensure minimal endogenous GLP-1 signaling, and at dark cycle onset and calcium recordings will be made before, during, and 2 hrs after semaglutide (1,3,10,30 nmol/kg103) or vehicle treatment. Experiments will be conducted in a counterbalanced, within-subject design. Changes in fluorescence will be analyzed by comparing changes in calcium-dependent (490 nm) to calcium-independent (405 nm) signal, providing internal control for movement and bleaching artifacts. Following testing, brains will be removed for GCamp6s and fiber placement in the LC, defined by immunohistochemical detection of a marker of NE neurons, dopamine beta hydroxylase.

Animal care and handling, surgical manipulations, fiber photometry recordings, rodent sacrifice, tissue sectioning, immunohistochemistry and microscopy will all be skills learned by the PURM researchers over a 10-week period. Projects will be overseen by Dr. Hayes and the senior Hayes Lab Research Associate, Dr. Samantha Fortin.

PHILOSOPHY

Kok-Chor Tan

Justice in Wildlife Conservation

My project can be modified to accommodate remote activities if made necessary by University policy.

I am working on a book project entitled “Justice in Conservation: the ethics and politics of wildlife conservation”. The basic question of this project is this: How can we integrate our obligations to non-human nature and our obligations to fellow human beings?

Most of us believe that wildlife and environmental conservation is a moral imperative. It is also a given that we have obligations of social and global justice to each other. So, what should we do when there is a moral conflict between what we owe to non-human animals and what we owe to people? Are the goals of global poverty eradication and biodiversity conservation at odds? Is social justice in conservation achievable? Or are there genuine dilemmas of just conservation, and if so, can we find creative ways of circumventing them?

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The student researcher will assist me in the following ways: (i) help me with literature review (including locating recent articles in journals and books on environmental/animal ethics and biological conservation, and writing up brief summaries), and (ii) find real world examples of problems of conservation justice (through library and internet research). We will meet weekly or biweekly to discuss our results.

Through this project, the research assistant will learn how a philosophical book project is conceived, framed, and carried out and how to conduct philosophical research. The assistant will also learn about the philosophy of animal ethics and social justice. Meetings with me will be occasions for philosophical exchange and debate, and also be an opportunity for general mentoring.

The ideal research assistant will have done at least one course in normative philosophy (e.g., ethics, political philosophy). It will be a bonus if the assistant also has an interest in biological conservation.

PHYSICS & ASTRONOMY

James Aguirre

Metamaterial Antennas for Radio Cosmology

My project can be modified to accommodate remote activities if made necessary by University policy.

During the first billion years of the universe's history, hydrogen between galaxies marks the effects of stars and accreting black holes on their surroundings, and potentially can be used as a probe of cosmology and as a means of testing for new physics operating at this time. By permitting access to such a large range of cosmic time and the largest scales in the universe, maps of hydrogen emission are probes of a wide range of astrophysics and fundamental cosmological parameters, including the evolution of dark energy. In order to make measurements of the faint radio emission from hydrogen a reality, antenna technology must be engineered to a significantly higher standard than our current designs. This is because the ability to make the measurement is directly tied to our ability to calibrate our instrument, and this is fundamentally limited by the antenna's response to radiation in both frequency and angle, and how well we understand it.

This project will adapt ideas and designs from engineered metamaterials for antennas at millimeter wavelengths and scale them up in size by a 1000 to meter wavelengths, providing a prototype for building precisely specified antenna low-frequency antennas at scale. Undergraduate researchers will learn design, simulate, build and test several designs for metamaterial antennas using both printed circuit board (PCB) construction at intermediate frequencies and metal plate and carbon fiber construction at low frequencies. The simulations will be compared against reality by measurements using laboratory setup and measuring the response of the antenna to satellites and bright radio galaxies.

The opportunities afforded to undergraduates in my group on this project include learning valuable technical skills (electromagnetic simulation, mechanical drawing, printed circuit board layout, etc). They will also participate in writing up the results of the design and measurement for publication.

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Gary Bernstein

Dark Matter and Dim Planets

My project can be modified to accommodate remote activities if made necessary by University policy.

Summer undergraduate researchers will be able to choose from a variety of projects related to astronomical research in Professor Bernstein's group. Areas of work include processing astronomical sky images from large CCD cameras; searching for planets orbiting the Sun beyond Neptune; and understanding the nature of dark matter by measuring the distortions of images caused as the dark matter deflects light from distant galaxies. All projects will involve the processing of images and/or data using the Python programming environment. Students will also gain expertise in data analysis and statistics, as well as astronomical knowledge specific to their project.

Some projects may be done collaboratively with graduate students or postdoctoral researchers in the group.

Mark Devlin

Astrophysics and Cosmology with the Simons Observatory

My project is entirely in-person.

Our work involves building state of the art telescopes and cameras to make millimeter wave maps of the sky. We use these to study the evolution of the universe over cosmic time.

Our instruments are extremely sensitive. The detectors operate at just 0.1 degrees above absolute zero. Our current camera is the largest cryogenic receiver ever built. It cools 1000 kg of material to 4 Kelvin and 120 kg to 0.1 Kelvin. To ensure it is operating we need to utilize dozens of cryogenic thermometers which are very difficult to read out. The commercial options are too slow, too expensive, and can only read out a few at a time.

Our first project will build on a PURM award from two years ago. The student continued to work in our group from her first summer doing exceptional work developing a new thermometer readout system. Building on her work, a PURM student would understand the basics of our cryogenic receivers and construct a fully-functional cryogenic thermometer system. They would develop a software interface and then test the system in a ultra-low temperature dilution refrigerator. It is a fun project and will be a great use to our work.

Our second project involves designing a servo system to point a balloon-borne telescope payload for NASA. Our group has been flying high-altitude balloon payloads many years. A key component of these systems is pointing the telescope when hanging from a balloon. It is really challenging. A previous student designed and built a new pivot motor that connects the telescope to the balloon. We would like a new student to develop the hardware to control the pivot she built along with a flywheel to point

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the telescope using a test setup in the lab. It involves both hardware and software. It is a challenging project, but we have a lot of experience and can work with students to make sure they make progress.

Our students will work with graduate students and postdocs on their projects. We like to have several students at a time so no one is working alone and can bounce ideas off each other.

Marija Drndic

Studies and Applications of 2D Materials

My project is entirely in-person.

This is a 10-week project involving growth, transfer and studies of new 2D materials grown in the Drndic lab. The main focus of this project is on the growth, stacking, and atomic resolution characterization of novel atomically-thin ("2D") materials. Over the last several years, our lab has been focused on the advancement of 2D materials growth, efficient techniques for transferring the 2D flakes from one substrate to the other efficiently and in high yield, and the basic materials characterization including atomic force microscopy and state-of-the-art instrumentation (JEOL NEOARM at 30 kV, in collaboration with other Drndic lab members). The project will be carried out in our lab and also in the Singh Center, where we use the cleanroom and fabrication tools and microscopy.

In collaboration with mentors from the Drndic lab, the student will also learn about Raman and photoluminescence spectroscopy characterization of the 2D materials to study the bulk electronic, optical, and phononic details of the atomic lattice (single-layer and bilayer) and Moire superlattices (which are stacks of two or more layers of 2D materials, which we call 2D heterostructures).

In the first one-two weeks, the student will be trained to grow and transfer the 2D materials from one substrate to the other using microscopy and chemistry techniques, and characterize them with optical microscopy. Once the student shows that they have mastered these techniques, the student will assist other lab members in making the actual devices for physical measurements ongoing in the lab, including electrical measurements in the Drndic lab and transmission electron microscopy measurements in the Singh Center.

We will consider a successful outcome of the summer project if the student develops a good grasp on the practical aspects of working with 2D materials as well as a decent understanding on what 2D materials are and how they fit within the larger picture of materials that physicist's study, why they are interesting for basic physics studies and what is the range of their possible applications, as envisioned by the physics community at this point. The student will have a chance to participate in a world-class research, have a chance to contribute to new scientific results, be an author on new papers and also interact with other labs and collaborators at Penn with whom our lab collaborates. The student will have a chance to continue contributing beyond the summer.

Mentors will be graduate students: Rachael Keneipp, Jesse Elliott.

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Bhuvnesh Jain

Analysis of Dark Energy Survey Data on Galaxy Clusters and Cosmology

My project is entirely in-person.

My group is involved in analyzing data from the Dark Energy Survey, the largest survey of galaxies to date. We are interested in understanding how galaxies move and evolve in galaxy clusters. One of the primary tools used to map their mass distribution (which is mostly dark matter) is gravitational lensing, the magnification and shearing of background galaxy images by the cluster. We also study the large scale structure in the universe to address cosmological questions. Machine learning methods are an integral part of our analysis.

Students typically team up with one or two other students and interact with all members of my group, including graduate students and postdocs. The specific project they work on depends on timing, skill and interest. A strong background in calculus and familiarity with python programming is required.

Charlie Johnson

Nanoscale Sensor Concepts

My project can be modified to accommodate remote activities if made necessary by University policy.

Project 1: The goal of this project is to create a multiplexed array of DNA-graphene biosensors capable of detection of multiple biomarkers of HIV or other diseases in human bodily fluids (blood, urine, etc.) at clinically relevant levels. The student will be involved in all aspects of the project including graphene synthesis, sensor fabrication, and sensor array testing. Course work or experience in Physics, Chemistry, Bioengineering, or Computer Programming is desirable but not essential. This work will be done in collaboration with Prof David Issadore (Bioengineering).

Project 2: Metal dichalcogenides, a growing family of 3-atom thick materials, offer the prospect of device structures with enhanced performance compared to similar devices based on graphene, making them suitable for integration into new sensor concepts, wearable devices and systems, and many other applications. This project will explore the properties of devices based on two-dimensional materials with sizes as small as 20 nm to test their suitability for use in next generation computer chips and new types of biochemical sensors. Course work or experience in Physics or Chemistry is desirable but not essential.

Project 3: Topological physics can be engineered into any system described by waves, including quantum mechanical electron waves in materials, light waves (photons) in dielectric metamaterials, and sound waves (phonons) in mechanical metamaterials. This project will explore new concepts in “topological phononics” in the GHz regime based on samples nanofabricated in Penn’s Singh Center for Nanotechnology. This project could be experimental or computational in nature depending on student interest. Course work in Physics, Electrical Engineering, or Mechanical Engineering is desirable but not essential.

In each project, the student will be mentored by a postdoctoral fellow and a PhD student.

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Joseph Kroll

Ocean Acoustic Observatory for Fin and Blue Whales

My project can be modified to accommodate remote activities if made necessary by University policy.

New state-of-the art technology in processing acoustic signals makes it possible to locate and count endangered fin and blue whales over hundreds of kilometers from sounds recorded on 100 acoustic recorders on the continental shelf of the eastern US. Little is known of the temporal and spatial distributions of these whales, and even less about how their health may be affected by the booming offshore wind industry that will provide an enormous amount of clean electrical energy.

Sounds from these whales can be detected at 50 to 100 km as their loud low-frequency calls near 20 Hz travel through the ocean waters with little attenuation. The acoustic receivers will collect 1000 terabytes of digitized sounds per year requiring reliable automatic means to detect and preprocess whale calls prior to localization. Localization will be done using measurements of the time-differences of arrival of the sounds between pairs of receivers. The new technology makes it possible to generate very reliable confidence intervals of location.

Students will learn about sound propagation in the ocean, signal processing, methods for automating the preprocessing of data, and how to write high-quality re-usable software in the MATLAB programming language. It is anticipated the software will be used to locate these animals with real data later this year. The project will be supervised by Dr. John Spiesberger (Dept. of Earth and Environmental Science) and Professor Joseph Kroll (Dept. of Physics and Astronomy). For more information contact Dr. Spiesberger at johnsr@sas.upenn.edu and prospective students may wish to look at https://www.scientificinnov.com/

Elliot Lipeles

Particle Physics with the Large Hadron Collider

My project can be completed entirely remotely.

The ATLAS experiment at the Large Hadron Collider collects and analyzes data on proton-proton collisions at extremely high energy to search for new fundamental particles or anomalous behavior of the known particles. The experiment is run by a large international collaboration. Our group at Penn contributes to this collaboration through the development of advanced on-detector electronics, cutting-edge computing, and sophisticated data analysis.

There are several possible roles within the group, ranging from technical electronics work related to building the next-generation detectors which are currently under construction, to writing and simulating algorithms for the computing challenge, to data analysis of existing data. This combined chain of tasks is all aimed at testing many different proposed or possible new particle scenarios. The tools used include C++ and python coding, various dedicated analysis tools, and machine learning. There will be opportunities to learn or apply some of these skills. There are many possible individual summer projects which will be matched to students' experience and interests.

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The Penn group is a vibrant and diverse collaboration of four faculty and several postdocs and graduate students. We have regular weekly meetings where undergraduates can see the scope and range of topics pursued within the group. There may also be opportunities to present work to members of the international collaboration.

Mathew Madhavacheril

Discovering Cosmological Relations with Symbolic Machine Learning

My project can be modified to accommodate remote activities if made necessary by University policy.

Cosmological observables like the cosmic microwave background, gravitational lensing and the clustering of galaxies are informative because they tell us about important properties of the universe such as its age, geometry, expansion and composition. The observables however do not map neatly to these properties; they constrain combinations of the properties. In this project, we will use recently developed tools in machine learning that enable automated symbolic regression in order to map out combinations of properties of the universe that are constrained by various observables. This will allow us to propose new ways to combine the observables to maximally extract information from upcoming large data-sets.

Through this project, the mentee will learn how to make predictions for cosmological observables using existing codes, how to do Bayesian inference of cosmic properties using such predictions and apply cutting-edge methods in machine learning to discover new relations between the observables and the cosmic properties.

Arnold Mathijssen

Ultra-fast Communication in Intelligent Living Systems

My project can be modified to accommodate remote activities if made necessary by University policy.

Collecting and exchanging signals is vital in biology, but how is this information computed and recollected? And what sets the physical limits of rapid communication in living systems? These fundamental questions in biology also lie at the heart of modern material science and medicine: How can rapidly adaptive materials be made with basic active components?

In this project, we will explore how individual cells can communicate with each other within millisecond speeds to collectively outsmart predators using community intelligence. We recently discovered (Mathijssen et al., Nature, 2019) the existence of hydrodynamic trigger waves in cellular colonies of S. Ambiguum at speeds hundreds of times faster than their swimming speed, presenting an exciting new mechanism for intercellular communication at ultrafast scales. In the blink of an eye, these microbes create waves in the water that other cells can sense and retransmit. We will explore how quickly these cells can move safely, how much information these signals can carry, and how these interactions can perform simple calculations like 1+1=2.

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That premise opens up a whole range of possibilities. By combining elementary computations, higher-level logic operations can be performed that could provide feedback and enable collective information processing. Understanding how biological systems do calculations may also allow us to build intelligent materials or nonelectrical microrobots for applications in advanced medical procedures and biotechnology.

Students will have the opportunity to learn techniques in experimental and/or theoretical biophysics, such as high-speed microscopy, information theory, fluid mechanics, and microbiology. Projects can be tailored according to specific individual interests.

Christopher Mauger

Cutting-Edge Electronics for Extreme Environments in Experimental Particle Physics

My project is entirely in-person.

The experimental particle physics group in the Department of Physics and Astronomy at Penn (Professors Mauger, Klein, Kroll, Lipeles, Rankin and Thomson) participates in several large experimental collaborations (ATLAS, Dune, T2K, SNO+) studying the fundamental constituents of matter and their interactions. The group's technical contributions to these experiments are made possible by our internationally-renowned instrumentation group headed by Mr. F. Mitchell Newcomer and Mr. Paul Keener. This group designs high-speed analog and digital electronics, including application specific integrated circuits (ASICs), that process and collect the electronic signals produced in particle physics detectors. These on-detector electronics often have to function in high-radiation or very cold environments that lie outside the guaranteed operating points of commercial electronics, motivating the design of custom electronics. The group also designs the systems of electronics that are used to collect the data (DAQ) from these on-detector electronics. In addition to projects for existing experiments, there are also projects aimed at research and development of new signal processing techniques for future experiments.

Many undergraduates have had the opportunity to work with this group. They learn about analog and digital electronics, signal processing, ASICs, designing printed circuit boards and programming field-programmable gate arrays (FPGAs). Activities can include design, construction and testing of circuits as well as techniques in circuit simulation. No prior experience is required, and a strong sense of curiosity is beneficial. Some basic knowledge of electronics such as the material covered in Physics 0151 or 0171 would be helpful as well as knowledge of programming techniques and knowledge of programming languages such as Python. Day to day activities will be overseen by one of the members of the instrumentation group and an associated faculty member. For more information contact Joseph Kroll (kroll@hep.upenn.edu).

Dylan Rankin

Accelerating Discovery at the Large Hadron Collider and Beyond

My project can be modified to accommodate remote activities if made necessary by University policy.

Experimental particle physics studies the interactions between particles in order to better understand the fundamental nature of our universe. At the Large Hadron Collider (LHC) at CERN this involves

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accelerating protons to a speed of 99.9999991% the speed of light and then colliding these protons at extremely high energies. The ATLAS detector is one particular detector build at CERN to capture and measure the properties of the particles produced in these collisions. With the detector we have collected a huge amount of data from the results of these collisions and are using it to search for new particles. While the Standard Model (SM) of particle physics is able to describe the vast majority of the collisions with remarkable accuracy and precision, we know that it is incomplete. In addition to more theoretical questions about the naturalness of the SM, it does not contain a description of dark matter. The discovery of new particles at the LHC could help us to answer key questions about our universe.

Possible projects with the Penn ATLAS group include helping to understand the feasibility of searches for new particles, applying advanced machine learning techniques to data analysis efforts, studying the possibilities for fast machine learning inference on field programmable gate arrays and GPUs, and performing studies to inform the design of future detector upgrades and collider experiments. More information about the Penn ATLAS group can be found here https://web.sas.upenn.edu/pennatlas/.

Potential skills used include: Python, C++, Unix, machine learning, data science, high level synthesis, presentations, particle physics

Masao Sako

Cosmology with the Roman Space Telescope

My project can be completed entirely remotely.

The Nancy Grace Roman Space Telescope (Roman) is NASA's next large flagship mission that will conduct the next-generation experiment in cosmological measurements. One of the main goals is to use Type Ia supernovae to map out the expansion history of the Universe between now and 8 billion years ago. This research will involve preparatory work to help guide the mission including forecasts to develop observing strategies, simulations, and software development to perform the analysis. We will be making use of data from existing space telescopes including Hubble (HST) and James Webb (JWST).

Robyn Sanderson

Testing Dark Matter Theories with Galaxy Interactions

My project can be modified to accommodate remote activities if made necessary by University policy.

Dark matter is the most abundant material in the Universe; a typical galaxy like the Milky Way forms inside a blob of dark matter called a "halo" that is ten times more massive than the visible galaxy. Since we have not yet detected a dark matter particle directly, some of our best constrains on its properties come via its gravitational influence on the stars and gas in galaxies. Our group uses state-of-the-art simulations of Milky-Way-like galaxies performed on supercomputers to propose new tests, and interpret potential signatures, of different dark matter models.

Depending on their specific project, students will gain skills in: coding in Python and Jupyter, reading and analyzing simulated and real astronomical data, using the Linux operating system, the bash shell, or a

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computing cluster, making and interpreting plots and images, and characterizing data using machine learning.

Some examples of possible projects for this year:

1) Quantifying velocity misalignments along simulated tidal streams Tidal streams are long tails of stars spanning the Galaxy that are created when the Milky Way's tidal forces rip apart smaller galaxies and globular clusters. Since the stars in a stream share similar orbits, they are useful for mapping the gravitational force exerted on them by the Milky Way. Over 100 tidal streams around the Milky Way have been discovered, many of which exhibit a peculiar property: the stream star velocity vectors significantly misalign with the stream's track through space, contrary to what is expected if the Milky Way's mass distribution is relatively constant in time. The misalignments could be induced by interactions between tidal streams and the Large Magellanic Cloud, the Milky Way's most massive satellite, if it also possesses a significant dark matter component. Students will work with doctoral candidate Nondh Panithanpaisal to investigate whether simulated tidal streams also show these misalignments, what causes them, and how their degree changes over time.

2) Distinguishing dark matter self-interactions with tidal streams The simplest viable models of "cold" dark matter posit no interactions between dark matter particles, but some observations appear to agree better with a "self-interacting" model. This type of model produces galaxies with a different inner structure, and hence could change how tidal streams form. Students will work with doctoral candidate Arpit Arora and Dr. Danny Horta to compare the properties of tidal streams around Milky Way-like galaxies simulated in both cold and self-interacting dark matter.

Evelyn Thomson

Experimental Particle Physics at the High Energy Frontier

My project is entirely in-person.

Experimental particle physics seeks to understand the fundamental particles and forces in the Universe. With the ATLAS experiment at CERN, a huge amount of data is available for analysis to search for new particles. Possible projects based at Penn include designing searches for new particles, applying machine learning to improve searches or sharpen the resolution of calibrations, and developing outreach materials for local high schools and science festivals. Skills: Python, C++, Unix, presentations, particle physics. Additional mentors include postdoctoral fellow Dr. Michael Hank and graduate students James Heinlein, Lauren Osojnak, and Bobby McGovern. The ATLAS group at Penn has four faculty, so please also check out the possible projects under the supervision of Professor Dylan Rankin, Elliot Lipeles, and Joe Kroll. More information about the Penn ATLAS group can be found here https://web.sas.upenn.edu/pennatlas/. See in particular the post on the US ATLAS SUPER symposium for a sense of the wide range of possible undergraduate research projects using ATLAS data.

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Liang Wu

A New Generation of More Efficient Solar Cells and Faster Memory Devices Based on Topological Materials

My project is entirely in-person.

At the moment, we mainly use silicon solar cells to convert sun light into electric current and the efficiency is stuck at 20%. The community has been trying to increase the efficiency in the past few decades, for example, by using organic materials, but not succeeded. Therefore, one needs to search for new classes of materials. Recently, theorists proposed that topological materials could have higher conversion efficiency by shining visible light. Now let us jump into a different topic by shining an invisible ultrafast light on the same class of materials. The current CPU of a computer runs at gigahertz. (1 gigahertz basically mean that a switch is turned on and off 1,000,000,000 times per second). Can we increase the running speed by a thousand times? The answer is also yes if we shine ultrafast light pulses on topological materials.

What are topological materials? Topological materials are a new class of materials that have robust properties even if one twists or scratches the materials. The word of "topological" basically means "super-robust". They were first predicted by two Penn theorists, Prof. Charlie Kane and Prof. Eugene Mele in 2005 and realized in experiments recently. They offer the new opportunities for faster memory devices, more-efficient solar cells and even quantum computers.

In the first project, you will first fabricate devices made out of topological materials in the Singh center and add electrical contacts. Then you will shine visible light and measure the photocurrent to test the conversion efficiency. In the second project, in order to switch the device from on to off state 1000 times than gigahertz, you will shine femto-second (0.000000000000001 second) invisible laser pulse to switch between on and off state. Students could either work on one subject depending on the interests or two projects if time permits. If you want to know more about our research, this article in Penn Today is good resource. https://penntoday.upenn.edu/news/bringing-ideas-life-through-experimentalphysics?utm_source=Primary&utm_campaign=f21bde7544

POLITICAL SCIENCE

Julia Gray

International Organizations from the Inside Out

My project can be completed entirely remotely.

The biggest issues of our time -- the climate emergency, conflict prevention, economic exchange -- require cooperation between countries. But how exactly does this cooperation work, beyond the signing of agreements and the founding of international organizations (IOs)? This project consists of two related

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streams. The first involves compiling qualitative timelines of IO activities. Students will conduct in-depth research, based on news sources and on the daily activities -- including meetings, discussions of initiatives, achievements, and setbacks -- of IOs around the globe throughout history, including the UN agencies as well as regional organizations such as NAFTA and the European Union. These timelines will shed light on the way that IOs work, and the factors that lead to their survival and resilience. Requirements include interest in global and regional cooperation; language ability (particularly Arabic and Russian) is a plus; no particular technical background required.

In the second stream, students will examine the way in which news media cover these organizations, with a particular focus on historical black newspapers in the United States. International organizations serve different purposes for different audiences, and as such, different media describe these IOs in different ways; preliminary evidence shows that black newspapers tended to report on these IOs in terms of representation and attention to global black issues. Students working on this aspect of the project should be familiar with data analytics and basic programming in R. We will work with basic text analytic and natural language processing techniques to identify the entities, topics, and concepts used in different media coverage of IOs.

I particularly welcome the opportunity to work with students who are first generation, highly aided, and/or underrepresented minorities.

Daniel Hopkins

Political Nationalization in the U.S. and Other High- and Middle-Income Democracies

My project can be modified to accommodate remote activities if made necessary by University policy.

The United States and select other high- and middle-income democracies (including the United Kingdom and Spain) have seen political convulsions in recent years, while other countries' political systems (including Canada) have seen more muted shifts. In the U.S., one emerging political challenge has been related to the nationalization of politics, meaning the increasing extent to which voters focus on federal politics in Washington, D.C. instead of state and local politics. But are such nationalizing political trends evident in other high- or middle-income democracies? If so, what are the causes and consequences of nationalization? One hypothesis is that nationalization is driven by changes in the news media landscape, as people rely more on the internet and cable television and less on newspapers to learn about politics.

This research project involves the analysis of elections, survey data, and media content from a range of countries, including the U.S., the U.K., Canada, Germany, Denmark, Spain, Sweden, Switzerland, Argentina, and Mexico, among others. PURM students will be involved in many aspects of the project, including encoding and analyzing survey or election data; editing scholarly manuscripts; identifying research on specific countries in English and other languages (where applicable); identifying relevant articles in domestic and foreign newspapers, and translation (where applicable). Experience with R and English fluency required; knowledge of political science, other social sciences, Python, French, German, and/or Spanish helpful but not required.

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Melissa Lee

International Statebuilding and Domestic Politics: Violence and Governance Reform

My project can be completed entirely remotely.

In August 2021, the Taliban captured Kabul and became the new rulers of Afghanistan. The sudden collapse of the U.S.-backed government, twenty years after the American invasion to topple the Taliban for its support of the terrorist group al-Qaeda, was a dramatic capstone to failed twenty-year international effort to build a stable and effective state in Afghanistan.

Why do international statebuilding missions fail? This project will investigate the relationship between international statebuilding and domestic political order. It will examine how international actors pressure domestic elites in host countries to adopt reforms and how domestic elites subvert and evade that pressure while capturing external resources like foreign aid for personal or political gain. It seeks to move beyond the binaries of "success" and "failure" by exploring the various ways in domestic political orders evolve and change in response to external intervention, focusing in particular on the nexus between violence and governance reform. The project will examine multiple post-Cold War cases of international statebuilding, including but not limited to Afghanistan. The PURM mentee will work on one or more components of the overall project.

Professor Lee is seeking students interested in studying a policy-relevant topic from a scholarly perspective. Researchers will have the opportunity to gain experience with the following skills: identifying and summarizing scholarly books and articles; working with large quantitative datasets; working with primary source documents; and managing bibliographic data and citations. Interest in foreign aid, conflict and peace, the rule of law, and developing countries is helpful.

Erik Wibbels

Land, Refugees and Conflict in Uganda

My project can be modified to accommodate remote activities if made necessary by University policy.

PDRI-DevLab is collaborating with local and international institutions to reduce the incidence of conflict in Uganda through two related projects. The first project (with the World Bank) evaluates the Improvement of Land Governance Project in (ILGU). ILGU is designed to improve land governance and reduce conflict over 'mailo' land. Mailo is a type of customary land tenure that was created during the colonial period, creating landlords and tenants. Mailo lands are prone to tenure insecurity and conflict, which are exacerbated by rising land values. Since 2017, ILGU has produced innovative land inventories, mediated conflict, and facilitated agreements with landlords. Our research investigates the impact of ILGU on tenure security, land conflict, and investment by smallholders. Results will inform policymakers on the development of Uganda's National Land Policy.

One major source of pressure on land and, thereby, of conflict in Uganda, is its 1.4 million refugees. Thus, our second project tests an innovative approach to reducing prejudice against refugees. Previous research shows that the arrival of large numbers of refugees can be a source of tensions with host populations. Our research examines the effectiveness of using radio programs as a method for reducing

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hostility of host communities towards refugees. The project tests the impact of, a humanizing, character-based radio soap opera on host citizen attitudes. Our approach goes well beyond previous research with a multi-episode story, building on evidence that longer story arcs can have stronger effects by "transporting" listeners into a protagonist's experience. Thus, this cutting-edge study will provide original evidence on the effectiveness of real world, parasocial/vicarious contact as a scalable approach to prejudice reduction.

Students will be exposed to all aspects of the research process. This will include developing survey instruments, developing original radio content, conducting realtime data quality checks, data cleaning, and helping to draft research reports. These positions require strong writing skills and would benefit from a basic level of experience with R or Stata.

These projects are interdisciplinary in nature, fusing elements of computer science, economics, public policy, and media studies. The land project utilizes geospatial analytics that are a novel means of assessing the impacts of land policies. The anti-prejudice project involves a new approach to using entertainment to reduce out-group hate. Thus, students will do applied research that bridges academia and policymaking while developing skills relevant to industry, policy, and academia.

Other mentoring faculty: Heather Huntington and Guy Grossman.

PSYCHOLOGY

Delphine Dahan

Monologues Are Hard, Dialogues Are Easier: Collaboration in Unscripted Conversations

My project can be modified to accommodate remote activities if made necessary by University policy.

Through the use of language, people can coordinate their actions in order to accomplish things together, such as letting a friend know where to meet them. But why is it harder to do so by leaving a message on their voicemail than by talking to them on the phone? Some scholars have argued that what people do when they interact with each other in real time, through dialogues as in conversations, is quite different from what they must do in non-interactive situations: Conversational partners actively collaborate to establish that, for each utterance, what the speaker means by it is what their addressee takes them to mean. Such collaboration takes many forms. For instance, when addressees feel confident to have succeeded, they can indicate so with nods or 'uh uhm', brief signals that assert their understanding. When, on the other hand, their confidence in having understood is lower, they may seek to confirm their understanding by displaying it (e.g., offering a reformulation for the original speaker to evaluate in turn), a more effortful but effective way to reach the mutual belief of understanding. When people communicate in non-interactive situations, on the other hand, such collaboration is no longer possible, and people must formulate or interpret utterances based solely on their best guess of what the other may mean or understand, an effortful and error-prone process.

Research in my lab has examined multiple aspects of such collaboration by collecting and analyzing the verbal behavior of participants engaged into goal-oriented tasks, such as a matching game. Students interested in joining the lab will be involved in all stages of the research, such as scheduling participants and recording their conversations, as well as annotating the language they used to accomplish the task.

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Students will work closely with the Principal Investigator and the research team, with regular meetings to discuss important work from the literature as well as progress of our own research, its findings and their implications. Along the way, students will learn to write simple scripts to automatize the coding and analysis of linguistic data.

Loretta Flanagan-Cato

Community Engagement Neuroscience

Second-year only

My project can be modified to accommodate remote activities if made necessary by University policy. Mentoring of students for this project will be done by myself, Lori Flanagan-Cato.

In the past few years, in the ABCS course "Everyday Neuroscience," Penn students work with local high school students to support basic science learning. This course has demonstrated benefits for Penn students, including self-confidence, improved mood, and reduced inter-group anxiety. Much less is known about the possible benefits for the high school students. Therefore, the goal of this project is to examine surveys and academic records from the high school students to assess the possible academic benefits of the course for them.

The participating PURM student(s) will received training regarding working with human data. They will also use Excel and R to manage data sets and perform statistics. We will have a weekly journal club to develop skills in reading relevant scientific literature. Participating students will have an opportunity to talk directly with the high school students in focus groups, as well as join in conversations with their teachers, to gather qualitative data. In this way, students will gain experience and skills needed for working closely with a community partner on a research project.

Sara Jaffee

Evaluation of the PHLHousing+ Program

My project can be modified to accommodate remote activities if made necessary by University policy.

PHLHousing+ is a program administered by the Philadelphia Housing Development Corporation that provides monthly cash assistance to 300 low-income families who were randomly selected from the Philadelphia Housing Authority (PHA) wait-lists. Evaluation of PHLHousing+ involves the comparison of families in the cash assistance group to two other groups, also selected at random from PHA wait-lists: (1) 300 low-income families who receive housing choice vouchers and (2) 600 families who remain on the wait-lists. All three groups are surveyed every six months for 2.5 years. Student research assistants will be responsible for monitoring survey completion, contacting families, data cleaning, and the design of surveys and codebooks for one-on-one qualitative interviews (as well recruitment for qualitative interviews). Undergraduate RAs will work closely with the study project coordinator and post-doc and will participate in weekly team meetings with the PI and the rest of the study team.

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Martin Seligman

Psychological Rest and Restoration

My project can be modified to accommodate remote activities if made necessary by University policy.

There is no dearth of academic research, as well as popular work, that stresses the importance of taking time to rest. While it is widely agreed upon that we need to rest, both physically and mentally, there is no consensus on how we should rest. Are we mentally restored by tuning-out to a show or movie? Does fun restore us; do activities we enjoy? Perhaps, counterintuitively, we are restored by expending effort, such as by exercising or playing a technical piece of music. Our lab is currently investigating these and related questions as part of our endeavor to understand the attributes, antecedents, and individual differences associated with psychological restoration.

Undergraduate researchers will be involved in all parts of the research process, and will work closely with lab members to ensure that ample opportunities are given for didactic exchange. Undergraduates will participate in reviewing the literature relevant to rest and restoration, refining theory and generating hypotheses, study design, data collection and analysis, and presentation of findings. Students will work closely with Noah Love, Prof. Martin Seligman's research coordinator, with oversight from Prof. Seligman.

Larry Silver

The Arts, Humanities, and Human Flourishing

My project can be modified to accommodate remote activities if made necessary by University policy.

The arts and humanities (A&H)--collectively referred to as culture–are critical for human flourishing and play a central role in the education of children, the leisure time of adults, and the cohesion of communities, nations, and society at large. Yet we have little scientific knowledge about the relationship between cultural engagement and human flourishing. This research opportunity allows for participation in two research projects depending on student interests.

Project 1: Music has the power to transform us: It can leave us speechless and in awe, inspire deep reflection about our lives, and provide us with shared experiences that bridge divides and foster positive relationships and flourishing communities. What is less clear, however, is how we can tap into this transformative power to improve flourishing on a larger scale. In this project, students will have the opportunity to learn about existing scientific research on the connection between music and flourishing, and to work with data examining how flourishing in the workplace is connected to music listening behaviors and preferences tracked through Spotify. This work will use new tools available to understand how musical features (e.g., tempo, energy) shape our flourishing at work.

Project 2: Engaging in A&H breathes new life into our everyday existence. For Black Americans, there is a rich cultural history of hip-hop, dance, film, and literature that have increased collective and individual well-being. Recently, attention has focused on the ability of A&H to increase flourishing; however, this work has not focused on how A&H engagement varies by race and culture. In this project, students will explore systemic and cultural barriers to participation in A&H in Black Americans. Additionally, we will

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explore art forms Black Americans participate in and the well-being impacts of those experiences. This survey will allow us to better understand how A&H contributes to flourishing in multi-cultural groups and better develop culturally-tailored programs to improve flourishing through A&H.

Students will gain expertise in the science of flourishing, participate in a range of research activities (e.g., survey development, participant recruitment) and develop generalizable professional skills, including data literacy (through assisting in statistical analyses) and scientific communication (through writing about project findings). Mentorship will be provided by interdisciplinary researchers with expertise in both A&H and psychology, including Humanities and Human Flourishing Director, Dr. James Pawelski, Associate Director of Research, Dr. Katherine Cotter, and Postdoctoral Fellow, Dr. Christa Mahlobo.

Alan Stocker

Testing AI Models of Human Visual Working Memory

Second-year only
My project can be modified to accommodate remote activities if made necessary by University policy.

Our ability to faithfully maintain visual information in memory is limited even for short memory durations (i.e., in visual working memory). Visual working memory (vWM) not only lacks accuracy but also distorts low-level feature information, which can lead to characteristic biases during memory recall. Our current understanding of these distortions and biases is limited, and no theoretical framework exists that can accurately account for experimental data. The goal of the proposed project is to explore a particular class of AI models (auto-encoders) and test whether they are suited as a basic description of vWM. The project will consist of first exploring the suitability of using auto-encoders to model vWM task via simulation. In a second phase, the model then should be compared and fit to actual human memory data that has been collected in the lab.

The ideal student has a good computational/mathematical background, and some experience with modern AI models, ideally including auto-encoders.

Daniel Swingley

Infant Learning of Language's Words and Sounds

My project can be modified to accommodate remote activities if made necessary by University policy.

How do babies learn their language? In our research we have found that infants learn to understand words, and to identify their language's speech sounds, during the first year. How do they do that? This project investigates early learning in two different ways:

(1) by carefully analyzing maternal speech to babies in English, Mandarin, French, or perhaps other languages (depending on the student's skills, and what corpora are available). First we will measure characteristics of the sounds in the language, and then we will apply computational models of category learning, or we will get native speakers to rate or identify words or sounds. By understanding which

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parts of parental speech are easier to learn from, we can understand better how infants begin to make sense of it.

In this branch of the project, the student will learn skills of phonetic measurement and computational analysis, some specific (e.g., speech software) and some quite general (unix scripting, R). Students who are inclined toward computation may additionally learn some speech-technology skills, depending on how the project goes.

(2) by testing infants in experiments, we can learn some of the details of what infants know and when they know it! For example, when we learned our native language, we learned that certain sounds "count" as the same. For example, the t in tip, stop, and hat is one thing to us, and we know how to make that sound too, in all different contexts.

How is this learned? Are these sounds "the same" because to some extent they sound the same, because we say them using similar gestures of the mouth and vocal tract, or because we learned to read? No-one knows. But we can find out, using experiments where we play speech samples to babies, and evaluate how they categorize sounds.

This work will help us to understand language development. Projects of this sort cannot be done in just one summer, but students working on these experiments still make a real contribution!

We'll discuss which branch of the project will work best, and go from there. The student will participate in the babylab's research meetings and learn about a range of diverse projects concerning language acquisition. The results of the study will be presented at a professional research conference.

Prior coursework in cognitive psychology / cognitive science, linguistics, or computer science would be helpful.

Rebecca Waller

The Promoting Empathy and Affiliation in Relationships (PEAR) Study

My project is entirely in-person.

Children with callous-unemotional (CU) traits are at high lifetime risk of antisocial behavior. CU traits are known to be heritable, which is thought to manifest as low affiliation (i.e., deficient motivation for social bonding) and fearlessness (i.e., reduced sensitivity threat). Parenting practices (e.g., harshness and low warmth) also predict risk for CU traits across childhood. However, no work in early childhood has identified attentional or physiological markers of low affiliation and fearlessness nor examined associations with later CU traits. Moreover, no studies have tested whether parenting practices are underpinned by low affiliation or fearlessness that is shared by parents, which could shape parent-child interactions and exacerbate risk for CU traits. Addressing these questions can inform knowledge of how CU traits develop and isolate novel parent and child targets for future specialized treatments for CU traits. The Promoting Empathy and Affiliation in Relationships (PEAR) study is a new NIMH-funded study that seeks to establish risk factors for CU traits in 3-6-year old children. The PEAR study will recruit 500 children and parents at ages 3-4 (time 1) and ages 5-6 (time 2), with data collection beginning in early 2023. Measures will include parent-reported questionnaires, computer tasks, and observation,

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combined with eye-tracking and physiological assessments, to facilitate a multi-method investigation of low affiliation, fearlessness, and parenting practices as risk factors for CU traits.

Undergraduate research assistants will be fully trained on the PEAR study protocol throughout the summer and fall of 2023. During lab assessments, parents complete questionnaire measures and children and parents both complete observational tasks, computer tasks, and eye-tracking tasks paired with continuous collection of physiological data. Undergraduate research assistants will be trained to work with families and implement all our study protocols, including: (1) Multiple pan-tilt-zoom cameras and microphones integrated with Noldus Observer Software to allow for synchronized data collection; (2) Biopac MP160 data acquisition and analysis systems with AcqKnowledge 5 software, allowing physiological data from parents and children to be collected and synchronized with video recordings; (3) Wireless BioNomadix modules to collect parents' and children's electrocardiogram (ECG) and respiration and electrodermal (EDA) data; (4) Computer tasks built using SR Research Experiment Builder or Psychopy; and (5) Eye-tracking data using the SR Research Eyelink 1000 Plus and Pupil Invisible mobile eye-tracking glasses from Pupil Labs. Other mentors on the project include senior grad students and post-docs in the EDEN Lab.

RELIGIOUS STUDIES

Jolyon Thomas

Religion and the Politics of Public Education in Japan and the United States

My project can be modified to accommodate remote activities if made necessary by University policy.

This research project involves a final round of data collection for a book in progress. The book is fully drafted, but certain sections need to be further substantiated with evidence from archives in Japan and the United States.

Research will generally be conducted in person with material documents such as special interest magazines (e.g., teachers' union magazines, magazines of religious groups), government documents, and historical newspapers.

I can hire up to two research assistants. I have strong preference for at least one assistant to be a native speaker of Japanese, especially someone who will be resident in Japan during for at least part of the summer. I may be able to hire a second assistant to help with archival research in Van Pelt library and other local and regional archives.

Research tasks may involve:

- Visiting archives in Japan (e.g., the National Diet Library) and/or the U.S. (e.g., the National Archives and Records Administration II in College Park, Maryland)
- Reading and summarizing magazine articles in Japanese and English -Offering commentary on the book manuscript as a "sensitivity reader"

Students who work on this project will:

- learn how to use finding aids and databases to locate relevant material.

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- learn how to organize bibliographic information using Zotero software.
- learn how to organize archival photographs with relevant metadata using Tropy software.
- learn how to write short summaries of articles.
- become acquainted with the late stages of the book-writing process, including crafting responses to external readers' reports.
- get credit in the Acknowledgments section of the published book.

Beyond CURF funding, I may be able to offset some DOMESTIC travel expenses in cases where travel to regional archives is necessary. This will be determined on an ad hoc basis and must happen strictly according to university rules.

Students who participate in this project must be highly motivated and capable of working with minimal supervision. Due to my research travel plans, for large portions of the summer I will be away from campus at archives in Japan and the western US. Meetings will be infrequent and will often be conducted by Zoom rather than in-person. That said, students who work on the project will receive direct training at a series of in-person meetings in the late spring/early summer.

SOCIOLOGY

Irma Elo

Migration from Ghana to the United States and Cognitive Aging in Chile

My project can be modified to accommodate remote activities if made necessary by University policy.

The student RA would work as an integral part of two ongoing research projects and will have opportunities to interact closely with research teams composed of faculty and graduate students at the University of Pennsylvania, colleagues at Duke University and the University of Southern California as well as colleagues at the Regional Institute of Population Studies at the University of Ghana and the Catholic University of Chile. The first project is a pilot study involving new data collection on migration from Ghana to the U.S. to fill existing gaps in knowledge and to provide data for a subsequent NIH grant application. Sub-Saharan Africans represent an important and rapidly growing share of foreign-born blacks in the US and Ghanaians represent the third largest group of Black African immigrants residing in the US.The second project is an ongoing study of cognitive aging in Chile. The comparative study of cognitive aging in several middle-, low-, and high-income countries is high priority for the National Institute of Aging. We work in close collaboration with a number of national and international colleagues on this topic. We expect that the student RA would work approximately half time over the course of the summer on each of these projects. The student would learn how to develop questionnaires, conduct literature reviews, learn data management, and data analyses.

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Paula Fomby

Where Does the Time Go? Parents' Leisure Time and Time with Children, 1965-2018

My project can be completed entirely remotely.

This project documents trends since 1965 in how American parents use their leisure time. The focus is on who parents spend their time with. PURM mentees will create data files and perform descriptive analysis to answer two research questions. First, how much of parents' leisure time is spent with children, compared to time alone, with a spouse or partner, or with friends and family outside of the household? Second, when parents are with children, how, where, and with whom do they spend their time together? We'll consider trends for the US population overall and by demographic characteristics including parent gender, marital status, racial and Hispanic ethnic identity, and educational attainment.

This project uses time diary data from representative samples of the US population. Time diaries provide a standardized record of how a person used their time on the previous day. Mentees will learn techniques in survey data management, programming to generate descriptive statistics like frequencies and means, and data visualization (graphs) in Stata and R. Mentees will work together to construct a common data set to work from and then each mentee will be assigned to work on one research question.

Lance Freeman

Understanding Neighborhood Change in the Early 20th Century

My project can be completed entirely remotely.

The undergraduate research mentee will collaborate as a research assistant for a study of neighborhood change in early 20th century American cities. The project will develop a novel approach to examining neighborhood change by making use of pre-World War Two census data that allow respondents' names and addresses to be identified. When combined with the respondent's age, gender, place of birth and race/ethnicity, it becomes possible to reliably trace individuals over time. This novel methodology will provide a new lens with which to understand neighborhood change as most such studies rely on aggregate level data to infer change in the composition of a neighborhood over time. With this project we can examine not only aggregate level changes but the specific individuals that were components of any change.

The Undergraduate Research mentee will learn to use the Stata statistical software program to execute and refine algorithms that have been developed to match individuals who appear in the census over time. The research assistant will also develop and refine skills in coding, demographic analysis, and methods for refining algorithms.

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Emily Hannum

Climate Risk, Pollution, and Childhood Inequalities in Low- and Middle-income Countries

Second-year only

My project can be completed entirely remotely.

Two summer activity alternatives are possible, depending on student interests: 1) For students with a substantive interest in the topic, the activity would be developing desk reviews of country- and region-specific research and data on climate, pollution, and child welfare. 2) For students with data science interests and skills, activities would include supporting data preparation and analysis for the project.

Concern is rapidly increasing about accelerating climate changes and their implications for the health and welfare of children. In a recent press release, the United Nations Children's Fund (UNICEF) estimates that approximately one billion children are at extremely high risk of experiencing impacts of the climate crisis; many will experience multiple climate shocks combined with poor essential services such as water, sanitation and healthcare. At the same time, while air pollution is decreasing in many high-income countries and some middle-income countries, it remains very high in large areas of low- and middle-income countries in which the majority of the world's children reside. Children from poorer countries and from economically and socially marginalized groups within countries may be particularly vulnerable to climatic and environmental hazards. To date, there has not been a global study of the degree to which the ill effects of extreme climate and air pollution exposures are borne differently by children according to individual, family, and overall country characteristics.

Focusing on low- and middle-income countries, this project advances and disseminates scientific knowledge about how global childhood inequalities condition both the risks of experiencing climate hazards and extreme air pollution and the implications, once exposed. Project partners include faculty members and students at the University of Pennsylvania and the University of Houston and researchers at the Asian Development Bank, the Inter-American Development Bank, the Regional Institute for Population Studies in Ghana, UNICEF, and the World Bank. These research partnerships will inform analyses and provide direct support for dissemination of findings to stakeholders in a position to support interventions or advise on policy. In addition, these collaborations will provide global engagement and training opportunities to a diverse group of students and emerging scholars.

Doctoral students Nazar Khalid, Xiuqi Yang, and Kai Feng are also part of the team. For more information, visit: https://web.sas.upenn.edu/climate-environment-children/comparative/

Dorothy Roberts

The Social Experience and Science of Interracial Marriage in Chicago, 1937-1967

My project can be completed entirely remotely.

I am conducting an interdisciplinary book project on interracial marriages in Chicago from 1937 to 1967. I inherited from my father, an anthropologist at Roosevelt University, numerous boxes containing original interviews he conducted in Chicago during this period with hundreds of interracial couples, as well as notes, articles, and other related materials. I am using this archive to write a book exploring the

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role interracial marriage played in the changing racial politics in Chicago from the perspectives of the couples and of social scientists, like my father, who were studying interracial marriage. How did interracial couples and social scientists understand these marriages in relation to Chicago's "color line" and the intensifying challenge to the racial order? This summer research project will focus on social scientists' changing analyses of interracial marriage during the three decades my book project covers. The student will help me to analyze the archive on interracial marriages and conduct additional research related to this topic. The student will learn how to conduct and analyze original research, including social scientific, legal, and archival data. This position would be especially helpful to students interested in careers in law, sociology, anthropology, Africana Studies, and history. It requires excellent organizational and research skills, creative thinking, and care with original documents.

Dental Medicine

ANATOMY & CELL BIOLOGY

Claire Mitchell

Image Analysis to Advance Lysosomal Signaling in Neurodegenerative Diseases

My project is entirely in-person.

This project is concerned with understanding of how injured lysosomes are repaired and renewed following injury, and allows students to become familiar with several key techniques in cell biology and associated software packages. Specifically, the student will help identify novel proteins involved in membrane repair and lysophagy after lysosomal damage; identification of these proteins will help understand whether failure of lysosomal regeneration contributes to waste accumulation and other pathological events in age-dependent neurodegenerations or lysosomal storage diseases. The successful applicant will be trained in a series of tasks adjusted for successful progression.

Initial training will be given in image analysis to enable the student to process images taken by other lab members using spinning disk confocal microscopy. The proteins will be analyzed for changes in expression and degree of colocalization in disease versus control states using ImageJ analysis routines. Students will perform statistical and graphical analysis of the data using Graphpad software and prepare figures for publication. Students will then be trained in cell culture techniques and learn how to prepare material for microscopy studies as the summer progresses.

Students are expected to present their data at weekly lab meetings and eventually help generate new scientific hypotheses. Previous students have maintained a continued relationship with the lab throughout their undergraduate careers and appeared on publications. The lab has typically 6 to 8 members, providing the opportunity to interact with researchers at various levels of their career while remaining small enough to give students personal attention.

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ORAL MEDICINE

Adeyinka Dayo

Prevalence of Calcifications in Cone Beam Computed Tomography Scans of Patients with High Cholesterol Levels

My project can be modified to accommodate remote activities if made necessary by University policy.

Determining the prevalence of calcification in CBCT of persons with high cholesterol levels.

My research focus is to identify radiologic biomarkers that can serve as early detection of systemic diseases. The methodology is by evaluating different imaging modalities of the head and neck of healthy persons and persons with underlying systemic disease to identify incidental findings and statistically analyze data for associations that may exist. Primarily the student will learn radiographic anatomy and acquire the skill of evaluating cone beam computed tomography (CBCT) scans.

The prevalence of incidental findings on diagnostic images acquired for dental patient management is as high as 94% when considering CBCT and panoramic radiographs, some of these findings if detected can be a signal to an underlying systemic disease. Soft tissue calcification is one such finding. The ability to identify trends between the presence of calcifications and systemic disease will ultimately lead to identification of radiologic biomarkers that can aid early detection of undiagnosed systemic conditions. Preventive measures can then be instituted early to prevent complications.

The goal of this project is to identify soft tissue calcifications among person with high cholesterol levels attending PENN dental medicine clinics and characterize such calcifications while evaluating associations. The student researcher will be mentored by Dr. Adeyinka Dayo. Through this project, the student researcher will gain research experience, understand the importance of translational research, and learn how to review, interpret and report CBCT scans. The student researcher will also learn to analyze and interpret data and convey the results of the study clearly in a scientific presentation.

ORAL SURGERY AND PHARMACOLOGY

Katherine Theken

Investigation of Variability in Analgesic Response to Ibuprofen After Wisdom Tooth Extraction

My project can be modified to accommodate remote activities if made necessary by University policy.

The current opioid crisis has highlighted the need to optimize pain management with non-addictive analgesics, such as non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs are recommended as first-line analgesics for the majority of patients undergoing third molar (wisdom tooth) extraction. However, there is considerable variability in the degree of pain relief that patients experience, with 20-30% of patients requiring supplemental opioid medication for adequate pain control within 6 hours of the initial NSAID dose. In order to avoid undertreating patients who will not respond adequately to NSAIDs, oral surgeons routinely prescribe opioids to all patients to be taken if needed, resulting in unused opioids for

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many patients who do not require them which are subject to misuse and diversion. The use of precision medicine approaches to tailor analgesic therapy would enable oral surgeons to prescribe opioids only to those patients who require them and avoid unnecessary opioid prescriptions in those patients who can achieve adequate pain relief with NSAIDs alone. This project focuses on identifying the factors that contribute to inter-individual variability in the analgesic response to ibuprofen and need for opioids after third molar (wisdom tooth) extraction. The ultimate goal of this work is to identify biomarkers that are predictive of analgesic response to NSAIDs and facilitate a precision medicine approach to pain management.

The student researcher will be jointly mentored by Drs. Katherine Theken and Elliot Hersh. Through this project, the student researcher will gain experience with several key molecular biology techniques, including RNA extraction, the use of polymerase chain reaction for quantification of gene expression, and measurement of inflammatory mediators by immunoassay. The student researcher will shadow our clinical research coordinator to gain hands-on experience with clinical research and participate in weekly lab meetings and journal clubs. Finally, the project will allow the student researcher to analyze and interpret data and convey the results of the study clearly in a scientific presentation.

PATHOLOGY

Kelly Jordan-Sciutto

Interplay Between Astrocyte Lipid Metabolism in Oligodendrocyte Differentiation During Neuroinflammation

My project is entirely in-person.

Lipids are required for the metabolism and function of all the cells in the brain, especially the oligodendrocytes whose membrane forms the myelin sheath that is necessary for conduction of nervous impulses and maintenance of axons. A convergence of evidence suggests that a genetic variant of apolipoprotein E (E4) induces the integrated stress response in astrocytes. The integrated stress response regulates several cellular metabolic responses including protein translation, mRNA stability and lipid metabolism. As astrocytes have been shown to provide lipids to oligodendrocytes as they myelinated axons, we hypothesize that ApoE4 induced ISR response in astrocytes may disrupt lipid donation to oligodendrocytes. Intriguinging, the ApoE4 allele is associated with increased risk for Alzheimer disease and may explain observations that myelin reduction is observed early in Alzheimer disease progression.

To address this hypothesis, students will learn to culture primary rat astrocytes or oligodendrocytes and using immunocytochemistry, immunoblotting and real-time PCR to determine whether APOE4 expressing astrocytes exhibit altered lipid metabolism and the impact of this altered metabolism impacts oligodendrocyte myelination. Students will learn the critical aspects of experimental design including positive and negative controls and validation controls. Training in scientific rigor and reproducibility will also be taught and modeled as part of the experience. In addition to developing technical laboratory skills and experimental design, students will be taught the latest technologies to analyze their data (fluorescent microscopy, immunoblot imaging and realtime PCR data analysis) and the

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use of biostatistics to interpret their findings. Students will also be taught to critically evaluate literature related to the project and use this literature to understand the implications of their findings.

There are two parts to this project. The first is to examine the impact of ApoE4 on astrocyte lipid metabolism pathways and the second is to examine the interaction between astrocytes and differentiating olidogendrocytes. These projects are carried out in collaboration with Dr. Judith Grinspan and are being led in the laboratory by a Senior Scientist, Dr. Hubert Monnerie, and a post-doctoral Fellow, Dr. Lindsay Festa. We have an inclusive and collaborative environment providing students with the opportunity to build professional skills in presentation, collaboration, writing, and networking. We also will provide input on career development in scientific endeavors with a goal to provide a full mentoring experience to guide students toward careers in research and discovery.

PERIODONTOLOGY

Dana Graves

Diabetes and Oral Health

My project is entirely in-person.

Dr. Graves's laboratory has been involved in studying several aspects of oral biology. His recent interests focus on two complications of diabetes, impaired wound healing and enhanced periodontal disease. Interestingly, many of the same factors that contribute to impaired wound healing also contribute to increased periodontal disease. One project involves an examination of the wound healing response and the other project involves an assessment bacteria induced periodontal bone loss. Both of these projects use genetic deletion to shift the host response, which can rescue the negative effect of diabetes on both complications. Recent experiments involving single cell RNAseq point to previously unrecognized factors in the pathogenesis of both pathologies. Subsequent experiments are designed to follow-up on these results to confirm that observations at the mRNA level are also seen at the tissue level. A number of parameters will be examined in both projects to quantify the impact of gene deletion and diabetes on critical molecular events that control cytokine production, inflammation, the response of lymphocytes and macrophages and tissue formation. The techniques used include histomorphometry, computer assisted image analysis, flow cytometry, bioinformatics, western blot analysis, immunofluorescence, RNAscope, PCR, chromatin immunoprecipitation assays, etc. An undergraduate who participates in these experiments will be teamed with a project leader to learn how to design experiments including controls, how to perform key aspects of a technique and data analysis.

Kang Ko

Investigating Cell Death Mechanisms in Periodontal Pathogenesis

My project is entirely in-person.

Periodontitis is an oral inflammatory disorder characterized by chronic inflammation and bone loss around teeth. Dysbiosis of oral microbiome initiates persistent inflammatory reaction, but tissue destruction is mostly carried out by the host response. In this project, student(s) will investigate cell

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death mechanisms in diseased periodontal tissues that could explain overt inflammation and periodontal bone loss. Specifically, we will explore the extent of necroptosis, pyroptosis, and ferroptosis in murine periodontitis model as well as in human biopsies. This is a research opportunity for wet-bench experience in basic and translational sciences.

Research skills that student(s) can expect to learn include:
1. Histological analysis of healthy and diseased gum tissues
2. Immunohistochemical labeling techniques and analysis
3. Multifluorescent microscopic data acquisition and analysis
4. Statistical approaches and data management
5. Scientific writing

Pre-health students are highly encouraged to apply.

PREVENTATIVE & RESTORATIVE SCIENCES

Geelsu Hwang

Effect of Fluid Dynamics on Biofilm Formation

My project can be modified to accommodate remote activities if made necessary by University policy.

Biofilms are structured microbial communities attached to surfaces, which play a significant role in the persistence of biofoulings in both medical and industrial settings. The development of the biofilm is a sequential process that starts with a loose association of the microorganisms to a surface and then converted to strong adhesion. There are many factors affecting the process of bacterial adhesion to a surface; duration of exposure of bacteria to surfaces, the population of inoculated bacteria, bacterial characteristics (e.g., cell wall components, appendages, motility), and type/richness of nutrients could affect. Surface properties of the substrate, such as surface charge density, wettability, roughness, stiffness, and surface topography are also considered important factors governing initial bacterial adhesion to surfaces. Although fluid flow dynamics can alter the bacterial behaviors on surfaces and many infectious biofilms in the human body are formed under dynamic conditions, their important role is often overlooked. Here, we will utilize a new biofilm testing flow system powered by 3D printing technology and mathematical modeling.

Students on this project will understand the effect of hydrodynamic flow on bacterial adhesion and biofilm formation. They will also learn how to evaluate biofilm properties using biochemical, microbiological, and confocal imaging methodologies. This project is suitable for students who are interested in integrating engineering and microbiology to understand the process of bacterial adhesion and biofilm formation.

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Design

ARCHITECTURE

Laia Mogas Soldevila

Earth-Based Bio-Composite Structures

My project is entirely in-person.

In this project a team of interdisciplinary undergraduate researchers will optimize and fabricate an architectural structure entirely made of new earth-based bio-composites.

-- Background: This PI is an interdisciplinary Architect and for the last decade has interfaced with Materials Science and Biomedical Engineering to transform material systems proven by life sciences to be benign to the human body into at-scale Architectures benign to the Earth. Specifically, she develops ultra-sustainable blends and objects from sand, shrimp shells, fungi, plant fibers, algae gums, or silk protein materials that outperform some technical composites and ceramics, and ultimately biodegrade without toxicity unlike their man-made counterparts.

-- Completed Research: DumoLab Research interdisciplinary laboratory at Penn (https://www.design.upenn.edu/dumolab/work), is 1 year old and has produced seminal projects investigating everyday biodegradable objects, sand-based structures as concrete alternatives, and printed cellulose-based lattices as air-interactive modules.

Our team is composed of architecture, biology, and materials science undergraduate and graduate students, and we collaborate with environmental science and biotechnology doctoral and postdoctoral researchers at Penn and MIT. Our additive bio-fabrication platforms produce meter-scale bio-based structures with tunable mechanical and interactive performance to demonstrate their potential as sustainable architecture systems. The project presented here directly contributes to this endeavor.

-- Project Steps and Skills to Acquire:
OPTIMIZE and learn how to produce previously selected bio-composite blend. (2 weeks)
TEST pre-blending and additive technology accounting for on-site large scale setup challenges. (2 weeks)
EXECUTE composite dome under guidance of graduate students and PI (6 weeks):

- use cad-cam software to discretize structural foundation
- define workflow for layered deposition accounting for environmental constraints
- prepare imaging setup to document fabrication steps
- install formwork and prepare inner surfaces
- additively deposit bio-composite blend and apply finishings
- recap on steps followed and assess durability, stability and aesthetics obtained
- outline text for joint publication of results with mentors help

-- Direct Mentorship: On top of PI direct mentorship in lab, students will learn from: Liam Lasting, Architect and lab alumni returning to Penn to lead execution of the presented project. Ji Yoon Bae, our projects director and Architecture PhD student developing bio-architectural systems.

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Franca Trubiano

Building at RISK Forced Labor, the Construction Industry, and Human Rights

My project can be modified to accommodate remote activities if made necessary by University policy.

This research project centered in the department of Architecture studies the ways in which building, the larger built environment, and the building industry place people at risk. Whether by disregarding the use of forced labor in the production of materials or by imperiling the lives of workers on unsafe building sites, the act of building places people at risk. In addition, the globalization of design and construction practices means that cities as diverse as North Carolina, Shanghai, New Delhi, Doha, and London are witness to vast levels of human migration by those in search of work in the building industry. These sites, are hence, not only on the front line of serious transformations in the political character of building-based labor, but they are also the sites of human rights abuses. Rarely however, do designers (be they architects, landscape architects and urban designers) consider how the transnational and transactional space that is the building site impacts those that work therein. Initial research on migrant labor in the construction industry reveals a general lack of transparency and accountability in the supply chain of building; with the result being, that many who labor in the building of cities are disempowered and at risk.

This research project, originally funded by the Humanities, Urbanism, and Design (H+U+D) Inclusive City Colloquium 2018-20 at the University of Pennsylvania, calls for a considered analysis, review, and critique of the many ways that buildings place people at RISK. Building on an extensive bibliographic database, students will identify and articulate action items and strategies in service to the education of designers and policy makers who are called upon to practice and govern in an ever more globalized and networked environments. Undergraduate students from Penn Law, School of Social Policy and Practice, History, Labor economics, Urban Studies, and majors in Architecture are invited to apply. Students will engage in text-based research and analysis of existing bibliographies on the subject.

FINE ARTS

Joshua Mosley

Using Animation to Explain Accelerated Sea Level Rise Scenarios and Adaptation Pathways for the Netherlands

My project can be modified to accommodate remote activities if made necessary by University policy.

The goal of this research project is to combine the art of animation with climate adaptation science and technology in order to communicate effectively and persuasively through animated video. As a collaborator, the student will learn to grasp and communicate the policy and design dilemmas posed by accelerated sea level rise and associated impacts. The project creates opportunities for students to engage with artists and experts in the fields of climate science, water management, climate adaptation and climate policy. Students will be mentored as we develop strategies to intervene in public debates through the production of animated videos that bring unacknowledged aspects of climate adaptation in the Netherlands into public view in a manner that has a positive influence on public opinion and policy making.

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For the month of June, this work will be done on-site, in the Netherlands. Our days will be filled with cultural orientation, site visits, drawing, expert interviews, meeting with local artists and animators, workshopping ideas, developing scripts, and storyboarding. By the end of our stay, we will have completed animatics for two short videos. Following this stay in the Netherlands, the teams will work in Philadelphia or remotely for 35 hours per week for six weeks. By the end of the summer, two videos will be ready for release.

The goal of the project is to produce new episodes of the Poldergeist series of animated videos that inform both the Dutch public and the public at large about the impact of accelerated sea level rise on the Netherlands and to contribute to the public debate about the best adaptive approach. To get a sense of the nature of this project, please check out some of the videos created by past PURM student researchers here: https://www.youtube.com/channel/UCQrvu36tni8MEpLR4ZqFJsQ

Students involved in this research project receive the standard PURM grant. In addition, the project pays for the cost of airfare, domestic travel, and accommodation for the month spent in the Netherlands.

Interested students should have some experience in drawing and animation and will be expected to share a small portfolio during the interview process.

Education

EDUCATION POLICY

Sade Bonilla

Strengthening Virginia's Pandemic Recovery Efforts to Provide Workforce Education

My project can be modified to accommodate remote activities if made necessary by University policy.

The purpose of this project is to examine barriers to postsecondary enrollment, persistence, and completion for low-income, Black, and Hispanic students and generate knowledge that will lead to significant improvements in their progress through and completion of workforce training programs leading to high-demand occupations. To achieve these aims, the research team will partner with the Virginia Community College System (VCCS) to examine the Get A Skill, Get A Job, Get Ahead (G3), VCCS's central pandemic workforce recovery strategy first implemented in fall 2021.

The successful candidate(s) will work closely with Professor Sade Bonilla and her research team to document administrative data; conducting data analysis; and drafting policy briefs and reports for research partners. The research assistant(s) will gain skills in data coding and management; learn about issues of equity and access in broad access institutions; and work on a team to produce a report/brief for policymakers and practitioners. The candidate will code using Stata (prior exposure to coding is helpful but not required); conduct literature reviews; conduct documentation reviews; and assist in writing a brief/report. Students majoring in social sciences (economics, public policy, sociology, political science etc.) with an interest in education policy are encouraged to apply.

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LITERACY, CULTURE, & INTERNATIONAL EDUCATION

Amy Stornaiuolo

Studying Youth-Led Writing Communities Online

My project can be completed entirely remotely.

The last five years has seen an explosion in young people making an impact through their writing online – and online writing communities often nurture those writerly identities. We are a dynamic and collaborative research team studying this phenomenon by both developing and studying a global writing community for youth called Write4Change, which links adolescents around the world who are writing to make an impact on their communities and the world more broadly. We are looking for an undergraduate researcher interested in online communities, digital writing, and social justice to join our team.

We have been working with a group of adolescents around Philadelphia in 2022 to redesign the community to design Write4Change to become a primarily youth-led space on a different online platform, and we have data from the last decade of studying how young people from around the world connect with each other in an educational online writing community. This project is part of a participatory design study that understands young people to be critical actors and agents, some of whom serve as co-researchers on the team exploring what we have learned in the past and what we will do next.

The undergraduate researcher would work with the team to recruit members to the re-envisioned online community, moderate the youth's writing and engagement online, help develop curriculum materials, and study what emerges. The 10-week summer internship will involve weekly research team meetings, qualitative data collection about youth's engagement with digital writing, and qualitative data analysis using online QDA software. The undergraduate researcher will be mentored to learn about ethnographic, participatory, and digital methods of data collection and analysis as well as about designing educational technologies and interventions.

No prior research experience is needed. Future opportunities for presentation and publication are available if the undergraduate researcher is interested. The research team is fully remote, so while there will be opportunities to join local members in person for co-working, these activities will be available online also and the research itself will take place virtually. Experience with online literacy/writing communities and/or interest in digital writing, international and multilingual communities online, youth's digital literacies, and/or educational research are particularly welcome.

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TEACHING, LEARNING, & LEADERSHIP

Dorene Balmer

Designing for Equity in Medical Education: An Innovative Application of Design Thinking to Co-Create Equitable Assessment Systems

My project can be completed entirely remotely.

We are conducting a medical education project in which we use a stakeholder-participatory strategy to co-create and test a prototype of a more equitable assessment system in pediatric residency. We will produce two key deliverables: an evidence-based guidebook that other medical education programs with varying contexts, resources, and expertise could use to develop more equitable assessment systems; and a tested prototype of an equitable assessment system that could be adapted, scaled, and implemented on a larger scale in pediatric residency education.

Our project is important because there is substantial evidence that assessment systems in medical education produce inequitable outcomes for learners with historically underrepresented and marginalized racial/ethnic, gender, disability, and other social identities. These inequities have lasting harmful impacts on learners, patients, and society. Our ability to address these inequities is limited by significant gaps in our knowledge about how to design more equitable assessment systems. Our proposal seeks to help fill these gaps by creating foundational knowledge about how to use stakeholder-participatory strategies to take practical action on the pressing problem of assessment equity in medical education.

We will use a stakeholder-participatory strategy, Design Thinking informed by Design Justice, to co-create with stakeholders (e.g., resident learners, faculty assessors, program leaders, education leaders, and program administrative staff) a prototype of a more equitable assessment system that is customized for their local context. We will test and refine the customized prototypes by using them to assess residents through the course of their training. We will systematically collect information about barriers and facilitators to implementation and necessary adaptations to inform future scaling. Using a mix of qualitative and quantitative methods, we will collect evidence of the equity, utility, feasibility, and acceptability of the prototype assessment system from stakeholder perspectives. We will pay special attention to demonstrating that our work to improve equity does not compromise the quality of assessment or lower standards for summative decisions. We will compile findings from each step of the process to create the guidebook, which will aid dissemination and replication across a wide array of diverse medical education training programs.

Roles and skills training for student in Summer 2023

1. help manage and analyze qualitative data from stakeholder interviews
2. observe design sessions and, as appropriate, partner in facilitating conversations in the design sessions
3. help manage, analyze and organize qualitative data from small-group design sessions with stakeholder to construct design principles

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Engineering & Applied Sciences

BIOENGINEERING

Lukasz Bugaj

Single-cell Analysis of How the Cell Cycle Affects Cell Death During Cancer Therapy

My project can be modified to accommodate remote activities if made necessary by University policy.

Many cancers can be treated with potent drugs that block specific cancer-associated proteins. However, after some time on treatment, cancers often develop resistance to these drugs. Thus there is a critical need to understand how cancer cells respond and adapt to the drugs we use to target them. Our lab studies drug resistance in a class of lung cancer cells, the deadliest form of cancer in the US. Our work indicates that upon drug treatment, cells preferentially die in some phases of the cell cycle over others. By understanding this cell cycle dependence, we hope to identify cellular factors that might promote cancer cell death more efficiently. However, very little information exists about how cancer cell behavior varies as a function of cell cycle stage. In this project, we will directly observe and quantify the cell cycle progression of cancer cells upon treatment with therapy. We have generated cancer cell lines that express fluorescent reporters that indicate all 4 cell cycle stages. Using these cell lines, we have begun to generate time lapse movies of these cells under drug treatment.

The goal of this summer PURM project will be to quantify how cell cycle progression changes during drug treatment, and to develop and test hypotheses for why these cell cycle changes occur. We will use a combination of published and custom MATLAB scripts to automate cell detection, tracking, and fluorescence quantitation. We will also import single-cell time lapse data into R and visualize the cell cycle and cell fate (eg, survival, death) data. Success in this work will generate new knowledge on the relationship of drug treatment to cell cycle progression, and will generate/test new hypotheses for effective drug treatments that leverage cell-cycle-specific mechanisms to promote cell death. Through this process, the student will develop many important skills including programming in MATLAB and R, confocal imaging, image analysis, cell tracking, data wrangling and analytics, data visualization, and cancer biology. The student may also learn wetlab techniques like cell culture, cell line generation, and live-cell imaging, as dictated by the project.

Nathaniel Dyment

Tendon Mechanobiology

My project can be modified to accommodate remote activities if made necessary by University policy.

Tendon disease (tendinopathy), particularly caused by overuse, often results in tissue microdamage. This microdamage, in turn, impairs transmission of tensile mechanical signals through the tissue, resulting in under-loading of endogenous tendon cells. This de-tensioning results in breakdown of the tendon matrix and eventual weakening of the tendon. A common therapy for tendinopathy is physical

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therapy where different loads are applied to the tendon. This project focuses on how applied loads, and how the cells respond to them, affects tendon growth and homeostasis. Students will work with innovative surgical and genetic mouse models that alter the loading environment and the ability of the cells to respond to load.

Riccardo Gottardi

Tissue Engineering for Cartilage Reconstruction and Regeneration

My project is entirely in-person.

At the Bioengineering and Biomaterials Lab at Children's Hospital of Philadelphia we have adopted a rapid translational approach for tissue-engineering new biomaterials to help patients. Our priority target is engineering cartilage constructs for laryngotracheal reconstruction and orthopedic osteochondral regeneration. For rapid translation, we design scaffolds based on FDA approved materials: starting from the simplest building blocks we build the complexity that drives stem cell differentiation. Moreover, the engineered tissues we develop are based on new stem cell sources that can be harvested with minimally invasive outpatient procedures.

In this project, the students will have the opportunity to learn about biofabrication, cell culture, and biomaterials. Students will not be directly involved in animal work, but they will have the opportunity to study engineered tissues grown in the lab before they are implanted in animals, and to work with graduate students and postdocs to study how the engineered tissues perform after they are implanted.

We are looking for enthusiastic and motivated undergraduate students with good verbal and communication skills who want to join our exceptional team of scientists and students in our research journey.

Some of the techniques routinely uses in the lab are: cell and tissue culture, fluorescence microscopy, histology and immunohistochemistry, real time PCR, mechanical testing, and 3D printing. No previous experience in any of these techniques is required.

We offer:

- A collaborative and open environment that fosters learning and scientific growth
- An exciting environment where trainees can learn and grow to develop new research directions working with incredible collaborators
- Individual mentoring to enhance your professional profile and tailored opportunities to support specific professional goals
- A highly translational focus to address patient-centered medical problems and to push research from bench to bedside
- The opportunity to contribute to presentations and publications, and present work at internal and external gatherings

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James Gugger

Using Brain Imaging to Predict Seizures After Head Injury

My project can be modified to accommodate remote activities if made necessary by University policy.

Traumatic brain injury is one of the most common causes of epilepsy. Brain imaging acquired after head injury and before the onset of seizures may contain information that can be used to develop predictive models of epilepsy risk. Such tools would lead to dramatic improvement in the care of patients with head injury. Unfortunately, analysis of brain imaging is complex and requires skills in computer science and engineering to optimally leverage the neurobiological readouts embedded in the data. This project is focused on analysis of structural and functional MRI data from patients with traumatic brain injury. The student will learn the skills needed to analyze neuroimaging data including basic processing and statistical analysis. Some programming experience is desirable, but not necessary.

Michelle Johnson

Assessing Motor Activity from Infant-Toy Interactions

Second-year only

My project can be modified to accommodate remote activities if made necessary by University policy.

An estimated 5% to 10% of children have neurodevelopmental disabilities, which are often caused by early brain injuries. Estimates suggest that more than 10% of infants in Sub-Saharan Africa including Botswana are at risk for development delays due to early brain injuries. Early brain injuries can be caused by HIV, preterm birth, hydrocephalus, neonatal stroke, asphyxia, seizures, prenatal drug use, or maternal infections. These events often expose the child to long-term neurological impairments and developmental delays. However, not all children with early brain damage have persistent physical disability, clouding the ability to predict future physical function and the need for intervention.

Motor training is the most effective treatment for physical neuromotor impairments caused by early brain injury but is less effective once the child reaches school-age beyond the critical period for the development of motor control centers in the brain. These observations suggest that there is a window of opportunity for movement interventions to reduce lifelong physical disability. Early and effective treatment depends on accurate identification and characterization of motor impairment in the first few months of life. Existing clinical tools have a host of limitations, including requiring unusually high levels of training and expertise, are time-consuming, often subjective, are not sufficiently sensitive to screen infants younger than 6 months, may have limited predictive value, or are not able to be administered in the infant's natural environment.

We have collected lots of data of infants interacting with and without toys. We are looking to analyze the videos to understand trends in the interactions across age, gender and birth situation (pre-term or full term). The student would assist in collecting data and help us in processing this data set for the trends.

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Brian Litt

Investigate Stimulation-induced Biomarkers of Epileptogenic Cortex in Epilepsy

My project is entirely in-person.

Epilepsy affects 1% of people, and one-third of people with epilepsy have seizures that cannot be controlled by medications. Surgery offers the best chance of seizure freedom in these patients, but our current approaches to identifying the seizure-generating brain regions are insufficient. Clinicians sometimes perform electrical stimulation with the goal of identifying the seizure-generating brain regions, but we lack good biomarkers to understand how stimulation reveals the seizure-generating regions. In this project, the student will examine intracranial EEG data in patients with epilepsy who underwent electrical stimulation. The student will perform signal processing on the EEG data and investigate multiple approaches to identify features of the EEG that localize seizure generating regions. This project would be ideal for a student interested in bioengineering and signal processing. You would be mentored by Dr. Brian Litt, Dr. Erin Conrad, and Dr. Joshua LaRocque. Skills you would learn include signal processing, data reduction, and machine learning. Prerequisite skills include Matlab.

Joel Stein

Identifying Epileptic Brain Networks from Clinical Structural and Diffusion Magnetic Resonance Imaging

My project can be modified to accommodate remote activities if made necessary by University policy.

Epilepsy is a serious neurological disorder affecting nearly 70 million people worldwide. Identifying brain areas responsible for causing seizures in epilepsy is crucial for guiding treatment. Non-invasive whole-brain imaging like T1-weighted and diffusion-weighted MRI is acquired in almost all patients as a part of the routine clinical procedure to assess abnormalities in brain structure. In addition to routine clinical MRI scans, some patients also consent to high-quality MRI acquisition for research. One of the main differences between the brain imaging data acquired for clinical and research purposes is that the clinical scans are acquired in a limited time, constraining the size of MRI data (e.g., fewer magnetic field directions in diffusion MRI) and limiting supplementary MRI sequences (e.g., field maps). The difference in the clinical and research MRI protocol is a significant barrier to translating our research findings into clinical practice [1]. This project aims to fill the gap in our understanding of how these different protocols affect the identification of abnormal brain areas and epileptic networks.

In this project, the student will have a unique opportunity to work on data from 100+ epilepsy patients who consented to research MRI acquisition. The student will develop pre-processing methods to generate synthetic field maps for clinical MRI acquisition and apply advanced neuroimaging approaches with machine learning methods to identify which brain structures may be abnormal. Rigorous statistical quantifications will be applied to benchmark the differences against the brain structure of a healthy cohort. We will develop data harmonization methods to bridge the gap between clinical and research MRI protocols. The student is expected to have good programming expertise in MATLAB/Python, basic knowledge of statistical methods, and preparedness for a steep learning curve in epilepsy neuroimaging.

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The student will be mentored by the team of Joel Stein, MD, PhD (neuroradiologist), Kathryn Davis, MD (epileptologist), and Nishant Sinha, PhD (epilepsy imaging researcher). The project builds on our established work in neuroimaging, network science and computational modelling [1,2]. The project is challenging and is aimed toward a publication in which the student will have the opportunity to contribute.

References:
Sinha et al. 2022, Epilepsy Current, http://doi.org/10.1177/15357597221101271
Sinha et al. 2021, Neurology, https://doi.org/10.1212/WNL.0000000000011315

COMPUTER & INFORMATION SCIENCE

Kevin Johnson

OBSERVER Project

My project can be modified to accommodate remote activities if made necessary by University policy.

Project purpose:
The research project is being conducted to create a database of clinic encounter information that will allow researchers to review, develop and test novel ways to improve clinic visits. The goal of this project is to develop a revolutionary, new generation of electronic health record documentation algorithms and processes that will augment and replace traditional patient encounter documentation and workflows.

Goal of the project:

1. Create the Observer Repository-- clinical encounter data consisting of the following linked data: (1) screen recordings; (2) exam room videos; (3) EHR audit log; (4) patient visit/lab/radiology data; and (5) a recorded debrief of the visit by patient's provider.

2. Develop and test algorithms that identify clinically relevant features in Observer data that help summarize the clinical encounter. For this aim I will apply computational methods including computer vision, natural language processing and deep learning to data within the Observer repository. I will focus initially on primary care internal medicine visits. Our objective will be to automatically identify visit data related to cognitive function and depression—two common and often underappreciated issues during primary care encounters.

3. Assess the value of information difference between computer-generated documentation versus the clinician-generated documentation. I will use the annotated patient encounter video and a team of providers not involved in the construction of these computer-generated notes to evaluate accuracy, completeness, and communication value of both notes relative to the video of the visit.

Skills mentees will learn:

Understand the basics of artificial intelligence as it relates to healthcare. The basic concepts of transcription, annotation, and videography. Interacting with the scientific community both virtually and in person.

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Kevin Johnson, MD, M.S. - Principal Investigator (Oversight of the research study)
Eric Eaton, PhD - Co investigator (Assist PI)
Stacy Iannone, PhD(c) - Project Manager

Yasmin Kafai

Promoting Learning About Machine Learning Among High School Youth

My project can be modified to accommodate remote activities if made necessary by University policy.

Over the past five years there has been a push to promote artificial intelligence literacy including machine learning across the K-16 computing curriculum. Developing an understanding of machine learning (ML), which includes using data rather than code to influence the behavior of computer programs, is essential for AI literacy. While young people may not fully understand how ML works, in their everyday lives they have rich experiences with ML-powered applications, using them while going school, playing games, listening to music, and socializing with their peers.

We are proposing the design, implementation, and analysis of high school youth's ML applications in an electronic textile workshop to learn about (1) youths' understanding of ML and (2) how youth design ML applications . The research context will be a STEM SCHOLAR summer program workshop at The Franklin Institute in Philadelphia, PA. The two dozen high school youth from the larger Philadelphia area participating in the project come from marginalized communities and have expressed a strong interest in STEM and computing. We will be designing and implementing a two-week long workshop in which youth will design their own ML-powered e-textiles. E-textiles involve creating wearables using programmable microcontrollers, sensors and actuators that can be sewn into fabrics. In the workshop we want students to create interest-driven e-textiles projects (using micro:bit) that use machine learning (teachable machine & tensorflow) to create new ways of interacting with e-textiles using sensor data. We are particularly interested in how students debug and design bugs while considering the social implications of computing.

Penn undergraduates will participate in all aspects of research activities with a focus on these skills:

Prototyping ML applications: Undergrads will learn how to make e-textile prototypes for the workshop and prepare sample code for high school students.

Participating in Data Collection: Undergrads will learn how to video record workshop participants interactions, document artifact design and completion, record observations of workshop activities, and conduct interviews with high school students. They will also learn about regulations from social science research in practice and pass CITI clearance.

Analyzing Data from Observations, Interviews and Artifacts: Participating undergrads will learn how to document and prepare multimodal data for analysis. For instance, they will learn how to compile data from video records, interviews and collected artifacts for the case studies or how to analyze students' pre and post interview data.

Luis Morales-Navarro, PhD student in GSE, will lead workshop and research activities onsite

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Danaë Metaxa

Users' Perceptions of Political Content on TikTok

My project can be modified to accommodate remote activities if made necessary by University policy.

TikTok has emerged as one of the most popular new social media platforms in recent years. As with other social media platforms, users on TikTok are exposed to a wide range of content that might shape their beliefs and behaviors. Such content, when related to civic life, is termed political, and is worth studying to understand the impact of this platform on people's civic engagement, political beliefs, and other key attributes involved in a functioning democracy.
While some recent work has studied explicitly political content (i.e., content that creators tagged with "#democrat" or "#republican"), we are interested in a much broader set—content that users perceive as political, whatever that means to them, especially implicitly.
This study, led by two Master's students in the CIS department, involves building a tool to allow users to self-annotate the TikToks on their personalized feeds, labeling whether that content is political, whether implicitly or explicitly, and why. We will deploy this tool to participants, and then analyze the resulting data in various ways—qualitatively analyzing people's responses, and using machine learning to try and predict labels given automatically and manually extracted attributes of the videos—to understand what content on TikTok users perceive as political, and why.

Research duties may include:

- Literature review
- Participant Management
- Create material advertising the study
- Organize participant compensation
- Distribute study materials
- Manually annotate/analyze data
- Data cleaning
- Create a poster synthesizing research findings
- Attend weekly lab meetings & mentor meetings

Duncan Watts

Integrative Experiments on Group Dynamics

My project can be modified to accommodate remote activities if made necessary by University policy.

Experimental social science traditionally tests one hypothesis at a time, oftentimes using in-person labs to test one intervention in only one context or scenario. Using computational techniques and technologies, we're building large-scale experiments to create an atlas of interventions in multiple group contexts by integrating research in social science and computer science disciplines. These interventions will be tested across a large number of factors — including group size, demographics, group history - in many contexts, eg in deliberating contentious topics or effectively cooperating as a team. Previous work has demonstrated possible interventions for how to improve group dynamics, but the efficacy of these interventions across factors and contexts has not been tested at scale.

In this PURM project, students will join in the development and implementation of a human-subjects experiment designed to test techniques to improve small-group interactions in online settings.

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Experiments will take place in custom built web interfaces and interventions will draw on existing social science theories. Students will work as part of a team in an agile research environment and will be using modern development environments. Ideally, applicants will be located in Philadelphia for a hybrid summer experience.

This project will expose students to 1) basic approaches in the emerging field of computational social science 2) social-psychological theories of group behavior 3) front and back end web development, and 4) cutting-edge methods for conducting high-throughput human-subjects experiments. Students may choose to focus their effort more on the technological or social-psychological aspects. Specific tasks could include identifying and implementing web-based surveys designed to measure particular behavioral outcomes, developing components of a website to coordinate crowd-sourced public groups in advancing scientific knowledge or analyzing textual/audio/video data from experimental sessions. Students with experience working with Javascript, React, and other web technologies would be a particularly good fit for this project, as would students with experience in natural language processing, or speech and video analysis.

Students will work with members of the Computational Social Science Lab at Penn, including staff scientist Dr. Mark Whiting, postdoctoral researcher Dr. James Houghton and research operations manager Eric Shapiro. This is an ongoing project, and successful students may be interested in participating further in the future.

ELECTRICAL & SYSTEMS ENGINEERING

Deep Jariwala

Solar Energy Harvesting with Hybrid Light-Matter States

My project can be modified to accommodate remote activities if made necessary by University policy.

Polaritons are hybrid light-matter quasiparticles comprising of light particles (photons) as well as matter excitations e.g. electrons. Due to their part light characteristics, polaritons can travel over longer distances during their lifetimes than particles that are purely matter (electrons). Polaritons are therefore interesting for solar energy harvesting as the longer transport lengths could enable improved charge collection in photovoltaics or charge to chemical conversion in artificial photosynthetic structures. By altering the geometry, the polariton energies can be tuned and the characteristics of the system can therefore be altered. Our group is exploring polaritons in two-dimensional semiconductor structures and the central goal of this project is to use them for harvesting light into electrical or chemical energy.

The research group is well experienced with the study of polaritons and two-dimensional semiconductors as well as photovoltaic devices and light-driven chemistry. The project involves, selecting the right semiconductor material, characterizing its fundamental properties, design and fabricate the necessary device structures and then perform the opto-electronic measurements and data analysis and verify them using theory/computation. The selected student will be working with a senior PhD student (TBD) under the supervision of the professor to develop the measurement scheme, design and make the materials/devices and then measure and analyze the data. The student will get hands on

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experience on material characterization and opto-electronic measurements in the lab. In addition some simulations and theory will also be involved as part of the project combined with data analysis using scientific computing softwares to understand and interpret the data.

MECHANICAL ENGINEERING AND APPLIED MECHANICS

Igor Bargatin

Photophoretic Levitation of Aircraft for Earth's Mesosphere

My project can be modified to accommodate remote activities if made necessary by University policy.

Earth's mesosphere, in the elevation range 50-80 km, is largely unexplored because no propulsion mechanism exists that can provide sustained flight there. Understanding this region is important, however, because its carbon dioxide levels impact climate model predictions and because meteors disintegrate there. In the Bargatin Research Group, we are using photophoretic levitation to fill this research gap. Specifically, we shine bright light on thin microarchitected films, causing them to hover in mid-air. We have shown that we can control the flight of these films, which we call microflyers, and that their payload capacity is large enough to carry basic atmospheric sensors.

We seek two undergraduate student interns with interests in, but not limited to, mechanical engineering, aerospace engineering, materials science, physics, and chemistry. The interns will help us design and test the next generation of microflyers by experimenting with new three-dimensional structures and novel film architectures and coatings. They will learn to conduct levitation experiments using our vacuum chamber, analyze the results, and suggest changes to improve the microflyers' performance. The students should expect to learn about conducting research experiments, using computer programs like MATLAB or Ansys Fluent, and discussing and communicating their findings with other students and scientists. Also, the interns may have the opportunity to contribute to peer-reviewed publications or conference presentations related to this high-impact project.

The interns will work closely with senior undergraduate or graduate students for guidance, such that no prior experience is necessary. The Bargatin Group welcomes all members regardless of differences in age, color, disability, ethnicity, family or marital status, gender identity or expression, language, national origin, ability, political affiliation, race, religion, sexual orientation, socio-economic status, veteran status, or other characteristics.

Up to two student interns will be selected for this project. Both will receive mentoring by Prof. Bargatin and by Matthew Campbell, a postdoctoral scholar in Bargatin Research Group.

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Robert Carpick

Sustainable Machinery Through Anti-Wear Zirconia Nanocrystal Coatings

My project is entirely in-person.

Mentors: Parker LaMascus, Dr. Pranjal Nautiyal

A key factor that inhibits sustainable technologies like wind turbines and electric vehicles is premature material surface under harsh environments. Anti-wear coatings can protect machine surfaces, extending their lifetimes to create energy and material savings. Though coatings are highly effective, they are difficult and expensive to manufacture. Reliable and affordable coatings are a crucial component of next-generation sustainable technology. The proposed project advances a novel coating technology for use in the manufacturing of bearings and gears by in-situ sintering of metal oxide nanocrystals (NCs) onto the contacting surfaces as a pre-treatment. These coatings are highly durable, imparting superior wear and fatigue prevention even under harsh conditions.

On this project, the student will characterize zirconia nanocrystals-containing fluid, which are deposited onto machine parts to provide a novel anti-wear nanocoating. The researcher will become an expert user of the mini traction machine, a benchtop tribometer that mimics gear operation, to optimize the growth rates and steady-state features of the nanocoatings. To probe the coatings' mechanical and chemical properties, the researcher will use white light interferometry and advanced chemical characterization techniques like Secondary Ion Mass Spectrometry. These tools will assess the hardness, roughness, and chemical composition of the coatings, providing fundamental scientific insight for this new class of anti-wear coating. This research is heavily focused on dissemination in peer-reviewed journals and research symposia.

Working among a diverse and active lab environment, the researcher will learn transferable skills like Python data analysis, technical writing, safe chemical handling, oral presentation, and research poster design. Academic background in materials, mechanics, chemistry, or physics is desired, but no experimental background is required. This project, at the crossroads between fundamental academic inquiry and industry impact, is an ideal introduction to cutting-edge sustainability research.

Jordan Raney

Nonlinear Mechanics of Soft, Intelligent Materials

My project is entirely in-person.

Our group (the Architected Materials Lab) uses advanced 3D printing tools to design and fabricate highly nonlinear, intelligent, reconfigurable structures. We have ongoing projects related to nonlinear deformation of mechanical metamaterials and smart actuators. One project involves the design of metamaterial actuators that could act as pumps to augment movement of oxygenated blood for certain heart conditions. Another project uses smart materials in soft actuators to design smart systems that autonomously deform in response to their environment (which might be useful in medicine and robotics).

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Cynthia Sung

Origami Robot Design

My project is entirely in-person.

Our lab investigates how we can combine ideas from origami (the art of paper folding) and robotics to make robots easily, quickly, cheaply, and on-demand. Using these ideas, we have created a number of robotic systems, including ones for manipulation, legged walking, underwater swimming, and more. See sung.seas.upenn.edu for examples.

In this project, PURM students interested in learning more about electromechanical systems will explore curved crease origami designs for a robotic gripper. The underlying idea is to use a curved fold pattern to reduce actuation requirements without sacrificing grasping success. The student will work with a graduate student on this design and will learn/practice computer-aided design, laser cutting and 3D printing, basic electronics prototyping and programming, and experimental design.

Required prerequisites include: an enthusiasm for and prior experience in origami or other paper crafts

Useful skills include: prior experience laser cutting or 3D printing and Arduino

Ottman Tertuliano

Mechanical Properties of Tissues Under Dynamic Loading Conditions

My project is entirely in-person.

Our understanding of tissue mechanics is primarily established in a steady state and macroscopic framework. For example, we understand what it takes to fracture a whole femur under very controlled, equilibrium loading conditions. Many tissue fractures start at the microscale and occur under conditions that are difficult to controllably replicate in the lab (e.g., accidents or falls). Developing a fundamental understanding of these dynamic failure processes in tissues is critical for developing better therapeutic and clinical practices for tissue repair.

We seek an undergraduate with general interests in mechanical engineering, bioengineering, and materials science. Students will help perform nanoindentation experiments on bone to characterize mechanical properties such as elastic modulus, strength, and fracture toughness under physiologically relevant conditions. At the end of the summer students will have 1) gained experience conducting experimental research, 2) learned the basics of nanoindentation, 3) developed data analysis and plotting skills using MATLAB or Python and 4) developed scientific presentation and communication skills. Our lab is new, excited to be at Penn and we seek students with similar excitement for doing research. We welcome students from all backgrounds and identities. Students will receive mentorship from graduate students and postdoctoral scholars.

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Law

David Abrams

An Exploration of Large AI Models to Revolutionizing Law & Economics

My project can be modified to accommodate remote activities if made necessary by University policy.

Large AI Models such as ChatGPT-3 will undoubtedly have a major impact on a host of fields. Because widespread access to them is just beginning, little is known about where and how they may be best used. This project will explore the use of Large AI models in Law & Economics. Students will have the opportunity to be involved with cutting edge, exploratory research to help understand how these new tools can have the biggest impacts.

While the goals are extremely broad, students will have access to detailed data sets in the field of patents as well as criminal justice, but will not be restricted to those domains. Some technical background (such as programming or statistics) is helpful, but not required; the most important skills for this project are imagination and the ability to ask good questions. Students should be highly motivated and able to learn rapidly; by the end of the summer, there's a very good chance you will know more than me about parts of the project. Selected students should familiarize themselves with ChatGPT before the summer so they can hit the ground running. Note: this is applied use of Large AI Models, not development of novel Large AI Models, although some tweaking of models may be useful.

The hope is that by the end of the summer, at a minimum we will have identified the most promising avenues for the use of Large AI Models to push the frontier in Law and Economics. There is also the realistic possibility that progress will be rapid enough to begin the production of publishable academic work on the subject.*

*No AI was used in the composition of this project description.

Cary Coglianese

Regulation and Regulatory Processes

My project can be completed entirely remotely.

Cary Coglianese, a professor at the law school, directs the Penn Program on Regulation and conducts an extensive range of research projects related to all facets of regulation. Current projects include research on regulation and inequality, the regulation of artificial intelligence (and the use of AI tools by regulators), and various issues of environmental and climate change regulation. A research assistant would assist with a range of his projects and a variety of tasks that would likely include collecting and analyzing data, conducting library research, and assisting in manuscript preparation. Professor Coglianese is finishing up a book project on analytic tools and skills used by regulators and it is expected that a research assistant this summer would also help him as he completes this project. The Penn Program on Regulation's managing director, Andy Coopersmith, assists with managing student research projects and would provide additional mentorship.

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Jacques deLisle

China's Law at Home and Abroad

My project can be completed entirely remotely.

China's approach to law and sovereignty is Janus-faced. Sovereignty at international law and in international relations is conceived in terms of the inalienability and impermeability of (China's) sovereignty. On this view, legal commitments cannot encroach upon China's sovereignty or constrain the party-state's exercise of sovereignty within Chinese territory. Sovereignty domestically is defined in highly positivist and flexible terms. On this view, the state / the sovereign has unfettered discretion about how to govern its people and territory—including by law, constrained at most by procedural requirements (not substantive principles). The foregoing pattern is evident in China's approach to several contested issues, including: the governance of Hong Kong, the Taiwan question, Xinjiang, and disputes in the South and East China Seas, as well as China's engagement with the World Trade Organization and the international human rights regime.

The largely primary materials-focused research described above will be framed in the context of existing scholarship on Chinese law. The international law aspect of this part of the project is largely complete. The domestic law portion is not. Students will help to gather and evaluate recent interdisciplinary scholarship addressing many dimensions of Chinese law, legal institutions, and their political, economic, and social contexts. This part of the research will also be used in a thorough update and rewrite of a chapter on Chinese law and China's legal system in an edited volume on Chinese politics that is widely used in advanced undergraduate and graduate courses and read by scholars in the field more generally.

Students will learn how to collect and assess primary materials from China (and from China's counterparties in international disputes). (Chinese language skills helpful but not required for this part of the project). Working on this project will also give students a deep and broad exposure to English-language interdisciplinary scholarship on law in China, and students will learn how to find and evaluate such scholarship, and how academic research engages and addresses already-existing scholarship (a skill that will be especially useful to students contemplating graduate work in the social sciences, which requires "literature review" sections in research papers).

William Ewald

James Wilson Biography

My project can be completed entirely remotely.

James Wilson (1742-1798) was the first Professor of Law at the University of Pennsylvania. Before that, he signed both the Declaration of Independence and the US Constitution. He was appointed one of the first Justices of the Supreme Court--and then, when his land speculations collapsed, died in debtors' prison. (He is the only Supreme Court Justice to have been sent to prison.) That last fact caused his papers to be scattered and his name largely erased from the history books.

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New archival discoveries make clear that his role in the drafting of the Constitution was far greater than has been commonly supposed. I am at work on a full-scale intellectual biography, attempting to document his importance--and, in the process, to reclaim for Penn one of the principal architects of the Constitution.

As part of that project, I am preparing a scholarly edition of his papers. For that work, I need assistance in transcribing 18th-century manuscripts. Much of the job has already been done; it should be possible to complete the bulk of it this summer.

Scans of the original documents exist, but they need to be converted into text, which requires an ability to read Wilson's handwriting. (Fortunately, it is mostly very good.) The job needs to be done with precision, and is best done with two people working together: one reading out the text, the other transcribing then reading back what has been transcribed. That part of the task can be done entirely remotely, though it could also be done in person.

There are also various letters and other documents scattered in local archives. Tracking them down could involve an archival treasure hunt, which has its own kind of excitement.

I would expect this project to teach undergraduates something about the drafting of the Constitution, the life of James Wilson, and the practical aspects of archival research and the editing of historical materials. Some familiarity with US history of the revolutionary era would be helpful, but is not required. The main prerequisite is a capacity for meticulous work, for puzzling out difficult passages, and for paying attention to details.

Paul Robinson

Getting Away with Murder and Rape: Rethinking the Balance of Interests in Criminal Justice

My project can be completed entirely remotely.

A majority of killers elude justice. For more than 18,000 homicides annually, at least 10,000 killers walk away without a homicide conviction. Perhaps more troubling, homicide have the best victimization-conviction ratio of any offense. Of more than 1,200,000 aggravated assaults annually, only 8.3% are convicted for their crime. Of 64,000 annual rapes, 99.3% end in no felony conviction. That's more than 63,000 rapists walking away every year. What explains these failures of justice?

The host of doctrines and practices that regularly promote such justice failures are not irrational. Almost all are designed to protect some legitimate societal interest. However, there is reason to believe that lawmakers and system designers seriously undervalue the societal costs of failing to do justice and the societal benefits of doing it. The GAMR project examines the competing costs and benefits of the criminal justice systems most significant failure-of-justice doctrines, including matters relating to limitations on police investigative procedures, investigative errors, restraints on the use of technology, witness intimidation, poor community-police relations, the exclusionary rule, plea bargaining, the use of anti-justice distributive principles in criminal law codification and sentencing, executive clemency, and more. In each instance, the project considers reforms that have been made or proposed or could be

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proposed that would strike a different balance between the competing interests so as to reduce the justice-frustrating effect.

Work on the project to date has produced a first draft of a text that is used as the basis for a seminar at the law school and will be published as a book for the general public. The two PURM students this summer will work on the book manuscript, doing editing, research, cite checking, and brainstorming. We will meet on a zoom call each morning to agree on the work agenda for each of us during that day. More details on the project are available from Professor Robinson at phr@law.upenn.edu.

Christopher Yoo

The Challenges and Success Factors of Internet Connectivity Initiatives Around the World and Policy Implications

My project can be completed entirely remotely.

There are at least 2.7 billion still unconnected to the Internet across the globe. 1 World Connected, a research project of the Center for Technology, Innovation and Competition of the Law School, conducts evidence-based research on global Internet access initiatives. Our goal is to conduct a systematic analysis of Internet connectivity initiatives implemented by governments, technical communities, private sector, and civil societies around the world, and identify pathways for sustainable Internet connectivity initiatives. From 2017 to 2019, we conducted 120 in-depth interviews with program practitioners and implementers and generated 120 case studies on these initiatives. The case studies include supply-side efforts to extend the geographic coverage of the Internet as well as demand-side efforts designed to build capacity in the areas of digital literacy, gender equality, health, agriculture, mobile money, and e-government). Since 2020, many other connectivity initiatives, mainly in response to the COVID19 pandemic, have been implemented.

This year, we aim to update our database (revisiting old case studies and adding new ones) and analyze our data by coding the initiatives by multiple dimensions (e.g., longevity and public-private partnerships to understand the relationship between longevity, partnerships, and other factors). This analysis will build on our published work and recent reports which also analyse multiple case studies (e.g., on smartphone initiatives). We expect that the findings emerging from the analysis will inform policy makers and practitioners in technology and development.

Students' Duties and Responsibilities:

- Conduct a literature review on the success and sustainability of technology-based initiatives in the Information and Communication Technologies and Development (ICTD) literature
- Code case studies with respect to longevity, partnerships, and other necessary factors
- Help with the data analysis and create data visualizations

The academic and professional skills, experiences, and benefits a student would derive from working on our project:

- Gain insights on conducting research
- Improve writing skills, which will help you with your term papers in your future classes.

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- Develop an understanding on the Information and Communication Technologies and Development (ICTD) scholarship, and the roles different stakeholders such as public and private sector play in the scalability and sustainability of technology-based development projects.
- Develop coding and data analysis skills by working on a large dataset with different types of numerical and categorical variables.

Names and roles of other individuals involved in mentoring the student:

- Leon Gwaka, Postdoctoral Research Fellow
- Sindhura KS, Research Fellow

Medicine

ANESTHESIA

Victoria Bedell

Exploring the Effect of Mitochondrial Localization on Induced Unconsciousness in Zebrafish

My project is entirely in-person.

Despite comprising only ~2% of body mass, the human brain uses ~20% of the body's energy. This energy is used to establish and maintain electrical gradients for neuron signaling and synaptic transmission, as well as for a host of intracellular events, and is created mostly in the mitochondria. It has been well established that specific mitochondrial proteins are targets of general anesthetics, contributing to anesthetic sensitivity, most likely through reductions in oxidative phosphorylation and ATP availability. It is also known that complex systems have evolved to transport mitochondria to different intracellular locations, suggesting that mitochondrial location is critically important for normal cellular function. In neurons, for example, kinesin and dynein are motor proteins that transport cargoes such as mitochondria anterograde (down the axon) or retrograde (resp). Because previous work has shown that kinesin (kif) processivity is inhibited by propofol and etomidate, it is possible that mitochondria are mal-distributed in anesthetized neurons. The effect of anesthetics on mitochondrial location, or whether alterations in mitochondrial distribution alter anesthetic sensitivity, has never been explored.

There are multiple different projects that can be done exploring this fundamental question. In one project, the student can be involved in an understanding how mitochondrial neurons are altered in response to multiple anesthetics. To do this, they will work with fixed larval zebrafish. They will learn to dissect out larval zebrafish brains, perform a triple immunofluorescent stain, image the brains using confocal microscopy and analyze the differences in mitochondrial location with the neurons. A second project is understanding how accumulation of mitochondria at the synapse alters anesthetic response. To do this, they will use an established mutant line, actr10. They will learn to create a dose curve using

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the different anesthetics and add those to the live zebrafish larvae. Then, they will use the behavioral chamber and known general anesthetic behaviors to test for alterations in response to the anesthetic curve. Finally, they will analyze the data and learn to create Hill curves and calculate the EC50 for each drug.

Finally, there is a new project starting in the lab assessing the effect of altered mitochondrial movement on neuron signaling using GCaMP, a green fluorescent indicator of calcium signaling. The student will learn to use confocal fluorescence imaging on live zebrafish. They will be comparing unanesthetized zebrafish with those at different doses of anesthetics. This project will require at least a baseline knowledge of MatLab and ImageJ.

Seema Bhatnagar

The Neurobiology of Stress Resilience

My project is entirely in-person.

Psychiatric disorders such as post-traumatic stress disorder (PTSD) and depression are debilitating mental health conditions that are initiated or made worse by stressful live events. However, only a subset of stressed individuals develop these disorders. Why is it that some people develop PTSD and others don't? One possibility is that how individuals respond to stress can affect the outcomes following stress. The goals of this project are two-fold: 1) to understand the neurological and behavioral differences that lead to some individuals being resilient to the effects of stress and others being susceptible 2) to understand how resilience to stress impacts metabolic functions and weight gain with a high fat diet.

Students will learn how to analyze behavioral data obtained from stress experiments and virally-mediated manipulation of specific brain regions, as well as how to perform histological experiments to examine connectivity between different brain regions regulating stress. The student will develop a thorough understanding of neural circuit research using in various behavioral and analytical techniques including social defeat stress, contextual fear conditioning, metabolic analyses, and analyses of brain markers using immunohistochemistry and fluorescent imaging.

Students will be mentored by the PI and a senior member of the lab. The lab has considerable experience mentoring undergraduates and provides a dynamic learning environment.

Renyu Liu

Improving Stroke Care in Africa: Education and Impact

My project can be completed entirely remotely.

This would be an ideal project for a student majoring in graphic or arts, script writing, film or communication related fields. The student will be assisting Dr. Renyu Liu's team to produce and implement educational materials including posters, graphics, short videos, and short movies using the innovative approach Stroke 112 for Africa countries. This is part of the research project to improve

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stroke care in Africa. One example of the tasks is to develop a compelling short movie script telling a true story about life after a stroke in African countries. This project is a finalist for the Penn Global's Holman Africa Research and Engagement Fund. The Holman Africa Research and Engagement Fund could potentially offer 1:1 match the student funding for the project (not towards the student stipend). The student will work with Dr. Renyu Liu at the School of Medicine, and Professor John B. Jemmott III, Associate Dean for Graduate Studies at Annenberg School for Communication. The student will also have the opportunity to work with professional film makers and stroke experts and survivors in Nigeria.

Dr. Renyu Liu is a professor at the Departments of Anesthesiology and Critical Care, and Neurology, and the co-chair of the World Stroke Organization Taskforce for Prehospital Care. Dr. Liu has produced educational materials (posters, YouTube videos and award-winning short films) to promote stroke awareness among the public using a novel approach he developed where the emergency number (911 in USA, 120 in China, 112 in Africa) is used as a mnemonic for stroke symptom recognition. Educational materials have been produced for China, and for non-English speaking Chinese groups in the USA, and now educational materials are produced for countries in Africa, initially Nigeria.

The student will be mentored by Dr. Liu to help his team produce artistic, appealing educational materials on early stroke recognition to be distributed by collaborators in African countries and by various social media such as YouTube, etc.

Professor John B. Jemmott III has rich experience working with international collaborators to improve health in African countries. He will help mentor the student on critical aspects of an international collaborative project.

Dr. John Grothusen is Dr. Liu's lab manager, and an Emergency Medical Technician for Westmont Fire Company in New Jersey, will assist Dr. Liu in explaining any medical concepts related to stroke for the student to facilitate production of educational materials.

Alexander Proekt

Brain Dynamics Underlying Hallucinations

Second-year only

My project can be modified to accommodate remote activities if made necessary by University policy.

During the administration of subanesthetic doses of ketamine, the brain enters a dissociative altered state, characterized by vivid hallucinations and perceptual and cognitive distortions. During such states, despite the presence of rich internal experience, responsiveness to external stimuli is disrupted. How this state is sustained by the brain's dynamics is poorly understood. This project specifically seeks to understand the features of neural dynamics underlying disrupted perception while under subanesthetic concentrations of ketamine.

We seek to accomplish this by leveraging EEG data collected from humans completing perceptual tasks while undergoing infusions of ketamine. We can estimate dynamics during successful perceptual trials, and compare them against dynamics during unsuccessful trials, at increasing doses of ketamine. We will seek to answer questions such as: What features of neural dynamics are associated with successful

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detection of stimuli? Are they disrupted by increasing doses of ketamine? Can we predict whether an individual will respond to a stimulus based on neural dynamics immediately preceding its presentation?

Students will have the opportunity to develop computational skills, including advanced statistical modeling, machine learning, and EEG analysis, and develop exposure to the growing study of altered states. Additionally, students will learn broad scientific skills, such as experimental and analytic design, interpretation and communication of results, and complex data analysis. Students will attend and participate in group lab meetings. Students will be jointly mentored by Dr. Proekt and Diego Dávila, a PhD Candidate in Neuroscience.

Huafeng Wei

Intranasal Dantrolene to Treat Alzheimer's Disease

My project is entirely in-person.

The students will join an NIH grant funded project, aiming to develop intranasal administration of dantrolene, a drug used to treat malignant hyperthermia in anesthesia practice, as a future disease-modifying drug for treatment of Alzheimer's disease. Please see following medical school news website for more information. https://www.pennmedicine.org/news/news-releases/2020/march/giving-commonly-muscle-relaxant-through-nose-potential-treat-neurodegenerative-diseases.

Students will join part of the research project and be trained for generation of biomedical research ideas, writing of review paper and publications, learning experimental techniques on tissue cultures, determination of cell viability, intracellular calcium concentration, mitochondria function, inflammation and reactive oxygen species (ROS), under direct supervision of Dr. Ge Liang (Grace). The students will also learn the memory and learning behavioral tests in mice. Students are expected to attend a weekly lab meeting and opportunities to present journal clubs. The students are expected to assist collection of experimental data, analysis and manuscript drafting and publication.

Elizabeth Railey White

Screening of Simple Hydrocarbons as Anesthetic Antagonists

My project is entirely in-person.

An interested student would have the opportunity to learn in vitro and/or in vivo assays of pharmacologic activity of anesthetic molecules and to screen a library of small molecules that may act as anesthetic antagonists. It is known that some simple hydrocarbons have anesthetic properties, but we also have recent evidence from our lab that some simple hydrocarbons can actually act as anesthetic antagonists. Where does the transition of a molecule with only hydrophobic features transition from anesthetic to antagonist?

The first stage this project would be to help perform an initial literature search to provide a more complete understanding of the literature in this area. However, the majority of this project will be spent performing behavioral assays of anesthetic activity in larval zebrafish and thus the student should be

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comfortable working with live animals and humane euthanasia. We have a small lab, so mentorship would be provided by myself (Railey White, PI) as well as my technician (Diana) who has copious experience with this assay. In addition to basic zebrafish husbandry and breeding, the student will learn how to conduct a behavioral assay with zebrafish, the basics of drug screening, as well as how to analyze, interpret and present the data they've collected.

BIOCHEMISTRY & BIOPHYSICS

James Shorter

(Dis)Solving the Problem of Aberrant Protein States

My project is entirely in-person.

Neurodegenerative diseases and other protein-misfolding disorders (e.g. ALS/FTD, PD, AD, HD) represent a longstanding biomedical challenge, and effective therapies remain largely elusive. This failure is due, in part, to the recalcitrant and diverse nature of misfolded protein conformers. Recent work has uncovered that many aggregation-prone proteins can also undergo liquid-liquid phase separation, a process by which macromolecules self-associate to form dense condensates with liquid properties that are compositionally distinct from the bulk cellular milieu. Efforts to combat diseases caused by toxic protein states focus on exploiting or enhancing the proteostasis machinery to prevent and reverse pathological protein conformations. In the Shorter lab, we use a variety of techniques to elucidate and engineer therapeutic agents ranging from protein disaggregases, RNA disaggregases, short RNAs, and small-molecule drugs to combat the diverse aberrant protein states that underlie protein-misfolding disorders.

Cornelius Taabazuing

Discovery and Characterization of Caspase Substrates

My project is entirely in-person.

How cells respond and adapt to extracellular and intracellular dangers such as pathogens or DNA damage is important for survival and many disease states. The response to such dangers is usually mediated by large multiprotein death signaling complexes that can either eliminate the damaged cells or in some instances promote pro-survival pathways. However, the specific inputs that initiate the death signaling complex formation as well as the downstream signaling pathways activated by these complexes are not well understood. My overall research program is mainly focused on understanding the molecular mechanism of activation of death signaling complexes that regulate caspases, the downstream signaling pathways that they regulate, and how those processes can be exploited to generate therapeutics for inflammatory disorders and cancer.

The substrates of caspase-1 (CASP1) are all critical regulators of immune responses against pathogens. However, these cleaved substrates can also be detrimental to the host. For example, IL-1beta is an

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important substrate of CASP1, and IL-1beta blocking antibodies were recently shown to dramatically reduce the incidence of lung cancer. As the substrates of CASP1 are important targets for drug development, there is a critical need to identify CASP1 substrates and to understand their biological functions in order to elucidate the fundamental mechanisms controlling innate immunity and to develop new strategies to treat cancer and autoimmune disorders.

The goal of this summer project is to identify novel caspase-1 substrates in mammalian cells in response to a variety of different stimuli. Caspase-1 can be activated by multiple pathogens and even small molecule drugs. We recently developed a method to express the catalytically inactive yet active species of CASP1 in cells. The student will express this caspase-1 in epithelial and immune cells and activate CASP1 using different methods. They will then perform immunoprecipitations after caspase activation, and then use immunoblotting and mass spectrometry to identify substrates. They will gain skills in tissue culture, and biochemistry, and if time permits, skill in preparing samples for mass spectrometry analysis and data work up. This work will allow us to identify critical substrates of CASP1 that are important for immunity in different contexts.

The student will be directly supervised by me as well as my lab manager, Dr. Bohdana Discher, and a 2nd year graduate student, Patrick Exconde. Collectively, we will teach the students the technical skills in culturing cells, expressing proteins in cells, performing immunoprecipitations, and immunoblotting.

BIOSTATISTICS & EPIDEMIOLOGY

Aimin Chen

Environmental Chemical Exposure and Child Development

Second-year only

My project can be completed entirely remotely.

Environmental chemical exposure is ubiquitous in pregnant women and children, which may adversely affect pregnancy outcomes and child development. The research project for Penn Undergraduate Research Mentoring Program (PURM) is in the discipline of environmental epidemiology that examines chemical exposure in early life and child health outcomes in pregnancy and birth cohorts. The environmental chemicals include heavy metals (lead, mercury, arsenic, cadmium) and endocrine disrupting chemicals (bisphenols, phthalates, organophosphate and brominated flame retardants, perfluoroalkyl substances), with biomarkers assessed in blood and urine samples. The health outcomes include preterm birth, fetal growth restriction, and child cognitive and behavioral functions.

The undergraduate student will work on a project to examine the association between an exposure and an outcome. The student will gain experiences in PubMed literature search and review of the study topics. The student will participate in data management and statistical analysis by modifying sample codes in SAS or R and summarize study findings using tables and figures. The student will draft a report for the research project. The student will have an opportunity to collaborate with a large group of

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researchers in epidemiology, biostatistics, obstetrics, pediatrics, environmental health sciences, and public health. The research is conducted virtually using computer and software. The applicants are expected to have experience in biology, environmental sciences, public health, or data science.

Blanca Himes

Effects of Air Pollution and Environmental Variables on Respiratory Health Disparities in Philadelphia

My project can be completed entirely remotely.

Marked health disparities are known to occur by race/ethnicity and socioeconomic conditions in the U.S. for a variety of conditions, including asthma and COPD. The overall goal of this project is to better understand the relationship between demographic and environmental variables and prevalence and severity of various health outcomes in Greater Philadelphia. Students will use publicly available data (related to air quality, pollution, litter and housing), genetics, and/or and Electronic Health Record (EHR)-derived data to identify relationships among environmental and health-related variables. Data analysis will be performed primarily using R. If the student is not familiar with R, there will be an opportunity to learn it. Student must be an enthusiastic, driven, and mature individual who is looking for research experience as preparation for graduate or medical school, or a position that requires data analysis. The precise question to be addressed will depend on student interests and experience.

Danielle Mowery

Developing an Automated Method for Automatically Phenotyping Patients with Disease Phenotypes from Clinical Texts

My project can be modified to accommodate remote activities if made necessary by University policy.

Observational studies using electronic health records are fundamentally important to understanding the natural history, the disparities in prevalence, course, and treatment efficacy of patient disease. Machine learning (ML) and natural language processing (NLP) approaches to observational research hold great potential as they are reliable, time and cost-effective method for defining study cohorts. However, rich descriptions needed to most accurately phenotype patients as with or without a disease are often "locked" within clinical texts. Clinical scientists may review thousands of patient cases and their corresponding texts before conducting clinical and translational studies of disease. Manual review can be labor-intensive, expensive, unscalable, and not easily replicated for other clinical research studies. Automated methods for extracting descriptions of and classifying patients with atopic dermatitis could improve research efficiency and reproducibility as well as help clinical scientists conduct large-scale studies to establish safer and more cost-effective treatments for patients.

For this study, undergraduates will 1) conduct a socio-technical study with Penn clinicians and medical doctors as they characterize disease descriptions recorded within de-identified clinical texts, 2) develop and evaluate a natural language processing (NLP) system to automatically extract, encode, and classify patients with indicators of a disease, e.g., for atopic dermatitis mentions of pruritic skin, xerosis, rhinitis allergy, dermatitis, asthma, hay fever and other indicators, from clinical texts using clinical NLP toolkits,

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spaCy, and python, 3) present their findings to the Semantic Analysis of Text to Inform Clinical Action (SemAnTICA) research lab. Potential diseases and phenotypes of study include, but not limited to atopic dermatitis, cardiac arrest, asthma, among others.
In addition to completing this project, undergraduates will participate in weekly meetings in Dr. Danielle Mowery's vibrant research laboratory, the Semantic Analysis of Text to Inform Clinical Action (SemAnTICA) lab, where they will learn about rules-based, machine learning, and deep learning approaches to developing NLP systems for supporting clinical and translational studies ranging from the bench to the bedside and beyond!

Danielle Mowery PhD FAMIA
https://www.dbei.med.upenn.edu/bio/danielle-mowery-phd-famia

CANCER BIOLOGY

Xiaolu Yang

Cancer and Neurodegenerative Diseases

My project is entirely in-person.

The Yang Lab at the Perelman School of Medicine studies the molecular and cellular mechanisms that protect against cancer and neurodegeneration. Our current projects focus on two areas: (1) the tumor suppressor p53, metabolism, and autophagy, and (2) protein quality control and neurodegenerative diseases.

Cancer, which encompasses over 100 diseases that occur in most cell types and organs of the human body, remains a leading cause of death in the US and the world. The relentless cell proliferation that characterizes all forms of cancer is normally prevented by an elaborate tumor suppressive network. A central hub of this network is the preeminent tumor suppressor p53, whose mutations are the single most common genetic lesion in human tumors. We have revealed an important role for p53 in modulating metabolic pathways that are critical for biosynthesis and redox balance. We are investigating the function of p53 as both a sentinel and a regulator for metabolic activities. Furthermore, we are identifying and characterizing metabolic alterations that drive tumor initiation and progression. A recent extension of this research area is to define the role of metabolism and autophagy in stem cells, including embryonic stem cells and cancer stem cells.

Neurodegenerative diseases are becoming increasingly prevalent as the human population ages. They are highly debilitating and inevitably fatal, yet remain incurable. These diseases, including Alzheimer’s disease, Parkinson’s disease, amyotrophic lateral sclerosis (Lou Gehrig's disease), and polyglutamine diseases, are associated with misfolding and aggregation of proteins in the central nervous system, which ultimately leads to neuronal cell death. Our lab recently identified two new protein quality control (PQC) systems, which consist of tripartite motif (TRIM) proteins and poly-Asp/Glu (polyD/E) proteins, respectively. These systems are multifunctional, highly effective in suppressing protein misfolding and aggregation and, unlike canonical PQC systems, independent of ATP. We are investigating their mechanisms of action, their roles in protecting again neurodegenerative diseases, and their utility in treating these diseases.

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Our experimental strategies include molecular, biochemical, and cell biology techniques, genomic analysis, metabolic analysis, cell and animal models of cancer and neurodegenerative diseases, and human patient samples. Undergraduate students will be able to work closely with postdoctoral fellows, PhD students, and research specialists in one of these two areas.

CARDIOVASCULAR MEDICINE

Nosheen Reza

Optimal Management of Background Therapy in Patients with Symptomatic Obstructive Hypertrophic Cardiomyopathy Initiated on Mavacamten

My project can be modified to accommodate remote activities if made necessary by University policy.

Hypertrophic cardiomyopathy (HCM) is one of the most common inherited cardiovascular diseases. The most common subtype of HCM is that with dynamic left ventricular outflow tract obstruction, i.e., obstructive HCM. Historically, the medical management of obstructive HCM has centered on symptom palliation. In April 2022, a first-in-class treatment that addresses the molecular mechanisms of HCM, mavacamten, was approved by the United States Food and Drug Administration. As mavacamten is being increasingly prescribed, there remain many unanswered questions regarding the risks and benefits of continuation or withdrawal of background medical therapy in patients who are newly initiated on the drug. The overall objective of this study is to generate evidence regarding the reduction of background medical therapy in patients with symptomatic obstructive HCM who are newly initiated on mavacamten, a first-in-class novel cardiac myosin inhibitor.

Penn has a robust clinical program for the care of patients with inherited cardiovascular diseases. The student will be mentored by Dr. Nosheen Reza, an Assistant Professor of Medicine in the Division of Cardiovascular Medicine and a genetic and advanced heart failure and transplant cardiologist. In this project, the student(s) will work primarily with Dr. Reza to characterize the effects of sequential reduction in background medical therapy on the hemodynamics and health status of patients with symptomatic obstructive HCM who are newly initiated on mavacamten.

The student will gain experience working in a multidisciplinary health care setting, and this project has the potential to significantly impact clinical practice. The student will learn clinical research skills including clinical trial design, cohort creation, data collection, data analysis, record retrieval, and data management. The student will have opportunities to practice scientific writing and presentation and to create scholarship based on this project including abstracts for national scientific conferences and manuscripts for peer-reviewed journals.

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Victoria Vetter

Sudden Cardiac Death Prevention in Youth-Heart Safe Schools and Communities in Southeastern Pennsylvania

My project can be modified to accommodate remote activities if made necessary by University policy.

Sudden cardiac arrest (SCA) occurs when the heart suddenly and unexpectedly stops. Without intervention, sudden cardiac death (SCD) occurs. The US has >380,000 out-of-hospital SCA/year affecting 23,000 youth. Only cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use prevents sudden cardiac death. While survival in the community is only 10% after a SCA, survival in a school with an AED and cardiac emergency response (CERP) plan can be over 89%. Youth Heart Watch (YHW) is a SCA/SCD prevention program at the Children's Hospital of Philadelphia (CHOP) aiming to prevent sudden cardiac death among youth. The YHW Heart Safe School (HSS) program helps schools and youth organizations develop programs to save lives from SCA.

The number of AEDs in schools in Philadelphia, Bucks, Chester, Delaware, and Montgomery counties is unknown. Pennsylvania State Law (Act 35: 2014) mandates that schools report their AEDs, but compliance is poor and there is no true accounting of schools with AEDs. Many schools with AEDs, do not have a CERP outlining response to a cardiac emergency, nor do they practice SCA drills-unlike mandated fire and active shooter drills. YHW is working to designate schools as Heart Safe if they comply with a set of criteria that include having an onsite AED, CERP, and practicing SCA drills. The student will learn research design and methodology using REDCap to create a database of AEDs, CERPs and SCA drills in all schools in the 5-county southeastern Pennsylvania region. The student will participate in collecting, entering, and analyzing data in REDCap from schools in the 5-county area. The student will help determine the current status of the school's AED program and help with implementation of Heart Safe School Programs in these schools. The student will participate in visits to the schools to see how a HSS Program is implemented. The student will learn CPR and AED use and assist in instruction in the schools. The PURM student's work will help provide a needs assessment to be used to introduce and help pass a bill in the Pennsylvania legislature to require AEDs in schools with CERPs and drills. They will learn advocacy skills, how science can be the foundation of legislative efforts, and how public health reaches far beyond the medical office. The student will have the opportunity to shadow pediatric cardiologists in clinics at CHOP to learn about conditions that cause SCA/SCD, and the treatments applied to prevent this occurrence.

CELL & DEVELOPMENTAL BIOLOGY

Marisa Bartolomei

Outcomes in a Mouse Model of Assisted Reproductive Technologies

My project is entirely in-person.

Assisted Reproductive Technologies (ART) have helped many individuals start a family. Nevertheless ART, including IVF, is associated with a moderate risk for adverse events and conditions, including

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increased detrimental cardio-metabolic outcomes and a higher incidence of imprinting disorders. Because we can not address what aspect of ART contributes to these outcomes in humans, we have developed a mouse model that closely recapitulates the procedures and outcomes in human and also has normal fertility, eliminating infertility as a confounder. Using this model, we have tested many of the procedures used in ART. We find that the necessary culturing of embryos is most detrimental to morphology and molecular biology of the placenta. Additionally IVF mouse offspring have adverse metabolic outcomes, which are dependent upon the sex of the offspring. The proposed project will assist a graduate student (Cassidy Hemphill) and postdoctoral fellow (Eric Rhon-Calderon) evaluate outcomes of mice generated by IVF and an additional more commonly used and invasive procedure, blastomere biopsy. Behavior assays and metabolic testing (triglycerides, cholesterol etc) will be performed. Additionally, molecular and epigenetic assays will be used on post-mortem tissues. The candidate will contribute to a productive team research project, attend lab meetings and journal clubs and have the opportunity to experience cutting edge biomedical research. In addition to learning the various assays, the individual will learn about the biomedical research environment, the importance of computational biology in all aspects of research and considerations of rigor and reproducibility in research.

Kahlilia Blanco

Epigenetic Profiling of the Injured Brain

My project is entirely in-person.

OUR GOAL: Stroke is a devastating neurological disease that affects millions of individuals every year and causes severe disability or death. The goal of our laboratory is to improve clinical therapies for stroke patients by researching ways to prevent brain damage after stroke.

OUR RESEARCH: Epigenetics refers to processes that change the ways genes are expressed without changing the genetic code. Epigenetics can be altered by environmental factors such as diet, sleep, and stress. Scientific evidence over the last decade has revealed that epigenetics play a major role in stroke injury! Our research investigates the role of epigenetic factors in neuroprotection and their potential as stroke therapeutics.

PROPOSED PROJECT: The 10-week PURM project will be focused on profiling epigenetic patterning in the brain using in vitro and in vivo mouse models of stroke. In particular, the project will 1) examine spatial epigenetic changes by cell type (i.e. neurons, glia), 2) analyze temporal epigenetic changes (i.e. early and late stroke timepoints), 3) and assess cell death in the brain after stroke. DNA modifications such as DNA methylation, DNA hydroxymethylation, as well as noncoding RNAs will be assessed. The student will have the opportunity to acquire skills in DNA/RNA isolation, gene expression analysis, microscopy, cell culture, brain tissue processing, and basic cell and molecular biology techniques.

ABOUT US: Our lab is a supportive and welcoming environment for all of our trainees! The PURM student will be mentored by the principal investigator (Dr. Kahlilia Blanco) and trained/assisted in experiments by the lab manager (Sylwia Pietrzak).

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CELL & MOLECULAR BIOLOGY

Juan Alvarez

How Circadian Rhythms Impact Pancreatic Islet Development & Phisiology in Health & Disease

My project can be modified to accommodate remote activities if made necessary by University policy.

This is a unique opportunity to engage in cutting edge research at the interface of Diabetes, Circadian Rhythms, and Regenerative Medicine. Our lab (www.j-radlab.com/) studies how cells become functionally specialized, or "mature" (Alvarez-Dominguez and Melton, Cell 2022). We focus on the pancreatic islet, whose loss or dysfunction underlies diabetes. Diabetic patients can be cured by transplanting replacement islets. We developed methods to grow islets from human stem cells, which offer a limitless cell supply for transplantation therapy and basic research. We are using these organoids, and live mouse models, to study islet development and physiology in health and disease. We are particularly interested in how circadian & metabolic rhythms impact islet maturity (Alvarez-Dominguez et al., Cell Stem Cell 2020). Our long-term goal is to apply findings from our studies to build mature stem cell-derived organoids as better models of islet development & physiology and to develop new islet replacement therapies. Students will be able to contribute to projects according to their individual interests, within our main research themes:

- Modeling human pancreatic islet development and physiological maturation
- Engineering islet organoids for modeling type 1 diabetes onset and progression
- Dissecting how circadian feeding-fasting rhythms steer islet maturation

We are members of the Penn Institute for Diabetes, Obesity and Metabolism, the Chronobiology and Sleep Institute, and the Institute for Regenerative Medicine. Our lab offers a multi-disciplinary training environment, rich with opportunities for career development, mentoring, and outreach, in addition to scholarly pursuits. We embrace diversity, equity, and inclusion.

Students who join our lab gain expertise in Cell, Developmental & Molecular biology, and Bioengineering. This includes hands-on experience with live mice, human stem cell tissue culture, and single-cell technologies and analytical approaches, to address fundamental questions in tissue engineering and regenerative medicine.

The ideal candidate will be a student primarily interested in Cell/Developmental/Molecular Biology who also has a general interest in human disease treatment. Prior experience with laboratory bench or animal work, or with bioinformatics, is highly desirable.

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Kate Townsend Creasy

Circadian Regulation of Liver Glucose Metabolism in Hepatic Steatosis

My project is entirely in-person.

Hepatic steatosis is the accumulation of excess fat in the liver that can results from genetic factors and metabolic disorders, and it is the first stage of non-alcoholic fatty liver disease (NAFLD). NAFLD is the leading cause of chronic liver disease in the U.S. and is associated with Diabetes, dyslipidemia, cardiovascular disease, and is a leading cause of advanced liver disease contributing to liver failure. NAFLD is often underdiagnosed because there are typically no clear symptoms or biomarkers in early disease stages, and there currently are no FDA-approved treatments for NAFLD. It is therefore important to understand the genes and metabolic pathways that are involved in developing hepatic steatosis to better understand patient risks and identify potential therapeutic interventions.

Our work focuses on a gene called PPP1R3B that is associated with NAFLD in several GWAS studies. The PPP1R3B protein helps regulate the conversion of glucose into glycogen in the liver, but our work shows that impaired expression or function of PPP1R3B causes a switch to storing glucose as fat. PPP1R3B was recently identified as a potential circadian gene, but it is not currently known if PPP1R3B has a role in regulating circadian rhythms. In this project, we will examine the interactions of PPP1R3B with circadian clock genes and regulatory proteins and investigate how changes in Ppp1r3b expression alter circadian rhythm. We will use a combination of small interfering RNAs (siRNA) and adeno-associated viruses (AAV) to alter the expression of PPP1R3B in cultured cells and assess the impact on circadian gene expression and glucose metabolism.

This project will allow the student/s to become proficient in several molecular biology techniques involving basic cell culture as well as cell transfection methods with siRNA and AAVs. They will perform cellular RNA extraction, complimentary DNA (cDNA) synthesis, quantitative PCR, cellular protein extraction and quantitation, and Western blotting. They will also perform biochemical assays including colorimetric triglyceride and glycogen quantification assays. Students will graph, analyze, and help interpret the experimental results, and will present updates in an informal lab meeting setting. [Optional] Students may also learn beginner bioinformatics to analyze single-cell RNAseq data of human liver samples that could further support results from in vitro experiments.

DERMATOLOGY

John Seykora

Mechanisms of Skin Cancer and Inflammatory Diseases

My project is entirely in-person.

Our laboratory has developed novel approaches to study the mechanisms of UV-induced skin carcinogenesis and atopic dermatitis. We have transgenic mice that overexpress the Src tyrosine kinase Fyn in the epidermis. Increased epidermal Fyn kinase activity leads to spontaneous formation of precancerous lesions and squamous cell carcinomas (SCCs); SCCs are the second most common form of skin cancer. We also discovered a negative regulator of Fyn which we named Srcasm (Src-activating and

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signaling molecule). Downregulation of Srcasm is seen in human skin cancers, and to better understand the biological impact of Srcasm downregulation on cells in vivo, we have developed a Srcasm knockout mouse and Srcasm siRNA knockdown lentiviruses. We have ongoing projects using Fyn transgenic and Srcasm knockout mice to study the effect of UVB on skin cancer and to test new therapeutic approaches using topical kinase inhibitors.

In addition, our laboratory has also begun investigating the role of fibroblasts in regulating inflammatory skin diseases like atopic dermatitis. Projects related to atopic dermatitis are ongoing.

Students working on these projects will be supervised by a senior post-doc/fellow or technician and will be expected to assist in genotyping and analyzing the skin of these mice using molecular techniques. Students will be expected to learn how to make protein lysates from skin, perform western blots, perform immunohistochemistry, and isolate RNA and DNA. Once mastery of these techniques is demonstrated additional experimental responsibilities will be given. No prior experience is required; however, a commitment to become proficient at this work is necessary.

EMERGENCY MEDICINE

Antonio Davila

Role of Chronic Environmental Stress in the Development of Platelet Dysfunction in Trauma Patients

Second-year only
My project is entirely in-person.

Our lab is focused on understanding the impaired mechanisms of blood clotting that affect many patients suffering from a penetrating trauma (gunshot wound, stab wound, etc.). In a retrospective study conducted by the Penn Acute Research Collaboration (PARC) on patients admitted to the Penn Presbyterian Medical Center trauma bay, we found that 64.5% of these patients presented with a PD at admission. This alarmingly high incidence rate was correlated significantly with higher injury severity scores (ISS), penetrating trauma, and increased mortality.

The key question that we are asking is: Why is the prevalence of platelet dysfunction so high in our trauma population? We are using several approaches to address this problem:

We are analyzing plasma samples obtained from trauma patients to measure the levels of neural stress mediators and inflammatory cytokines. We will measure the levels of neuroendocrine mediators and inflammatory cytokines. We will determine the levels of cortisol and DHEA-S using traditional radioimmunoassay (RIA) and will measure cytokine levels utilizing the Ella Immunoassay system, an ultra-sensitive next-generation ELISA platform.

We are also analyzing the patients' genetic background as critically important to the proper coagulation following a trauma. Single-nucleotide polymorphisms (SNPs) in the coding region of several key inflammatory proteins and cytokines have been associated with altered coagulation, sepsis, and increased mortality. For this portion of the study, genomic DNA will be purified from patient buffy coat samples and genotyped using real-time polymerase chain reaction (RT-PCR) assays with specific

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fluorescence-labeled probes. PCR primers and fluorogenic probes were designed to identify SNPs and determine the number of tandem repeat polymorphisms in the hypervariable regions. We are looking for one or two undergraduate students who have some experience working in a laboratory setting- either in a research setting or as part of a course. Since the student researchers will be handling and processing irreplaceable patient bio-samples, it is necessary that they have some training and experience with wet lab work. Further, our clinical research lab only works with human samples and operates under enhanced BSL-2 guidelines.

After a training period, students will be expected to work largely independently for their summer position. As described previously, students will learn and perform many kinds of molecular biology procedures. These include: DNA extraction, PCR, restriction enzyme digestions, RT-PCR, ELISA, among others. In addition to the research requirements, students will also need to take several online training modules including HIPAA, bloodborne pathogens, and CITI trainings.

ENDOCRINOLOGY, DIABETES, & METABOLISM

David Merrick

Contribution of Adipose Progenitor Cells to Early Development Metabolic Disease in Obesity

My project is entirely in-person.

Obesity and the metabolic syndrome represent a profound public health challenge for which there are few effective therapeutics. The healthy growth of adipose tissue depends on the capacity of progenitor cells to undergo de novo adipogenesis. Our research program is focused on understanding the cells types, niche locations and intracellular signaling pathways that regulate mesenchymal progenitor cell activity. Using cutting-edge approaches including single-cell RNA transcriptomics, CRISPR-based rapid mouse model generation and in-vivo lineage tracing, we have discovered several novel progenitor cell populations. Mesenchymal progenitors represent a promising therapeutic target for the treatment of obesity and diabetes. Directing the differentiation of progenitor cells away from a deleterious pro-fibrotic phenotype and towards a metabolically beneficial fate could significantly improve outcomes for patients suffering from the consequences of obesity. We have several projects focused on understanding the physiological role of novel mesenchymal progenitor cell populations to metabolic health in adipose tissue and skin.

Subcutaneous adipose is composed of several distinct anatomical layers including dermal and classic subcutaneous depots. Subcutaneous adipose progenitors contribute directly to healthy hyperplasic expansion, and their lineage specification during development may be an important determinant of metabolic sensitivity to weight gain. Recent studies have demonstrated that dermal adipocytes are metabolically distinct from classic subcutaneous adipose depots, and regulate many critical physiological functions of skin biology. To explore the lineage hierarchy of subcutaneous and dermal adipose tissue we paired single-cell sequencing with histological analysis to create a cell atlas of subcutaneous adipose

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development in the mouse. We discovered several novel populations of progenitor cells that are predicted to give rise to subcutaneous and dermal adipocytes. One of the exciting next steps for this project is to employ a truly cutting-edge technology called spatial transcriptomics, which combines the power of single-cell analysis with special information, and should allow us to further pinpoint the special and temporal birth of dermal and subcutaneous adipose during development.

All trainees in the Merrick lab will become versed in core and cutting-edge laboratory skills that will serve as a robust foundation for future research efforts. These include: generation and analysis of single-cell and proteomic data sets, performance of quantitative polymerase chain reaction (qPCR) to measure gene expression, performance of immunohistochemistry to determine protein localization, proficiency with cell culture techniques, translational experiments in animal models of obesity, manipulation of human primary tissue cultures, as well as basic molecular biology skills such as DNA, RNA and protein quantification.

GENETICS

John Murray

High Throughput Identification of Developmental Regulators

My project can be modified to accommodate remote activities if made necessary by University policy.

Recent technological innovations have led to a wealth of molecular information about animal development. Single cell RNA-sequencing studies have generated "atlases" that describe all of the genes expressed in each cell of the organism across development. A key question facing the developmental biology research community is how to use these atlases to predict the functions of new developmental regulators.

Our lab recently generated one of these molecular atlases for the embryo of the nematode Caenorhabditis elegans. C. elegans is an ideal system in which to study developmental mechanisms due to its rapid, reproducible development, abundant experimental tools, and because most critical developmental regulators are conserved with humans and other animals. Using these atlases, we have identified novel conserved regulators of nervous system development.

For this summer project, the student will characterize the functions of these neurodevelopmental genes in C. elegans embryonic development. They will use state-of-the-art single-cell phenotyping tools (including time-lapse imaging, automated cell tracking, and expression analysis) to define the role of their gene of interest in development including defining their upstream regulators, downstream targets, and cell fates that they control.

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Zhaolan (Joe) Zhou

Pathogenic Studies of Mouse Models of Autism Spectrum Disorders

First-year only
My project is entirely in-person.

Autism spectrum disorders (ASDs) are a heterogeneous group of disorders with a strong genetic component. They share common deficits in social communications. While many of the identified ASD risk genes encode synaptic proteins that are predominantly expressed in neurons in the brain and critical for synapse development and function, recent human genetic studies have identified another group of ASD risk genes that are involved in epigenetic regulation. However, the mechanism by which mutations in epigenetic regulators contribute to ASD risk is not well understood.

In the Zhou lab, we have developed multiple mouse models carrying genetic mutations associated with ASDs and plan to employ a variety of molecular, cellular, genomic, and imaging based approaches to investigate the pathogenic mechanisms underlying those genetic mutations. Molecular and cellular neuroscience techniques, as well as experience working with mouse models, will be gained from this study.

MEDICAL ETHICS

Harald Schmidt

Promoting Equity in Bioethics, Medicine and Public Health

My project can be modified to accommodate remote activities if made necessary by University policy.

There are two distinct opportunities for 1-2 students to gain research experience and contribute directly to advancing equity in bioethics, medicine and public health.

First, the International Association of Bioethics (IAB) https://iabioethics.org, is conducting a series of outreach sessions around the globe to identify options to more actively promote equity and decolonization in international bioethics. Currently, senior scholars from high income countries disproportionately attend the IAB's biennial World Congress of Bioethics, and conversely, colleagues form middle-and low-income countries account for a far smaller share, and have less influence in agenda setting and other key elements. The IAB is engaging colleagues in 5 geographic zones in Spring/Summer 2023, to explore how access can be improved via options such as tiered fees, bursaries, dedicated support and mentoring sessions, as well new range of activities between Congresses. Students will help analyze the feedback from the outreach sessions, and complement it through structured literature reviews on dedicated related issues. This work will feed directly into the IAB's ongoing reforms (mentor is a member of the IAB's board of directors).

Second, despite major shortfalls in the US' response to the Covid-19 pandemic, there has also been unprecedented efforts to promote equity and, in the words of Marcella Nunez Smith to 'reverse the predictable pattern of who gets hit first, and worst', by using disadvantage indices (DIs) in vaccine allocations and other areas. (See: https://www.nature.com/articles/s41591-021-01379-6 for a description - note also that a PURM scholar contributed to this work as a co-author). DIs are place-based

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statistical measure that seek to capture the fact that disadvantage is typically intersectional, clustered, and cumulative in impact. By, for example, allocating in situations of intense scarcity larger shares of vaccines to zip codes that score higher in terms of the average disadvantage, both equity and public health have been advanced (In addition, DIs have helped to improve racial justice, by addressing racism, rather than race). Ongoing work explores in which areas outside of a pandemic DIs might be deployed (as there has been considerable use, but little work in terms of systematically mapping applications).

For both projects, the research will be desk-based document review and be focused around applying a structured evaluation matrix of retrieved literature. Depending on students' skill sets, interests and the progress of ongoing work, students may also contribute to, or lead publications (though leading a paper will likely require a more substantial commitment beyond the placement period).

MEDICINE

Sigrid Veasey

Mechanisms of Sleep Loss Neural Injury

My project is entirely in-person.

I am a Physician Scientist, and I have run an independent NIH-funded sleep research program at the University of Pennsylvania for 25 years. We discovered that chronic sleep disruption can lead to significant neural injury, where specific groups of neurons evidence heightened vulnerability. Two distinct forms of sleep disruption, which are evident in over 15% of adults in the United States, can impart irreversible changes to and loss of neural cells. The locus coeruleus neurons (LCn) that are critical for sustained attention and learning are particularly susceptible and sleep disruption impairs LCn function, induces loss and disrupts mitochondrial homeostasis. Chronic short sleep results in lasting neural injury in young adult mice. Injury observed one year after sleep loss exposure includes: in loss of not only LCn, but hippocampal CA1 neurons, hippocampal memory impairments and increased amyloid-beta, pathogenic phosphorylated tau and activation of the glial cells (astrocytes and microglia). Thus, many of the findings overlap with pathology in Alzheimer's disease.

We are now actively pursuing two areas of investigation to better understand the causes of sleep loss neural injury (and then develop therapies to prevent sleep loss neural injury). For the first, we have found that sleep loss markedly suppressing the availability of a protein that is critical for amyloid clearance from the brain, transthyretin. This protein helps amyloid clear from the interstitial space and persistent loss may contribute to impaired clearance of amyloid and progressive accumulation. We hypothesize that increasing transthyretin will prevent much of the injury we observe after sleep loss. To test this mice will be treated with a viral vector overexpression of transthyretin unilaterally in the hippocampus and a control vector on the contralateral side. Mice will be exposed to chronic slepe loss, given hippocampal memory tests and then brains will be examined for hippocampal injury and amyloid deposition. The second project involved determining the role of microglial cells in clearing amyloid aggregates after sleep loss. Mice have been created with an absence of microglial cells. These mice will be exposed to chronic sleep loss and we may then determine what roles are played in synapse loss and amyloid accumulation by microglia. Students will learn behavioral studies, brain sectioning, sleep deprivation and immunohistopathology assays.

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NEUROLOGY

Anjan Chatterjee

The Science of Aesthetics

My project is entirely in-person.

The project will involve the assessment of aesthetic experiences of people, places, or things. Depending on the students' interests, we have ongoing studies in human beauty and morality, in the built environment and wellness, and in the role of art in human flourishing. Each student is co-supervised by one of my four post-docs and me. These post-docs are Clifford Workman, Vasiliki Meletaki, Vicente Estrada Gonzalez, and Mariola Paruzel-Czachura. In addition to participating in our weekly lab meetings, I meet with each undergraduate once a week.

Students will learn to think experimentally, possibly code and run experiments, conduct statistical analyses, and present scientific findings. They will learn to work in a team and engage in multi-disciplinary research. Our lab has an artist in residence, an anthropologist, a senior art historian, and we have frequent visitors.

Erin Conrad

Quantitative EEG Analysis to Improve Diagnosis and Management of Epilepsy

My project can be completed entirely remotely.

Epilepsy affects 1% of the population and is a major cause of disability. Almost all patients with epilepsy and suspected epilepsy have at least one EEG performed to aid in diagnosis and to guide therapy. However, the current approach to EEG review is entirely manual, leading to incorrect or delayed diagnosis for many patients. Our goal is to apply quantitative methods of EEG analysis to improve the diagnosis and treatment of patients with epilepsy. There are several parts of this project tailored to students with different interests and backgrounds. All students involved in the project will learn about epilepsy, with additional learning goals depending on the subproject chosen.

Subproject 1: Perform clinical chart review to understand important clinical variables contributing to the diagnosis and management of epilepsy. This subproject would be ideal for a pre-medical student. Learning goals include understanding the diagnosis and classification of epilepsy and how to interpret clinical charts. No prior technical skills are required for this subproject. You would be mentored by Dr. Conrad.

Subproject 2: Develop a graphical user interface (GUI) to facilitate manual annotation of EEGs. We will need to understand how a quantitative algorithm compares to human review, and so we would like to build a GUI to show segments of EEG to clinicians. This subproject would be ideal for a computer science student or anyone interested in software design. Learning goals include developing an easy-to-use software package and GUI design. Prerequisite skills include Python. You would be mentored by data analysts Josh Asuncion and Brian Prager, and by Dr. Conrad.

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Subproject 3: Train and test machine learning algorithms to automatically diagnose and classify epilepsy. You will extract quantitative features from EEGs of thousands of patients and develop a machine learning algorithm to diagnose epilepsy. This subproject would be ideal for a student in computer science, electrical engineering, or biomedical engineering with some machine learning experience who wants to expand their knowledge. Learning goals include signal processing, feature extraction, methods in cross validation, and different classifiers. Prerequisite skills include Python and some experience in machine learning. You will be mentored by graduate student Will Ojemann, data analyst Brian Prager, and by Dr. Conrad.

Ana Cristancho

Effects of Prenatal Hypoxia on Neuronal Migration

My project is entirely in-person.

The Cristancho lab has developed a model of prenatal hypoxic brain injury that shares features seen in children with mild hypoxic brain injury, which affects about 300,000 children worldwide per year. In previous work, we found that prenatal hypoxia leads to long-term behavior deficits even though there is no evidence of cell death. These animals have evidence of abnormal function of potassium channel function in excitatory neurons one month after the injury. To understand why a brief prenatal exposure leads to long-term deficits, we have used single-nucleus RNA and chromatin accessibility sequencing. We found that migratory neurons selectively have dissociation between transcription and chromatin accessibility suggesting an epigenetic mechanism that disrupts neuronal migration and maturation. Here we seek to use animal and cell culture systems to understand hypoxia affects neuronal migration and maturation.

Project #1: (1st student) Question: Does prenatal hypoxia affect in vivo neuronal migration?

- Animals will be bred for timed matings. Pregnant animals will be injected with EdU, a thymidine analog that is integrated in replicating neuroprogenitor cells. Animals will be exposed to hypoxia in late gestation. We will harvest the brain at different time points to see if EdU levels that co-label with more mature neuronal markers are at different levels of the cortex between normoxia and hypoxia.

- Skills to learn: animal handling & breeding, hypoxia, intraperitoneal injections, immunofluorescence

Project #2: (2nd student) Question: Does hypoxia affect in vitro neuronal migration in a cell autonomous manner?

- Animals will be bred for timed matings. Animals will be exposed to hypoxia in late gestation. Neurons will be dissociated after exposures and placed in a two-level chamber with the bottom layer containing a chemotactic stimuli. We will determine if there is a difference between normoxia and hypoxia in how these neurons migrate towards chemotaxis.

- Skills to learn: animal handling & breeding, hypoxia, neuronal dissociation, cell culture, migration assays Primary

Mentor: Ana Cristancho, formal weekly meetings, daily interactions. In lab experimental mentors: Preeti Chauhan (post-doctoral fellow), Ethan Gadra (technician)

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Kathryn Davis

Epilepsy Quantitative Imaging and Electrophysiology Lab

My project can be modified to accommodate remote activities if made necessary by University policy.

Project 1: Transfer Learning and Deep Learning for Functional and Structural Connectivity Analysis in Epilepsy

Epilepsy is a neurological disorder characterized by recurrent seizures, which are caused by abnormal electrical activity in the brain. Studies have demonstrated that neuroimaging biomarkers, such as dynamic functional connectivity, static functional connectivity, and structural connectivity, can all help inform surgical outcomes in epilepsy. In this study, we propose an attention-based hybrid deep learning framework for predicting epilepsy surgical outcomes from these three types of connectivity. Our framework incorporates both convolutional and recurrent neural networks to model the temporal dynamics of functional connectivity, as well as a self-attention mechanism to capture the spatial dependencies among different brain regions, represented by both structural and functional connectivity. We propose a transfer-learning approach where our model is initially pre-trained in a large autism dataset (ABIDE), distinguishing neurotypical controls from individuals with autism-spectrum disorder (ASD). We will subsequently fine-tune our model for epilepsy surgical outcome classification using a large multi-institutional dataset of pre-surgical functional and structural connectivity data from epilepsy patients.

The project would involve the following steps:

1. Data preprocessing
2. Feature extraction
3. Model development
4. Model evaluation
5. Results interpretation

Project 2: Analyzing Harmonization Strategies for Functional Connectivity Data

Brain functional connectivity data can come from functional magnetic resonance imaging (fMRI), as well as intracranial and scalp electrophysiology (EEG). Among the most used representations for studying and analyzing this type of data we find network-based statistics. However, as datasets get larger and multi-center studies become more common, effective strategies for combining functional connectivity data across sites remains a challenge. The goal of this project is to leverage existing data harmonization strategies, such as NeuroCombat and NeuroCovBat, in order to better understand how to harmonize functional connectivity analyses across different data sources and to increase the generalizability of findings from these studies.

Students should have prior experience with programming, preferably in Python, and have a basic understanding of machine learning and deep learning. They should also have a strong understanding of the basics of statistics and linear algebra.

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Colin Ellis

Improving the Generalizability of Natural Language Processing Algorithms in Medicine

My project can be modified to accommodate remote activities if made necessary by University policy.

Every time you visit your doctor, your doctor writes a summary or note of your medical care in an Electronic Health Record (EHR). The EHR is a huge potential source of medical information that can be used for large scale research, especially if you combine EHR from multiple institutions. We are interested in tapping into the EHR and extracting this information to perform research at large scales to improve clinical care. Our current research is focused on Epilepsy, a common neurological disorder characterized by uncontrolled seizures. We have recently developed and validated Natural Language Processing (NLP) deep-learning-based algorithms to extract outcome measures from the medical notes of patients with Epilepsy. These algorithms were initially trained on a small subset of manually annotated epilepsy clinic notes. We have also characterized how well our methods adapt to different settings – in essence, how well they generalize to new, unseen data.

In this project, we will work on improving their generalization performance. Specifically, students on this project will:

1) Learn the fundamentals of NLP in Python using the Pytorch/Huggingface libraries, two leading libraries for NLP.
2) Explore methods for improving model generalization in the NLP literature. Students will perform a review of the relevant literature; we will also discuss how to critically read and interpret a scientific article.
3) Adapt and implement these methods for our purposes in the medical domain. Students will be applying existing codebases and writing new code to improve model performance, and to analyze and interpret results.
4) Learn about and experience the scientific publication process.

Students will be mentored by Dr. Colin Ellis, M.D., and PhD Candidates Kevin Xie and William Ojemann in the Center for Neuroengineering and Therapeutics.

Prerequisites: This is a very programming and computationally heavy project. As such, we strictly require: (1) Proficiency coding in Python; (2) At least one semester of an undergraduate machine learning course.

Ethan Goldberg

Mechanisms of Neurodevelopmental Disorders

My project is entirely in-person.

The Goldberg Lab studies mechanisms of neurodevelopmental disorders towards novel treatments, with a focus on childhood epilepsy and autism spectrum disorder (ASD). The Lab uses human and mouse genetics, electrophysiology, pharmacology, optogenetics, imaging, single cell biology, and computational

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approaches, in a range of model systems, from induced pluripotent stem cell (IPSC)-derived neurons to preclinical experimental mouse models.

Highly motivated first- and second-year students who are interested in basic/translational neuroscience research are encouraged to apply. Students will learn basic neuroscience lab techniques and data analysis under the mentorship of the PI and a senior graduate student or postdoctoral fellow.

Previous PURM students in the Lab have gone on to MD, PhD, or MD-PhD programs at competitive institutions.

Eric Marsh

Electrophysiological Biomarkers of Epilepsy and Intellectual Disabilities

My project is entirely in-person.

Epilepsy and Intellectual disabilities are a common neurologic conditions in children that often co-occur. There are both genetic as well as structural brain changes that lead to these conditions. Unfortunately for these patients, seizures can persist despite medications. Dr. Marsh's laboratory is interested in developing new ways of analyzing data obtained from electrical recordings such as EEG to allow for more detailed and individualized methods of controlling seizures and using EEG as a biomarker of brain state/function. Students will join the projects working under an experienced fellow or research faculty. Drs. Caren Armstrong, Joni Saby and Donald Joseph are potential direct summer mentors. Students will gain experience with EEG and EP recordings, signal processing, quantitative EEG analysis using MATLAB, statistical analysis of large data sets, brain anatomy, clinical chart review, and in vivo electrical stimulation. These projects are part of on-going NIH funded research projects.

Project 1: Children with epilepsy who fail medications are sometimes implanted with electrodes to determine if a surgical approach can stop their seizures. Our ability to identify the exact location and size of the area responsible for generating seizures is evolving. Understanding differences in brain network organization in patients with epilepsy will lead us to better treatment options. We have been analyzing low frequency stimulation of the implanted electrodes, called cortico-cortical evoked potentials (CCEPs), to determine the functional brain networks involved in epilepsy. The student will analyze EEG data to reveal temporal and spatial characteristics of the network of each patient and the networks will be compared across patients and to different patient characteristics (age, location, outcome, ect). Student(s) will have the opportunity to join the team during stimulation sessions at CHOP.

Project 2: Children with early onset epilepsies often have intellectual and developmental issues that are part of their condition. A number of these conditions have genetic causes and novel therapeutics are being developed. We are using EEG and evoked potentials to determine if EEG can be a biomarker of disease severity and functioning. The student will analyze EEG and evoked potentials and compare features to clinical severity measures. The student can learn to perform the EEG experiment along with novel analysis of the data.

Knowledge/skills of Matlab is required.

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Dawn Mechanic-Hamilton

Smartphone App Development and Testing for Rapid Assessment of Cognition in Aging

My project can be modified to accommodate remote activities if made necessary by University policy.

As the population of older adults in the US increases, so does the need for reliable and valid cognitive testing throughout the lifespan. The widespread use of mobile devices in all age groups opens up the possibility of mobile measurement of cognition outside the laboratory and clinic setting. Mobile measurement will address some of the limitations of current cognitive assessment practices and allow for rapid collection of large amounts of data. A team of researchers in the Penn Memory Center is developing an app for mobile and remote measurement of cognition, which we are piloting with a longitudinal cohort of older adults with and without cognitive impairment. The student will be involved in pilot testing the app, collecting feedback from users, and data analysis. Students will also have an opportunity to join PMC consensus conferences and shadow in the PMC clinic. The student will be mentored by members of the interdisciplinary team, including research coordinators, graduate students in clinical psychology, and the primary mentor, Dawn Mechanic-Hamilton, Ph.D. (neuropsychologist).

Jennifer Orthmann Murphy

How Do CSF1R Mutations Lead to Microglial Dysfunction?

My project is entirely in-person.

Autosomal dominant and recessive mutations in CSF1R lead to rare and devastating white matter disease. Microglia, the innate immune cells of the brain, are the main cells to express CSF1R. It is currently not known how mutations in CSF1R lead to microglia dysfunction and adult-onset disease. This project will involve a combination of immunopathological approaches to characterize potential mouse models to better understand the underlying mechanisms of disease and may ultimately lead to the development of in vitro models using human tissue collected from Dr. Orthmann Murphy's clinical research program. The undergraduate student will work closely with a neuroscience graduate student, Hannah Loo, who is developing this project. The undergraduate will learn tissue processing, cryosectioning, immunostaining, in situ RNA labeling, cell identity and functional characterization (including microglia, astrocytes, oligodendrocytes and neurons) and quantification of these cells, brain anatomy, and presentation skills with inclusion in lab meetings and journal clubs.

David Raizen

How and Why Do We Sleep When We're Sick?

First-year only

My project is entirely in-person.

We have all experienced profound fatigue and sleepiness when sick (e.g COVID19 or the flu), but the mechanism of this sickness symptom is not understood. It is important to understand this because some people are disabled by fatigue even when not sick.

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We use a microscopic worm, called C. elegans, to find genes that regulate sickness sleep. The undergraduate student would perform screens for genetic mutants with abnormal sleep behavior. The student would be supervised by current members of the Raizen lab as well as by Dr. Raizen himself.

Several prior undergraduates who started in the lab as PURM students, continued to perform research to complete the 399/499 honors thesis sequence. Some of these students published papers based on their research and have gone on to medical, dental, and graduate schools.

Jens Witsch

Neutrophil Extracellular Traps and High-Precision Magnetic Resonance Imaging Measures of Secondary Injury After Intracerebral Hemorrhage

My project can be modified to accommodate remote activities if made necessary by University policy.

Intracerebral hemorrhage (ICH) is a stroke type that leads to bleeding into the brain tissue and is associated with a high death rate. The reasons for death and disability are not only related to the bleed, but also to inflammation of the brain tissue. This inflammation can lead to brain tissue swelling (edema) around the bleeding site or to blood clotting in small vessels in other parts of the brain. Neutrophils are an important cell type involved in inflammation, but it is unclear how neutrophils cause harm. Neutrophils form bundles within themselves which they release into their surroundings. These bundles are called neutrophil extracellular traps (NETs) and have the ability to cause swelling and blood clotting. NETs can be measured in blood, but they have hardly been studied in patients with ICH.

Our main research questions are: (1) Do NETs lead to edema around the ICH? (2) Do NETs lead to strokes in other parts of the brain? To answer these, 40 ICH-patients will be enrolled in a study that will measure NETs in the blood, and edema and mini strokes on a brain imaging study (MRI). The goal is to show that NETs in the blood are related to edema and mini strokes. Ultimately, NETs might help us to understand and predict the risk of poor outcome after ICH, and NETs could be targeted with medications to reduce and treat the brain injury that NETs might cause.

We are seeking up to two undergraduate students who are interested in learning about (1) vascular neurology (intracerebral hemorrhage, stroke and related vascular diseases), and (2) magnetic resonance imaging (MRI).

Undergraduate student researchers will be actively engaged with the goal to acquire new clinical and scientific skills to further their career. There are three different roles that an undergraduate student can engage in and be a critical member of the scientific team:

1. Participate in data preparation/organization under the guidance of an experienced research coordinator. Learn about the role of a research coordinator, and gain insight into human research regulatory processes.
2. Be present during the MRI-review and conduct independent MRI-review for teaching purposes under 1:1-guidance and supervision. MRI sessions will provide ample opportunity for teaching and learning about MRI, its value in vascular neurology, neuroanatomy, and stroke pathophysiology.
3. Participate in the review of literature related to the subject: neutrophilic inflammation in hemorrhagic stroke, and participate in collecting data, writing, and publishing literature reviews.

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NEUROSCIENCE

Joseph Cichon

Investigating Use of Psychedelics to Treat Chronic Pain

My project is entirely in-person.

Chronic pain is among the leading causes of disability worldwide with up to 60% of patients suffering from comorbid depression. Psychedelic-assisted therapy has recently been found effective in treating a host of mental health issues including depression and has historically been useful in treating pain. Reports of psychedelic drugs in chronic pain have been widely documented, with anecdotal evidence indicating widespread success in a range of pathologies. I have previously shown that a neuropathic pain model induces the persistent elevation of cortical neuronal activity independent of the peripheral inputs, indicating a centralized pain syndrome, in mouse primary sensory cortex. More recently, I have shown that ketamine, an anesthetic with psychedelic properties, causes a rapid switch of neuronal activity in the neocortex with a specific suppression of wake-active neurons and activation of formerly wake-inactive neurons.

This PURM project will test a novel hypothesis: 1) Central neuropathic pain strengthens select cortical circuits tied to unwanted pain behaviors and mood symptoms; 2) Psychedelic agents rapidly destabilize disease-relevant circuits; 3) New, previously dormant, circuits emerge during psychedelic administration; and 4) Sustained activity of new circuits through activity-dependent plasticity maintain symptomatic improvements. Thus, a rapid circuit switch could explain both the rapid and sustained effects expressed by these agents in centralized pain syndromes.

The student is to take advantage of an established neuropathic pain model to generate a central pain syndrome and to test psychedelic agents at the level of behavior and neural circuits. The researcher will learn numerous behavioral tests to explore the pain condition, mood, and learning abilities. We suspect that centralized pain syndromes will impact all behavior domains as suggested by countless human conditions and psychedelic agents might enact rapid and durable behavioral changes upon administration. Student and PI will then begin to monitor the spontaneous neuronal activities in key cortical circuits tied to these behavioral abnormalities by the method of two-photon microscopy before and after treatment.

Andrew Edmondson

Roles of Glycosylation in the Brain

My project can be modified to accommodate remote activities if made necessary by University policy.

We have availability for two independent projects.

My lab uses model systems (primary cells, iPSCs, mouse) of rare genetic neurodevelopmental disorders that disrupt glycosylation (known as Congenital Disorders of Glycosylation, or CDG) to study glycosylation in the brain. Glycosylation is the enzyme-mediated process by which a carbohydrate (or

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"glycan") is covalently attached to a target macromolecule (typically a protein or lipid) and is the most abundant post-translational modification. The CDG disorders, a group of ~170 rare genetic diseases that disrupt glycosylation, emphasize the biological significance of glycosylation. Most CDG patients exhibit neurological deficits such as epilepsy and neurodevelopmental abnormalities. Disruptions in glycosylation have also been implicated in the pathophysiology of complex neurologic and psychiatric diseases, including Alzheimer disease, amyotrophic lateral sclerosis (AML), and schizophrenia. We currently focus on two major types of glycosylation, N-linked and O-linked.

(1) N-linked glycosylation: Most CDG disrupt N-glycosylation. The single most common genetic cause of CDG results from biallelic mutations in PMM2. Patients with PMM2-CDG typically suffer from multi-systemic symptoms, including intellectual disability, seizures, and cerebellar hypoplasia with resulting ataxia. We have mouse models that recapitulate various aspects of the disease. In this project, the student will investigate candidate glycoproteins identified by glycoproteomics in mouse brain.

(2) O-linked glycosylation: Our lab recently identified a new CDG caused by biallelic mutations in GALNT2. Patients with GALNT2-CDG exhibit global developmental delay and multi-focal treatment-resistant epilepsy. A mouse model for this disorder exhibits seizures. Genetic dissection of the circuit suggests that molecular events in both excitatory and inhibitory neurons contribute to the seizures. These findings implicate a role of O-glycosylation in learning, memory, and neurotransmission. In this project, the student will investigate candidate glycoproteins and disrupted O-glycosites identified by glycoproteomics in mouse brain.

A variety of molecular and cell biology techniques will be gained from participation in either of these projects, which can be tailored to the level of prior experience, interests, and goals of the student. Mentoring will be provided by Dr. Edmondson and other lab members. Additional opportunities for clinical shadowing are available for students ultimately interested in medical school. For motivated students interested in medical school or graduate school studies, opportunities may exist for continuing the research project during the school year.

The Edmondson lab embraces diversity in all forms (including age, color, disability, gender identity, relationship status, national origin, religion, and sexual orientation) and encourages lab members to be their whole selves.

Joshua Gold

Understanding Relationships Between Arousal and Cognition

My project can be modified to accommodate remote activities if made necessary by University policy.

Arousal can profoundly affect learning, attention, and other aspects of higher-brain function, but little is known about the underlying neural mechanisms. This PURM project is part of a long-term research program in my laboratory that aims to understand these mechanisms.

The project has two main components, either or both of which can be the focus of the summer research, depending on the goals, interests, and expertise of the student.

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The first component tests the hypothesis that arousal affects higher brain function via modulations of behaviorally relevant patterns of coordinated neural activity throughout the brain. We have collected a number of data sets from humans and non- human primates that combine measures of brain activity (e.g., electroencephalography, or EEG; electrocorticography, or ECoG) and measures of arousal (e.g., pupillometry, heart rate). Because of the complexity of these data sets, they typically must be analyzed in stages. The main goal of this project component is to tackle one stage of this analysis process, likely to involve relating a single arousal measure to a single neural measure. These analyses will be integrated with other, ongoing analyses to create a comprehensive picture of the relationship between arousal and coordinated activity throughout the brain.

The second component is to develop and test new approaches to measure key features of cognition and arousal. We are particularly interested in seeing if we can get measures of both eye movements (which can reflect attention and other aspects of cognition) and pupil size (which can vary with changes in arousal) from ordinary webcams. We have some preliminary findings that look promising, but much more work is needed. Success in this project component would have a dramatic, positive effect on our research, allowing us to test subject pools that are far larger and more demographically diverse than we can with our current in-laboratory testing.

This project would benefit from a student with strong quantitative skills and proficiency with Matlab.

Ben Scholl

Single-Cell CRISPR/Cas9 Manipulations to Study Molecular Mechanisms and Synaptic Pathology in Cortical Spines, Cells, and Circuits

Second-year only

My project can be modified to accommodate remote activities if made necessary by University policy.

Synaptic pathology is a prominent feature of psychiatric illness and many neurological disorders. For example, synaptic dysfunction is presumed to be an underlying cause of Autism Spectrum Disorder, as genomic studies have identified risk genes regulating synaptic structure and physiology, and NMDA receptor dysfunction is highly implicated in the emergence of schizophrenia, based on numerous studies from mouse to primates and humans. One gene strongly associated with ASD and other CNS disorders is Phosphatase and tensin homolog located on chromosome 10 (Pten). But while global mouse models with dysfunctional Pten exhibit synaptic pathology and mimic ASD symptoms, it is unknown how synaptic integration, organization, and function are impacted within individual neurons.

This project aims to understand how Pten signaling shapes synaptic integration and functional architecture in single neurons. This collaborative project uses CRISPR/Cas9 edits in single neurons in combination with in vivo synaptic calcium imaging measurements using two-photon microscopy.

Skills to learn and explore include: Python and Matlab for processing data and analysis, stereotaxic injections and mouse implantation, behavioral habituation, two-photon microscopy, viral expression of different reporters, and imaging processing pipeline tools. Students will be mentored by the PI and work alongside other senior undergraduates in the lab. Students will also be engaged in scientific discussion during lab meetings and be able to observe a variety of different projects ongoing in the lab.

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OPHTHALMOLOGY

Jessica Morgan

Adaptive Optics Imaging to Understand the Retinal Vascular Network in Health and Disease

My project is entirely in-person.

The Morgan laboratory in the Department of Ophthalmology studies the structure and function of the human visual system using adaptive optics scanning laser ophthalmoscopy, a technology which permits visualization of individual cells and capillaries, and optical coherence tomography angiography, a technology which permits visualization of perfusion in the living retina. With the ability to noninvasively observe the vascular features and blood flow comes the ability to quantify parameters of the vascular network in the diseased retina in comparison to the normal retina.

Students will work with data collected from normal and diseased retinas to measure and compare perfusion densities and the vascular phenotypes at several retinal eccentricities. During this project, the student will have the opportunity to participate in state-of-the-art ophthalmic research, interact with normal control and diseased study participants, learn image processing techniques and retinal anatomy, and participate in all aspects of data collection, analysis and interpretation. Motivated individuals with an interest in clinical research, pre-med, bioengineering, biology or neuroscience are encouraged to apply. Students must be highly organized, as this project will involve maintaining a database for retinal images and associated data. Prior experience with Photoshop and/or Matlab is preferred but not required.

Katherine Uyhazi

Developing Gene and Cell Therapies for Inherited Retinal Diseases

My project is entirely in-person.

Millions of individuals worldwide suffer from vision loss. The mammalian retina cannot regenerate after injury, and thus diseases that cause retinal cell death such as age-related macular degeneration cause irreversible blindness. My lab studies the pathways underlying retinal cell death in order to develop novel gene and cell therapies for ocular diseases.

One research focus of my laboratory is to develop gene therapy for the retinal disease gyrate atrophy. Gyrate atrophy (GA) is a retinal degeneration caused by mutations in the enzyme ornithine aminotransferase (OAT), which results in progressive and permanent vision loss. Patients typically present in childhood with night blindness, followed by early cataract formation and constricted visual fields. There is currently no cure for gyrate atrophy. Gene therapy, a technique in which a corrected copy of the mutated gene is delivered to the eye, is now a remarkable FDA-approved treatment (Luxturna) for one particular form of childhood blindness. Gene therapy also holds great promise for treating patients with gyrate atrophy, since this disease is caused by a single gene, the natural history of

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the condition is well understood, and there are mouse models currently available that mimic the human disease. We are currently developing gene therapy for gyrate atrophy in order to slow and/or reverse the progression of this disease.

A second research focus of my lab is to develop cell-based therapies for blinding diseases. Many patients are no longer candidates for gene therapy due to photoreceptor cell death, retinal reorganization, and scar formation. These conditions have historically been challenging to treat, as they require replacement of cells, not just genes, in order to restore visual function. Stem cell-based therapies hold great promise for these conditions due to their potential to regenerate photoreceptors and supporting structures. We are currently characterizing populations of photoreceptor precursor cells, in order to determine which cell types are best suited to replace retinal cells upon transplantation. We are also exploring pathways of endogenous regeneration from retinal Müller glia cells, which in some species are retinal "stem cells" that can regrow damaged light-responsive cells after injury.

Fundamental skills that will be learned by mentees throughout the 10-week summer project include basic molecular biology skills including isolating DNA, RNA, and protein, cloning, performing quantitative polymerase chain reaction (qPCR) to measure gene expression, performing immunohistochemistry to determine the localization of gene expression, and learning techniques for cell culture and working with mouse models of retinal disease.

Gui-shuang Ying

Evaluation of Inflammatory Biomarkers in Dry Eye Disease

My project can be modified to accommodate remote activities if made necessary by University policy.

Dry eye disease (DED), though multifactorial, is known to have inflammation on the ocular surface as a core mechanism of its pathogenesis. This project aims to advance our understanding of the role of inflammatory biomarkers on dry eye disease through performing secondary analyses of the rich and unique data from a large cohort of well-characterized participants in the Dry Eye Assessment and Management (DREAM) Study. The DREAM study is a multi-center placebo-controlled clinical trial, funded by the National Eye Institute, to evaluate the effect of omega-3 fatty acid supplementation for the treatment of dry eye disease (N Engl J Med 2018;378:1681-90). The DREAM study collected rich data of various biomarkers including conjunctival epithelial cells for HLA-DR and other cell biomarkers through impression cytology and tears for cytokines. All the DREAM participants also completed standard clinical evaluation for dry eye symptoms and signs at baseline, 6 and 12 months. Thus, the DREAM study provides unique opportunity to evaluate how the various inflammatory biomarkers are associated with the characteristics of dry eye disease.

The undergraduate student will work on a project for assessing associations between inflammatory biomarkers and severity of dry eye symptoms and signs. The student will perform PubMed literature searches, reviews of the relevant papers, and summarize the literature findings. The student will participate in the statistical analysis by developing or modifying analysis codes in R or SAS and summarize analysis results using tables and figures. The student will be guided by biostatisticians for applying the various statistical approaches (regression models, cluster analysis, latent class modelling) to evaluate associations of biomarkers with dry eye disease. The student will have the opportunity to

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develop the manuscript as the first author for publication with the help from a group of researchers in biostatistics, epidemiology, clinical trials, ophthalmology and biomarkers. The applicants are expected to have knowledge in biology, biomedical science, statistics, public health, computer science, or data science. The student will be mentored by Dr. Gui-shuang Ying, Carolyn F. Jones Professor of Ophthalmology at the Center for Preventive Ophthalmology and Biostatistics.

ORTHOPAEDIC SURGERY

Fanxin Long

Genetic and Metabolic Studies of Bone

Second-year only
My project is entirely in-person.

In the Long lab, students will be conducting research in skeletal biology, with the overall goal of discovering mechanisms and new therapies for bone disorders. Specific projects include functional studies of certain genes in bone development and homeostasis through tissue-selective knockout in the mouse. The effects of gene deletion are analyzed at tissue, cellular and molecular levels. The students will be mentored by lab members in performing techniques such as quantitative bone assessment with microCT, histological sectioning, confocal microscopy, cell culture, protein and mRNA analyses. There are opportunities for students to continue research beyond the summer program. Besides gaining technical expertise students are expected to further their knowledge in the mammalian skeletal system.

Foteini Mourkioti

Enhancing the Healing Abilities of Skeletal Muscles

My project is entirely in-person.

Skeletal muscle is an important tissue, not only because it covers the entirety of our body and allows us to produce force to move all body parts, but also because reduction in muscle strength in humans is strongly associated with mortality during aging in both men and women. In fact, after the age of 30, we begin to lose as much as 3-5% of our muscle strength each decade, and more than 25% after the age of 60. Moreover, skeletal muscle health deserves greater attention in today's world, where a sedentary lifestyle is the norm.

The Mourkioti Lab is interested to understand why our muscles lose their healing abilities as we age. We know that the older we get, the more difficult it is to activate stem cells out of their dormant, quiescent state. And, if a cell is dormant and can't be "awakened" on time, these cells are likely to underperform in terms of repairing muscle tissue after injury. We recently discovered a new angle to understand how muscles convert mechanical forces into biological signals. By generating new animal models, we were able to follow muscle stem cells in their endogenous environment. We found that these cells extend projections to sense their local microenvironment and employ a specific molecule to respond quickly to repair torn muscles. Additionally, we discovered that a signaling molecule that is significantly reduced as we age, leading to a reduced ability of stem cells to sense their environment in elderly muscles.

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Our current studies are very promising since they show that the use of pharmacological agents can increase the sensitivity of stem cells and boost endogenous muscle repair. We believe that we are at a starting point in our understanding of how to improve muscle strength and develop effective therapeutic interventions that will result in healthier muscles in older people. Using state-of-the-art microscopy methods that our lab optimized, we can now repeatedly monitor the same muscle over a long period of time and determine how cells communicate to change muscle composition and contractile properties.

We are seeking a motivated individual to work closely with a talented postdoc in the lab (Dr. Ji-Hyung Lee). The work will include several techniques, such as tissue handling, stem cell isolation, histology, immunochemistry, and quantification using an imaging software.

Neil Sheth

A New Paradigm for Delivering Musculoskeletal Care in Tanzania, Sub-Saharan Africa

My project can be completed entirely remotely.

In the developing world, there is a substantial deficit for the common man in access to surgical care. Only 3.5% of all surgical procedures are performed in low and middle income countries (LMIC), but LMICs account for 90% of the surgical burden. Without proper surgical treatment, being struck by a car and suffering a broken leg could result in a lifetime of disability and poverty, assuming you survive. Take Tanzania for instance - there are only 25 Orthopaedic surgeons for a population of 50 million people. How many patients go untreated on a daily basis?

We present a novel, sustainable, collaborative solution to this problem. We propose to build an Orthopaedic Center of Excellence in Moshi, Tanzania, in conjunction with Kilimanjaro Christian Medical Center, to be populated by foreign thought leaders year-round.

In the interim, due to the disruption from COVID -19, our team had to pivot. Until the new center is constructed at KCMC, we are looking to also partner in parallel with a private healthcare delivery organization, NSK Healthcare in Arusha, Tanzania. NSK has just constructed a new hospital that is functional and is equipped to perform orthopaedic surgery. With both institutions, with the University of Pennsylvania at the center, the collaboration is formulated to include the following:

- 35 major academic institutions, donating 10 days/year, to provide care and train local providers
- Each institution will sign out the service every 10 days to the next visiting institution
- Each team will utilize pre-determined clinical protocols for the delivery of musculoskeletal care
- Each team's clinical focus will be on Pediatric Orthopaedics, Orthopaedic Trauma, Adult Reconstruction (hip and knee), and Plastic Surgery (soft-tissue rearrangement and vascular surgery)

This model represents a way to cross-pollinate with and educate the next generation of Orthopaedic surgeons in Central and East Africa. The primary premise of this Orthopaedic center of excellence is to be an educational training center which will allow patients to receive the most innovative methods of care locally and raise the standard of care in Sub-Saharan Africa.

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PURM Position Logistics: As former PURM students have focused their research on KCMC, we will have an opportunity to understanding the needs of NSK healthcare and collecting data to help create a strategic plan for incorporating them into the delivery of musculoskeletal care in Tanzania. Our past PURM students have spent 10 days to 6 weeks in Africa during the Summer, although students can work remotely.

PATHOLOGY

Malek Kamoun

Machine Learning Strategies for Donor - Recipient Matching in Kidney Transplantation

My project can be completed entirely remotely.

Developing and applying smarter machine learning (ML) is critical to biomedical data mining and many other real-world applications. My lab is collaborating with Dr. Urbanowicz (Cedars Sinai Medical Center) to develop and apply interpretable ML and artificial intelligence methods that can automatically learn meaningful features, conduct feature selection, and train predictive/interpretable models in the presence of complex data relationships. Tackling these challenges can improve: our understanding of disease etiology, risk prediction, and personalized medicine.

Our current research is aimed at further developing our novel 'FIBERS' algorithm for automated feature learning, and combining this with other ML methods, to identify immunological risk factors that predict the likelihood of donor/recipient kidney compatibility. The long-term goal of this work is to improve kidney matching and decrease the likelihood of graft failure in recipients, as well as make our ML methods available to the broader research community so that they can be applied to a wide variety of problems.

Students joining this research internship will have the opportunity to (1) develop, expand, test, and evaluate novel ML algorithms and associated software packages, (2) apply ML and statistical methods to analyze donor/recipient kidney transplantation data (i.e. HLA amino acid mismatch variables), and (3) get involved with scientific writing (i.e. paper publication) and other research presentations (e.g. research posters or oral presentations). Students that make significant progress will have the opportunity to gain authorship on a research publication.

Pre-requisites: Experience with programming in Python (mastery of basics preferred, but commitment to learn welcome). Interest and/or experience in machine learning, data analysis, informatics, and/or statistics encouraged.

Dr. Kamoun will meet in person as needed to provide supervision and guidance. In addition, Dr. Kamoun and Dr. Urbanowicz will meet remotely with the intern via Zoom or BlueJeans to provide instructions and supervision related to the intern's project.

Dr. Kamoun will provide expertise in HLA Immunogenetics and guidance for the use of HLA data and for evaluating the plausibility of this data biologically and clinically. In addition, he will serve as the point-of-contact with co-investigators coordinate and integrate the research activities, facilitate real-time

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communication and access to study related materials, that is shared with co-investigators and will assure that progress is in line with the proposed research studies milestones.

Dr. Urbanowicz will provide guidance in the applications of new machine learning methods and software for the proposed studies.

Frank Lee

Mechanisms of the Hypoxic Response

My project is entirely in-person.

Low oxygen concentration, or hypoxia, is a feature of the most common diseases in the U.S., including heart attack, stroke, and kidney failure. Understanding the molecular mechanisms may provide the basis for new approaches to these common diseases. The central pathway by which humans respond to hypoxia is called the Hypoxia Inducible Factor (HIF) pathway. The key feature of this pathway is that the activity of HIF, which is a transcription factor, is regulated in an oxygen-sensitive manner. Under conditions in which oxygen is replete, HIF is in a low activity state. When oxygen is scarce, HIF transitions to a high activity state and induces the transcription of a multitude of genes that facilitate cellular and physiologic adaption to hypoxia. We have generated a number of genetically engineered mouse models in which the HIF pathway is activated or inhibited. We are interested in characterizing these mice. The student will participate in studies in which organs will be analyzed microscopically for changes in the morphology of different components of these organs. Analysis will be done using software such as ImageJ. The organs to be analyzed will include, but not be limited to kidney and heart. The overall goal will be to learn how laboratory research is conducted and contribute to a project relevant to important human diseases. The student will work with Dr. Lee and a senior research investigator in the lab.

Daniel Powell

Cancer Immunotherapy for Ovarian Cancer

My project is entirely in-person.

T cells are major contributors to antitumor responses and redirecting T cells against cancer cells using synthetic molecular biology as an effective way to treat patients with advanced blood borne cancers. The Powell lab seeks to utilize such gene-engineered T cell approaches to treat advanced ovarian. This is seen as a major opportunity but also a significant challenge. In order to do so, we are developing new multi-gene transduction protocols that not only allow T cells to see cancer cells, using chimeric antigen receptors, but to also have even greater activity once tumor recognition occurs. In order to do so, we are deploying gene editing and transduction protocols to test and optimize T cells for preclinical experiments, with the intent of bringing the most promising approaches to the clinic.

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Nancy Spinner

High Throughput Screen to Identify Pathogenic JAG1 Mutations

My project is entirely in-person.

We are using several molecular and cell biology techniques to investigate genomic variants in the protein Jagged1 to determine if they are disease causing, or benign. (ALGS) is an autosomal dominant multi-system disorder caused by mutations in two Notch signaling pathway genes, JAGGED1 (JAG1) and NOTCH2. This disorder affects the liver, heart, kidneys, and vasculature, with minor eye and skeletal findings, and characteristic facial features. JAG1 is a cell surface ligand, and NOTCH2 is one of 4 human Notch receptors. Our laboratory identified both genes as ALGS disease genes, and the proposed experiments form part of our current work to better understand uncertainty in Alagille syndrome diagnostics regarding the interpretation of genomic variants as benign or pathogenic. While we know a lot about the mechanisms of Jagged1 mutations (seen in ~95% of ALGS patients), which are caused by having one dysfunctional allele (haploinsufficiency), typically due to a protein-truncating mutation, about 15% of mutations are missense. Missense mutations are notoriously difficult to classify as benign or pathogenic since they result in full-length protein harboring a single amino acid change. We have now begun to design high-throughput assays, called Multiplexed Assays of Variant Effects (MAVEs) that allow us to screen thousands of missense variants simultaneously and score them for their functional ability. This functional data allows us to better classify missense variants as benign or pathogenic, which improves diagnostics.

The student will learn how to culture cells, harvest DNA, prepare cells for flow cytometry, and prepare libraries for long-read sequencing to analyze membrane expression of JAG1 in mutant cell libraries. JAG1 is a transmembrane protein, and pathogenic missense variants often result in the intracellular accumulation of JAG1, thus we will use flow cytometry to sort our mutagenesis libraries for those that have membrane expression (normal) from those that do not (abnormal). These experiments will involve visualizing cell surface expression using antibodies by both flow cytometry and immunofluorescence.

These experiments will be overseen by Dr. Melissa Gilbert, a senior scientist in the laboratory, and done under the supervision of a senior technician.

Wanding Zhou

Genomics Research of Cell identity and Cancer Diagnosis

My project can be completed entirely remotely.

Our lab is focused on developing genomic assays and informatics for studying cell identity and cancer diagnosis. We take the approach of interrogating DNA cytosine methylation status genome-wide and compare DNA methylomes from diverse human populations, tissue types, cell types and pathological status to build predictive analytic tools for clinical applications. Biologically, we hope to understand better the epigenetics mechanism of developmental biology and cancer biology. We work with diverse primary human and mouse tissues and cell types in malignant and healthy conditions.

We invite students to join one of three potential projects.

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1) Developing web-app for exploring functional implications of DNA methylation patterns. We invite students familiar with or willing to learn web development-related computational skills (e.g., JavaScript, D3, React, dash/streamlit/Shiny, HTML/CSS) to develop exploratory data mining and visualization data app for functional analysis. The student will be co-supervised by a current postdoc in the lab and CHOP application service teams to set up the data app. Prior exposure to UX design, CGI, R and Python-based web app development is highly welcome. We provide opportunities for undergraduate students to acquire programming skillsets and contribute to peer-review research publications.

2) Develop computational methods for DNA methylation-based human cancer classification. Student will be co-advised by David Goldberg, a graduate student in the lab to create accurate, versatile tumor classifiers leveraging hundreds of thousands of rich Infinium BeadChip data from public repositories and CHOP's clinical registries, in collaboration with the Children's Brain tumor network and diagnostic divisions. Student will learn to implement, evaluate, and interpret machine learning models, and understand epigenetic principles of cancer biology in applying genomic technology to cancer clinics. We aim to build predictive models to infer cancer types, molecular subtypes, and clinical outcomes such as patient survival and prognosis.

3) Developing high-throughput DNA methylation assays using long-read sequencing technology. The student will be co-advised by Heqiao Zhu and Solmoe Lee, current members of the Zhou lab, to implement efficient and high sample-throughput methylation assays using nanopore-based direction detection. We aim to explore the optimal experimental condition for robust assays that maximize the coverage of established genomic regions linked to human traits, gene expression, cell identity and genetic variation. Student will learn how to prepare genomic sequencing experiments, run high-throughput data analysis pipelines, and make biological interpretations of data.

PEDIATRICS

Danielle Cullen

Socially Equitable Care by Understanding Resource Engagement (SECURE)

My project is entirely in-person.

The goal of the SECURE (Socially Equitable Care by Understanding Resource Engagement) multi-site randomized controlled trial is to systematically evaluate the impact of social risk screening on acceptance, perception, and engagement with social resources among adult caregivers of pediatric CHOP patients through three specific aims:

1. Evaluate, using a randomized controlled trial, the impact of screening for social risk on caregivers' acceptance and engagement with resources from resource mapping software.
2. Evaluate, using survey methods, rates of resource utilization and the ultimate impact on social risk between caregivers with or without a preceding standardized assessment of social risk.
3. Explore, using qualitative interviews, how caregiver comfort level and perception of resources is affected by preceding social risk screening.

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While addressing social risk may be considered a moral imperative, this contribution will move the work of social care integration toward evidence-based practice by carefully examining the impact of screening.

The PURM scholar would be a central member of the interdisciplinary SECURE study team working to inform the future of social care integration at CHOP and in the region. The PURM scholar will have opportunities to participate in team meetings, study enrollment, ongoing data analysis, and interviews with caregivers to understand their experiences with social risk screening and resource referral as well as amplify the family perspective in health policy. Exact roles for the student will depend on research progress/needs at the time of start.

Christopher Forrest

PEDSnet Summer Research Projects

My project can be modified to accommodate remote activities if made necessary by University policy.

Background: PEDSnet is a multi-institutional learning health system that conducts observational research and clinical trials across multiple children's hospitals. By combining electronic health record (EHR) data across our 11 institutions, we provide a research analysis-ready database with data on more than 9 million children. This allows us to create large cohorts of patients to identify and characterize pediatric conditions, their incidence and prevalence, treatments patterns and patient outcomes. We are actively developing new methods to identify patients through computable phenotyping, which uses multiple pieces of patient health care data to represent their conditions with high accuracy. PEDSnet projects involve a wide range of pediatric health conditions, leading to new knowledge about the effects of COVID-19 in children, the relationship between kidney disease and bone fractures, and the impact of patient weight on respiratory diseases.

Opportunities: We are looking for 1-2 students who would be interested in joining us this summer to participate in ongoing and new PEDSnet projects. We have 2 possibles positions, one study-focused and the other data-focused.

Study-focused: this position involves participation in a PEDSnet study to learn how observational research is done and will expose the student to research study design, data collection, and data analysis. Prior experience in R programming language and a basic understanding of statistics would be beneficial, but not necessary.

Data-focused: this position focuses on participation in how PEDSnet handles EHR data from multiple institutions and will expose the student to data models, data harmonization, and integration. Proficiency in R would be expected.

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Emily Gregory

Medicaid Perinatal Payment Reform

My project is entirely in-person.

There are substantial gaps in health care utilization by birthing people in the year after birth with potential consequences for both maternal and infant health. Several types of Medicaid payment reform have sought to address these gaps, as well as quality of care in this period. Examples of this payment reform include bundled payments, perinatal episodes of care, and, most recently, extending pregnancy-related Medicaid eligibility for one year. Some of these innovations have been robustly evaluated while others have not.

PURM students will support work to review the literature on Medicaid payment reform. PUMR students may also assist with needs assessment of new families presenting for pediatric primary care. Students will gain skills in review of the medical literature, data management, and survey research. Students will attend meetings with the study team, working with Dr. Emily Gregory and clinical research coordinator Adya Maddox, MPH.

Brian Jenssen

Clinical Effort Against Secondhand Smoke (eCEASE)

My project can be modified to accommodate remote activities if made necessary by University policy.

We are looking for research assistants to assist with a portfolio of tobacco screening and treatment projects. The electronic Clinical Effort Against Secondhand Smoke (eCEASE) is funded through the National Institutes of Health (NIH). This study seeks to improve the quality of tobacco control service delivery in pediatric practices and help parents quit smoking. The study is based at 12 CHOP primary care sites. The intervention consists of the innovative Electronic Health Record (iEHR) platform used to screen families for tobacco use and refer smoking parents to smoking cessation resources and treatment. The main study aim is to compare parents' combustible tobacco quit rates, and adoption of tobacco-free behaviors between the two arms. The study Principal Investigator (PI) and co-investigator are Dr. Fiks and Dr. Jenssen. This research is housed within the Children's Hospital of Philadelphia's Clinical Futures department.

Broadly, Dr. Fiks and Dr. Jenssen conduct research in primary care settings to improve pediatric decision-making and child health outcomes and use clinical decision support systems and population health management techniques to protect children from secondhand smoke exposure and tobacco use. The RA will learn the fundamentals of human subjects' research, EPIC chart review, survey administration, collection of biological samples, and working in pediatric primary care settings. They will acquire content knowledge of smoking cessation treatments and will participate in research team meetings. The RA will assist with the follow-up part of the study upon successful training completion and will work in CHOP primary care clinics to approach enrolled parents for a follow-up survey and tp collect parents' saliva and breath samples for biochemical validation. The RA may also follow up with parents remotely. Prior experience in data collection and conducting surveys is preferred, but not required.

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The study, Refer2Quit, uses a similar approach to encourage parents or caregivers of CHOP Primary Care patients to refer other family members for smoking cessation support. The RA will assist in completing the pilot phase of the study, initiating the main study, recruiting participants, obtaining informed consent, and study data collection. The RA will also have the opportunity to assist with other work-in-progress on Adolescent tobacco/e-cigarette/vaping screening, intervention, and connection to treatments. The RA should be comfortable with approaching and conducting surveys with families. Customer service experience is a plus. The candidate must be detail-oriented with strong communication and organizational skills and comfortable working independently.

Ahmed Moustafa

A Strain Level Pathogen Tracking Pipeline for Personalized Patient Care and Infection Control

My project can be modified to accommodate remote activities if made necessary by University policy.

The microbial ARchive and Cryo-collection (microbialARC) is a new initiative that supports the collection, biobanking, and whole genome sequencing of commensal and pathogenic organisms with the goal of bringing personalized patient care and infection control at the Children's Hospital of Philadelphia (CHOP). To support this vision, microbialARC has collected every bacteremia isolate from patients at CHOP. To date, 900 bacteremia isolates have been collected over 9 months. This state-of-the-art approach to infection control will pave the way for personalized care and detection of emerging pathogens and antimicrobial resistance.

The students are expected to work with me and the team (Steven Jones and Bianca Galis, research technicians, and Dr. Ruth Fahey, admin and lab manager) on culturing and biobanking these pathogenic isolates. They will learn aseptic techniques and basic microbiology and molecular biology techniques. We will sequence and analyze the whole genomes of almost 2000 microbial isolates in 2023. The students will also be trained on genome sequencing. Moreover, the lab is full with automation equipment which will give the students an opportunity to understand more about high-throughput research. The students will also be introduced to basic concepts of microbial bioinformatics with an opportunity for hands-on experience to analyze microbial genomics data.

Audrey Odom John

Development of New Antimicrobial Agents

My project is entirely in-person.

The John lab is interested in microbial metabolism, with a particular interest in targeting microbe-specific metabolic pathways for development of new treatments for infectious diseases. One common challenge in drug discovery is that potential treatments may not cross cell membranes well. Prodrugging, in which a compound is converted intracellularly to the active molecule, is a tool frequently used to improve cell permeability and increase potency. We have recently identified several enzymes that activate prodrugs in bacteria and in malaria parasites. Ongoing projects aim to understand the

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normal biological functions of these enzymes, and to harness them to develop new treatments for staphylococcal infections and malaria. These projects will teach a number of research skills, including bacterial and cell culture, molecular biology, and enzymology. PURM students will be paired one-to-one with a dedicated John laboratory member who will teach techniques and provide daily project oversight and mentorship.

Read more about our lab's research here: https://www.research.chop.edu/john-laboratory/research-overview

Joseph Rossano

Research in Pediatric Cardiology

My project can be modified to accommodate remote activities if made necessary by University policy.

We have many research projects in our Cardiac Center including studies on congenital heart disease, cardiomyopathies, advanced heart failure, transplantation, and mechanical circulatory support in children. Many of these projects are aimed at understanding the epidemiology and outcomes of cardiovascular disease in children, including social determinants of health and involve multi-institutional collaborative observational and interventional studies.

No specific skills are needed, but some knowledge of basic epidemiology and biostatistics may be helpful.

Christopher Thom

Computational Investigation of How Blood Traits Impact Human Disease

My project can be modified to accommodate remote activities if made necessary by University policy.

We each make 200 billion red cells and 400 billion platelets every day. When the mechanisms directing processes go awry, hematologic diseases and/or cancer can result. The Thom lab investigates genetic determinants of blood cell formation, with an ultimate goal to enhance in vitro blood cell production for clinical translational use. We apply statistical modeling and machine learning-based techniques to genetic blood trait data to define important gene targets, and then test our computational hypotheses using genome-edited induced pluripotent stem cells (iPSC) and other cellular models.

We are working to improve our ability to computationally identify active blood regulatory sites and genes using human genetic data. This project would entail an introduction to genome wide association study (GWAS) data and other genomic data sets. We will expand machine learning-based prediction models based on our prior work, and identify those models or pipelines that yield the best predictions (e.g., penalized regression, random forest, boosting, neural networking, or a combination). Finally, we will apply our model to prioritize genomic sites most likely to impact human blood traits and delve into related biology to refine our predictions. Some familiarity with R and/or python is necessary, but the student need not have expertise in any specific machine learning algorithm.

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PHARMACOLOGY

Aalim Weljie

Understanding Circadian Metabolic Function Using Mass Spectrometry and Nuclear Magentic Resonance Spectroscopy

My project can be modified to accommodate remote activities if made necessary by University policy.

The Weljie Lab is located in the Department of Systems Pharmacology and Translational Therapeutics at the University of Pennsylvania. Our lab is at the forefront of metabolomics technologies to examine biological problems in a translational medicine context.

Metabolomics is a growing sub-field of systems biology centered on the study of small biological molecules in biological fluids and tissues. Recent research suggests that analysis of metabolite concentrations in living systems is informative in disease diagnosis, prognosis, and predicting drug efficacy in a personalized medicine context.

Our focus is on developing analytical methods to advance research in translational medicine. There is an intrinsic link between metabolism and function of the innate circadian clock system in numerous organisms and disease states. Still, the exact mechanism by which the clock controls mammalian metabolism is poorly understood. Our work seeks to fill this knowledge gap along with identifying biomarkers of cancer and environmental health.

Students interested in working with us may be engaged in the following types of projects, the exact nature of which will be tailored to specific lab needs and student interests:

1. Mechanistic studies of metabolic alterations as a function of time-of-day through isotope tracing studies in Drosophila
2. Biomarker studies of sleep dysfunction in human studies of insomnia and obstructive sleep apnea.
3. Methodological development of tools for custom labware and protocols for high-throughput screening metabolomics using 3D printing methods and sample handling robotics.

As our lab sits at the intersection of analytical chemistry, biology, and statistical analysis, students will be exposed to and have opportunities to dig deeper into cutting-edge applications in each of these areas.

Day-to-day supervision will be conducted jointly between the PI (Aalim Weljie) and Sr. Research Staff including Dr. Arjun Sengupta, Dr. Pinky Kain, and Dr. Ashley Woolfork.

PSYCHIATRY

Kelly Allison

The Physiology of the Weight Reduced State (POWERS)

My project can be modified to accommodate remote activities if made necessary by University policy.

PURM student fellows would be involved in several aspects of an NIH-funded consortium study based at Penn, Drexel, Tufts, Columbia, and Pitt. The POWERS study's purpose is to investigate the physiological

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and behavioral systems that contribute to variability in weight change following weight loss. We will be recruiting 205 healthy adults with obesity (body mass index [BMI] 30-<40 kg/m2, aged 25-<60 years). We will assess these participants before starting a behavioral weight loss intervention, again immediately after weight loss, and again at 4 and 12 months after weight loss. Participants will be carefully phenotyped while weight stable before and after undergoing a behavioral weight loss intervention consisting of individual instruction and group meetings focused on reducing calorie intake and increasing physical activity (Phase 1). Measures include weight and body composition, energy expenditure (EE), energy intake (EI), resting energy expenditure (REE), physical activity and exercise efficiency, sleep quality, food choice, behavioral and psychosocial assessments. Tissue (blood, muscle, fat) samples will be obtained for metabolite, hormone, genomics and proteomics assays. The anticipated ~120 participants who achieve >7% reduction in body weight following the initiation of the weight loss program will be encouraged to keep their weight stable at their reduced weight for 2-4 weeks, followed by a second round of careful phenotyping and tissue sampling (time T0). The observational weight maintenance phase (Phase 2) will last for 12 months, with additional phenotyping and tissue sampling conducted 4 (T4) and 12 (T12) months after T0. Data analyses aim to identify phenotypes and associated biological and behavioral pathways that contribute to weight change from T0 at T12.

The PURM student will learn from an active, multidisciplinary research team, including psychologists, nutritionists, endocrinologists, nurse practitioners, and clinical research coordinators. They will be involved in patient recruitment and retention, helping with logistics of study assessment visits, team study meetings, and data collection and entry. They would work closely with the clinical research coordinators on these daily tasks and would also attend regular meetings with the investigators. They would have the opportunity to learn about the field of obesity and weight management.

Emily Becker-Haimes

Improving Mental Health Service Quality with Implementation Science

My project can be completed entirely remotely.

PURM student(s) will work across three different projects that aim to improve the quality of mental health services. All projects employ methodology and insights from implementation science, which aims to understand how to increase clinician use of treatment strategies that are demonstrated to be effective within routine clinical settings. Students will be encouraged to learn about and engage with all aspects of the research process across the three projects, which comprise a mix of quantitative and qualitative methodologies. Student(s) will work directly with faculty mentor Emily Becker-Haimes (a clinical psychologist and implementation scientist), and other core members of the research team, including a postdoctoral fellow (Jesslyn Jamison, PhD) and senior research coordinator (Megan Brady). In addition to individual support and mentorship, students will be strongly encouraged to attend weekly project meetings.

The first project, Project ACTIVE, is a large, NIMH-funded study that is testing how to optimally support clinicians to deliver cognitive behavioral therapy, a leading psychosocial evidence-based practice, in community settings. In this project, students will gain experience with consenting and enrolling

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participants into a research study. Students also will have an opportunity to support qualitative analysis of data gathered from community clinicians as well as to observe clinician therapy practices in the community.

The second project, Project CALMER, is an exploratory NIMH-funded project to develop and test a novel strategy to support mental health clinicians to deliver leading evidence-based practices for suicide prevention. Students will learn about leading evidence-based strategies for suicide prevention, will contribute to the development of role play procedures to assess clinician competency in assessing suicide risk and conducting brief safety planning interventions to address risk. They also may have the opportunity to observe and contribute to qualitative interviews with clinicians about how to improve suicide prevention training practices. Students will receive training in and support to complete qualitative coding and analysis of interview data.

Finally, the third project, Project INTAAKE, aims to identify and learn from families of youth with anxiety or obsessive-compulsive disorder who are at-risk for failing to engage in evidence-based treatment. We are conducting a retrospective analysis of data with ~400 families and conducting ~10 qualitative interviews with caregivers of youth to learn about how we can better support families to engage in evidence-based mental health care. Students primarily will contribute to qualitative analysis; opportunities to engage with the quantitative dataset also are available.

Edward Brodkin

Clinical Trial of a Cognitive Behavioral Mindfulness-Based Program to Support Social Functioning in Adults on the Autism Spectrum

My project can be modified to accommodate remote activities if made necessary by University policy.

Difficulties with social interactions, the hallmark characteristics of autism, usually persist into adulthood, often interfering with individuals' ability to function in family, educational, work, and community settings. Although a number of interventions have been designed to help children on the autism spectrum with social functioning, very few have been developed that would be suitable for adults. We have developed a novel treatment program to enhance social functioning in late adolescents and adults with autism spectrum disorder (ASD), which we have named TUNE In (Training to Understand and Navigate Emotions and Interactions). TUNE in includes elements of cognitive behavioral therapy and mindfulness to help participants develop new skills in emotion regulation, stress reduction, social understanding, and social skills. Our early, pilot data suggest that TUNE In is helpful to participants. As a next step, we are conducting a larger clinical trial to more thoroughly test the effectiveness of TUNE In for improving social functioning, reducing stress, and improving overall quality of life in adults on the autism spectrum. We are conducting this trial as part of our larger U Penn Autism Spectrum Program of Excellence, which Dr. Brodkin co-directs.

U Penn freshman or sophomores who work on this clinical trial with the Brodkin lab team will have the opportunity to actively participate in our clinical research team, including assisting in carrying out the TUNE In intervention (by participating in group meetings of the clinical research team and participants), and in collecting pre- and post-intervention assessment data. U Penn students will be trained and supervised in all of these procedures by Dr. Brodkin and members of Dr. Brodkin's fulltime research

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team, including clinical research coordinators / recent U Penn graduates (Chandni Shah, Rose Rasty, Maya Rajan), as well as a postdoctoral fellow in the Brodkin lab (James Rankin). Students can expect to acquire skills of interacting with adult research participants; using validated assessments of social functioning, anxiety, and quality of life; and helping to deliver a cognitive behavioral mindfulness-based intervention. Students will also gain familiarity with using a standard clinical research database, REDCap. Students will have the opportunity to learn more about the autism spectrum, treatment approaches, and more generally about psychiatry and psychology. Students will be invited to attend weekly Brodkin lab meetings, and weekly meetings of the larger Autism Spectrum Program of Excellence at U Penn, which includes multiple labs in the U Penn Departments of Psychiatry, Genetics, and Neuroscience.

Gregory Corder

The Liver-Brain Axis: Metabolic dysfunction in Alzheimer's Disease

My project is entirely in-person.

The Corder Lab (Department of Psychiatry and Department of Neuroscience) is looking to work with highly motivated students that are interested in gaining lab experience and assisting with a cutting-edge neuroscience project to use a combination of genetically engineered mice, cognitive behavior, and fluorescent viruses to discover the connections between aging and diet/metabolism, within brain-to-liver systems, that increase the risk of Alzheimer's Disease.

Alzheimer's Disease (AD) is the most common cause of dementia, affecting nearly 6 million Americans and continuing to increase in prevalence with the aging population. AD is marked by the accumulation of amyloid plaques that interfere with normal neuronal metabolism and signaling in the brain. The primary risk factor for AD is advanced age, followed by genetic risks, and is often comorbid with metabolic dysfunction including obesity and liver dysfunction, such as a disorder called Non-alcoholic Fatty Liver Disease (NAFLD). Recent studies also suggest NAFLD may directly contribute to AD through impaired amyloid clearance. Dysregulated lipid metabolism is a common feature of both NAFLD and AD, and therefore, identifying and characterizing genes associated with NAFLD could also provide novel insights into AD inheritance and risk.

The mission of the Corder Lab is to decipher the neural basis of how the brain encodes decisions and sensory experiences, in models of neurodegeneration and chronic pain. Using advanced in vivo imaging of neural activity, neuroanatomical tracing, and genetics techniques, in rodent model systems, our group continues to deconstruct the brain circuits and molecular mechanisms involved in models of brain function and disease. From our lab's investigations, we aim to identify translational targets for developing novel treatments that improve brain function and prevent AD progression.

Students will have an opportunity to be a part of a young and dynamic lab, and to gain experience in advanced neuroscience and biochemical techniques, including viral-assisted neural circuit mapping, tissue histology and immunohistochemistry. Students pursuing, or intending to pursue, degrees in biology, neuroscience, genetics, or other medically related fields are encouraged to consider these projects. A willingness and/or comfort working with mice is required.

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The lab's Principal Investigator, Dr. Gregory Corder, as well as other lab members of the lab will provide one-on-one training in these techniques. You can expect that Dr. Corder and the entire team will do all they can to make the lab an exciting, fair, and rewarding place to gain new insights into the neurobiology of the mind and brain.

Mariella De Biasi

Effects of Adolescent Cannabidiol (CBD) Exposure on the Vulnerability to Opioid Use Disorder

Second-year only
My project is entirely in-person.

Adolescent cannabis use is associated with an increased risk of future opioid misuse. The primary constituents of cannabis are the psychoactive Δ9-tetrahydrocannabinol (THC) and the non-psychoactive CBD. Although adolescent THC exposure has been repeatedly demonstrated to increase future opioid use, it is not clear whether or how CBD alters the vulnerability to misuse opioids. This is particularly important because CBD is largely unregulated and widely-available over the counter, including in e-cigarette liquids. This PURM project will leverage the De Biasi lab's vapor administration systems to investigate the effects of adolescent CBD exposure on future morphine intake. Students will learn how to perform drug self-administration and other behavioral experiments to evaluate the contribution of adolescent CBD vapor exposure to the development of future opioid use disorders. Trainees will also learn to find and discuss academic articles; articulate hypotheses and design experiments; analyze data using statistical software (e.g. R); and present findings. Trainees will also gain wider exposure to scientific studies through weekly lab meetings and ongoing interaction with lab members. All training is provided, although previous rodent handling experience is preferred. Students will be supervised by a postdoctoral fellow (Jessica Shaw) and a graduate student (Kate Webb) in the lab

Wanjiku Njoroge

Pregnancy to Preschool: The Impact of the Pandemic on Mothers and Children, with a Focus on Syndemic Effects on Black Families

My project can be modified to accommodate remote activities if made necessary by University policy.

Problem:

The emergence of the COVID-19 global pandemic has had significant impact on the health and well-being of adults and children alike. In the US, the COVID-19 pandemic has highlighted the fractures in many systems including education, the economy, housing, and healthcare, widening known racial disparities. This is of particular importance considering the criticality of the peripartum period on early neurodevelopment. Research suggests that early maternal symptomatology can have a lasting, and negative impact on parent-child interactions, infant/child development, and mental health of both women and children. These findings take on further importance when contextualizing the disparate exposure of Black children and their families to structural racism and the COVID-19 pandemic.

Description:

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This multi-methods project consists of three aims which will longitudinally examine child neurodevelopmental outcomes by early identification of racially and ethnically diverse mothers with mental health challenges. The first aim implements extensive screening of postpartum Black and non-Latinx White (NLW) mothers using a battery of questionnaires and clinical psychiatric interviews to identify mothers currently experiencing distress and psychopathology, as well as determining resilience factors uncovering cross-cultural differences that may exist. Fathers/secondary caregivers will also complete similar questionnaires assessing levels of support. The second aim identifies maternal concerns about their child's development and mental health at two developmental time points (24 and 48-months, and assesses mother-child interactions on a series of dyadic play-based tasks. The final aim consists of qualitative interviews with a sub-sample of Black women characterizing the impact of the syndemic on their mental health, parenting practices, perceptions of their child's early development, and trust in the healthcare system. The overarching goal of this application is to deeply characterize the experiences of women and children impacted by the syndemic, filling the gap in the research of identifying specific maternal and environmental factors and mechanisms that critically influence early child development and mental health and allowing for future intervention development.

Next Steps: Identifying women disproportionately impacted by the COVID-19 pandemic and endemic conditions (syndemic) during the peripartum period, provides an opportunity to understand the developing child's environment, mother's mental health, and parenting experience.

- Lead: Wanjikũ FM Njoroge MD
- Team: Co-I's: Rebecca Waller PhD, Sara Kornfield PhD, Florence Momplaisir MD, MSHP, Raquel Gur MD, PhD
- Njoroge Lab team: Gina Cahill MPh, Tiffany Tieu BA, Christina Alexandre BA, Jasmine Miller BA, Kayla Holloway
- Funder: NIH/NIMH
- Project Contact: Gina Cahill

Courtney Wolk

Sustaining Evidence-based Practices in School Mental Health

My project can be completed entirely remotely.

Our team leads two large externally-funded projects aimed at supporting schools in implementing and sustaining evidence-based practices in mental health. The first project, BRIDGE, is being conducted in partnership with a large urban school district in the Mid Atlantic area and a local managed care organization. BRIDGE is an evidence-based model for mental health clinician consultation to teachers. We are rolling out BRIDGE with approximately 180 clinicians across 150 schools over a four-year period which began in November 2021. The second project, TeamSTEPPS for Schools, is a pilot study of an adapted version of an evidence-based team training intervention from healthcare, TeamSTEPPS, in schools with the goal of improving collaboration and coordination between school mental health and education personnel.Both projects are grounded in implementation science frameworks and have an explicit goal of developing sustainability plans and materials so that our partner districts and community members are able to maintain use of these evidence-based practices after the funding period ends.

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The student would work closely with the PI Dr. Wolk, postdoctoral fellow, and research coordinator to review the literature on best practices for sustainment and scale up and to help create sustainability materials (e.g., toolkits, asynchronous training content) for dissemination to our school partners in the final stages of these projects. In this process they would also help review and synthesize quantitative and qualitative data already collected by our team which will be used to inform the sustainability materials.

PULMONARY, ALLERGY, & CRITICAL CARE MEDICINE

Jeffrey Thompson

Circulating Cell-Free DNA Methylation Profiling and Deconvolution in Patients with Cancer or Suspected Cancer

My project is entirely in-person.

Dr. Jeffrey Thompson works closely with the Liquid Biopsy Lab, led by Dr. Erica Carpenter, focusing on the analysis of cell-free DNA (cfDNA) and body fluid analytes from cancer patients. Blood and other noninvasively captured patient samples are used to detect biomarkers which allow: (1) early detection of disease as well as post-therapy monitoring of minimal residual disease, (2) an efficient means of determining clinical and biological response to therapy and, thus, clinical decision making, and (3) cancer genetic phenotyping to drive personalized medicine. The focus of the Liquid Biopsy Lab is driven by the needs of investigators and clinicians, such as Dr. Jeffrey Thompson.

The student's research will focus on methylation profiling and deconvolution of plasma cfDNA for the diagnosis of patients with suspected cancer and/or to better understanding the biology of cfDNA shedding and prognostics in patients with cancer. The student will conduct assay development, perform sample preparation, summarize/analyze results, and be exposed to the clinical aspects of cancer patient diagnosis and treatment. Additionally, there may be clinical shadowing opportunities with Dr. Thompson. This is an ideal project for those interested in medical science, may be undecided between medical and/or graduate school, and would like to gain experience in translational research.

RADIATION ONCOLOGY

Gary Freedman

Introduction to Research in Radiation Oncology

My project can be modified to accommodate remote activities if made necessary by University policy.

The interested student will spend the summer in an academic Radiation Oncology department working with the faculty mentor and resident physicians.

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The goal of the summer project is to identify a clinical case or question related to clinical patient care that needs to be researched. The student will learn basics of data extraction from the EPIC electronic medical record and the ARIA radiation planning systems. The student may also learn about medical informatics and algorithmic data extraction.

Examples of student activities may include research and publishing of a clinical case report; assisting with an existing / ongoing clinical project by a resident physician involving the coding or analysis of radiation patients; or developing a patient-reported outcome questionnaire for patients undergoing treatment.

There will be opportunities for working with associated radiation oncology specialists in medical physics for students with a physics interest, or attendance at clinical case conferences for those students considering a career in medicine.

RADIOLOGY

Elizabeth McDonald

Breast Cancer Biomarker Development

My project can be modified to accommodate remote activities if made necessary by University policy.

We have a number of projects investigating mechanisms of response and resistance in breast cancer. Potential projects range from automated quantification of pathology image phenotypes (pathomics), mouse models of disease/animal image analysis, and clinical trial novel investigational radiotracer image analysis, depending on interest. We also have databases of genomic information linked to novel tracer imaging, for bioinformatics mining if interested. We believe that a combination of pathomics and radiomics will enable precision cancer care delivery of the future. These projects are well suited for anyone with an interest in breast imaging, nuclear medicine, translational imaging research, or cancer biomarker development. Please check out our lab website for more information: http://bit.ly/PennBCTRG

Ali Nabavizadeh

Automated Brain Extraction and Tumor Segmentation for Pediatric Brain Cancer Patients Using Deep Learning AI Methods

My project can be completed entirely remotely.

Brain tumors are the most common solid tumors in children, and high-grade brain tumors are the leading cause of cancer-related death among all childhood cancers. Tumor segmentation on MRI is essential for surgical and treatment planning, but manual segmentation is time-consuming and has high interoperator variability. Our lab has developed an automatic brain extraction and tumor subregion deep learning-based segmentation models in a multi-institutional study that can reliably segment the MRI scans of the children with a variety of brain tumor histologies and based on widely available standard MRI scans (https://www.medrxiv.org/content/10.1101/2023.01.02.22284037v1). In the next phase of the project, we plan to extend this work to include post-surgical patients so the model would

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ultimately be able to be used for longitudinal assessment of tumor volume and treatment response assessment in the context of clinical trials.

The successful candidate will work with a team of investigators at the Center for Data-Driven Discovery (D3b) at the Children's Hospital of Philadelphia and will be involved in manual segmentation of post-surgical brain tumors MRIs and subsequently check them with an experienced pediatric neuroradiologist for editing and final approval as ground truth. The internal cohort was split into training, validation, and withheld internal test subsets. DeepMedic, a three-dimensional convolutional neural network, will be trained and the model's parameters will be tuned. Finally, the network was evaluated on the withheld internal and external test cohorts.

Other mentors: Anahita Fathi Kazerooni, PhD, Ariana Familiar, PhD
At the end of the 10 weeks, the student will learn the steps involved in preprocessing and segmentation of pediatric brain tumors.

Fundamental required knowledge: Familiarity with neuroanatomy.
Preferred skill: Coding and AI experience or significant interest.

Chamith Rajapakse

Artificial Intelligence, Augmented Reality, Blockchain, and Web Development for Radiology, Orthopaedics, and Surgical Planning

My project can be completed entirely remotely.

Multiple projects involving medical imaging (MRI, CT, X-ray, DXA, and PET) in following technical areas are available: Orthopaedic Engineering; AI/ML/Deep Learning; Blockchains, Web Programming; Augmented Reality; Bio 3D printing; and Medical Record Data Collection. While no experience is needed and training will be provided for image analysis projects, computer programing skills (e.g., TensorFlow, Unity, Unreal Engine, javascript, PHP, etc.) would be beneficial for AI, AR, web programming projects. Most projects can be completed remotely. Preference will be given to students intending to apply for medical/graduate school or industry jobs that require advanced computer skills and who are interested in continuing the research beyond summer.

Hersh Sagreiya

Multimodal Deep Learning Algorithms in Abdominal Radiology

My project can be modified to accommodate remote activities if made necessary by University policy.

We have developed algorithms that use deep learning for quantitative clinical diagnoses and disease prognostication. These projects use multiple types of medical data, including imaging. We previously developed an algorithm that automatically calculates liver and spleen volume on CT to determine the presence of fatty liver disease (hepatic steatosis). We also developed an algorithm that quantifies abdominal fat on CT and another that determines the volume of individual muscles on CT. A new project analyzes thyroid nodules on ultrasound using machine learning. We seek to better understand disease

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development and clinical outcomes. We have linked imaging features to genetic data in Penn Medicine BioBank and the Electronic Medical Record to conduct genome and phenome-wide association studies (GWAS and PheWAS). One PURM student last year studied lean steatosis, analyzing how predictions from machine learning could be used to study patients with fatty liver disease despite a lean BMI. This included an analysis of related clinical phenotypes, biomarkers and a PheWAS, leading to a first-author manuscript. Another student developed a deep learning algorithm to identify the liver and spleen on MRI to determine the presence of hepatic steatosis. We are actively working on projects to bring machine learning algorithms to clinical radiology practice.

Our work in the Journal of the American Medical Informatics Association sought to automatically quantify abdominal fat on CT using deep learning: https://academic.oup.com/jamia/article-abstract/28/6/1178/6133906. A project spearheaded by medical students sought to estimate a synthetic lab value, hemoglobin A1C, using imaging and clinical data and is available on arXiv: https://arxiv.org/abs/2209.10043.

This project presents an opportunity to learn more about machine learning applied to medicine. These skills are valuable both for potential graduate work and the job market. Opportunities are available to further develop existing techniques, focusing on clinical and basic science insights. Other options include developing algorithms for identifying new findings on CT/MRI, developing multimodal algorithms, genome and phenome-wide association studies, and using these algorithms to make novel clinical predictions. Although skills in introductory computer science are a plus, students from all backgrounds are encouraged to apply, as projects can also focus on biological or statistical aspects. You will also work with Dr. Walter Witschey, Director of the Advanced Cardiovascular Imaging Lab, who has led several machine learning projects at Penn, as well as several researchers in this field. There will also be a weekly lab meeting where you can meet other students.

Paul Yushkevich

Automated Quality Assessment for Imaging Biomarkers for Alzheimer's Disease

My project can be completed entirely remotely.

With recent advances in image acquisition and analysis, imaging-based biomarkers have become a key tool in neurodegenerative disease research. With several large scale studies providing publicly available imaging datasets, there is a need for reliable tools for quality assessment that can enable high-impact, high-throughput studies that are not plagued by methodological confounds. To this end, this project will aim to to develop a learning-based tool for assessing quality of image segmentations in a dataset of early Alzheimer's disease. Annotated data for training a deep neural network will be available.

This project will require familiarity with UNIX-based computing environment, and ideally some experience with deep learning. Familiarity with medical image analysis is a plus, but not necessary.

Drs. Sandhitsu Das, Paul Yushkevich, David Wolk will be co-mentors.

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SURGERY

Arun Srinivasan

Novel Ways to Analyze MAG-3 Renal Scans to diagnose UPJ Obstruction in Children

My project can be modified to accommodate remote activities if made necessary by University policy.

Project Lead - Srinivasan, Sameer
Research Team Lead- Suhaib, Mitchell

MAG-3 renal scan is a radioisotope study performed in children and adults to analyze kidney function and excreation. It has particular characteristics that allows us to diagnose obstruction to urine flow from the kidney which needs a surgical correction. But at this time, our understanding and analysis of this study is still not completely explored. The goal of this study is to analyze this study for other identifiable factors that enables diagnosis of obstruction of kidney

Method: Research team will look at all renal scans done between 2014 and 2018 performed in the children's hospital of Philadelphia. The study output is in the form of numerical values for function and graphical representation of the contrast making its way through the kidney. We will use curve analyzer and calculate various slopes, most of them novel, to identify study characteristics that help diagnose problems

Skills:

Basic Word, PPT and Excel skills
Use basic curve analyzer tool and basic math skill sets
Understanding of basic human anatomy

Undergrad student will join the present research team who will teach them the basics of the MAG3 test and will make sure the student understands what we are trying to achieve

Nursing

BIOBEHAVIORAL HEALTH SCIENCES

Nancy Hodgson

COPE in PACE: Improving Healthcare for Older Adults with Dementia

My project can be completed entirely remotely.

Learn about dementia, evidence-based interventions, and implementation science with renowned dementia researchers at Penn, Drexel, and Thomas Jefferson University. This project offers a thorough introduction to biobehavioral research and offers students training in participant consent procedures,

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data collection and interviewing research participants. Students will collect and input data using REDCap, a notable research database software. Students may also work on literature reviews to gain knowledge of the field. Be in the room where it happens by working with the project lead, senior staff, and teams across academic and clinical institutions. The developers of COPE, Care of Persons with Dementia in their Environments, are actively engaged with this project.

To enhance their experience, students will have the ability to work on other research projects within Dr. Hodgson's portfolio including a collaboration with the Alzheimer's Association focused on dementia care coordination. Being engaged with these projects will allow students to learn about mixed methods research. This may involve training in programs such as Qualtrics, NVivo, and R to develop both quantitative and qualitative analysis skills.

Students have the option to create their own research project based on research skills learned through this mentorship from Dr. Hodgson and her Research Project Managers – Sonia Talwar, and Emily Summerhayes.

FAMILY & COMMUNITY HEALTH

Jianghong Liu

Culturally Tailored Exercise for Older Chinese Immigrants

My project can be modified to accommodate remote activities if made necessary by University policy.

New immigrants and ethnic minority groups often face health disparities due to language and cultural barriers, particularly among older adults. Both group exercise and culturally tailored format have been shown to bridge the disparities. Furthermore, research shows that regular exercise has been linked to reduced cognitive decline among older populations. This project aims to conduct a Chinese exercise program (e.g. Qigong, Tai-Chi) in the older Chinese immigrants in Philadelphia, to evaluate the effects of the 2-month intervention on their physical and mental wellbeing, including sleep, cognitive function, emotion, social connection, etc. We are particularly interested in cognitive health. This exercise program will be hybrid: virtual and in-person.

Students will be involved in all stages of the research with the team: recruiting participants, obtaining consent, scheduling for pre- and post-test, carrying out daily virtual or in-person exercise programs, organizing focus groups, entering data, and conducting literature search. Students will work closely with the PI and the research team, with periodical meetings.

We welcome one or two highly motivated students with good communication skills (both verbal and written), good work discipline, and a strong interest in prevention and wellness.

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G. Adriana Perez

A Community-Based Physical Activity Intervention to Promote Cognitive Health, Cardiovascular Health & Sleep in Spanish-Speaking Older Latinos

My project is entirely in-person.

This study provides research-training opportunities for undergraduate students interested in advancing health equity for historically marginalized Spanish-speaking elders at risk for developing Alzheimer's Disease and related dementias (ADRD).

The randomized controlled trial, Tiempo Juntos por Nuestra Salud (Time Together for our Health), tests a Spanish language physical activity intervention among adults 55 years and older with mild cognitive impairment (MCI). Physical inactivity is a public health priority for this population, who experiences a disproportionate burden of cognitive health disparities. MCI, considered the pre-dementia stage or Alzheimer's disease (AD), increases the risk of developing AD ADRD. Studies suggest that physical activity enhances cognition indirectly by improving health behaviors such as sleep and by reducing chronic conditions such as cardiovascular disease that affect neurocognitive function. In partnership with the Hispanic/Latinx community of North Philadelphia, Tiempo Juntos is led by Community Health Promoters and tests multilevel strategies: empowering education for behavior change, individual motivation, building a social support network, and promoting cultural and community resources for safe walking.

All study materials, including intervention and data collection procedures are in Spanish, therefore, it is critical for the Scholar to be bilingual with Spanish-language fluency. Other desired skills include strong written and oral communication skills, strong interpersonal skills. And most importantly, a desire to learn about healthy aging in the Latino community, including those with memory impairments.

Due to the multi-level theoretical design of the intervention, roles can be distributed accordingly to focus on distinct parts under each specific aim (i.e. focused on activities related to 1) exercise science, 2) cognitive health, 3) cardiovascular health, 4) sleep or 5) cost measures).

Examples of some roles/responsibilities:

- Assist in the recruitment and retention of study participants.
- Conduct face to face and telephone interviews in Spanish.
- Provide reminders for data collection and intervention appointments.
- With guidance from the study team, assist with data collection procedures (cognitive health questionnaires, blood pressure/heart rate assessment, sleep and physical activity tracking)
- Enter data into RedCAP, general data management
- Collaborate with PI, and other study team members, to ensure project success. This includes attendance and participation at ongoing team meetings.
- Compliance with human subject's standards and research protocols, maintains strict confidentiality.
- May also assist in manuscript development, community presentations, training, intervention development, program support, and administration activities.

Other mentors include: Study Project Manager and Coordinators who will assist with field research activities and leadership development for research training.

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Social Policy & Practice

Jacqueline Corcoran

Depression in Low-Income Women

My project can be completed entirely remotely.

This topic involves depression in low-income women. The first part involves systematic reviews of the literature, particularly depression in Black, Latinx, TANF programs, and home visiting programs. The skills involve screening studies using an identified process and tracking results; extracting data from the articles; compiling information in tables; and compiling references.

The second part involves decision-making for providers about which treatments they would recommend for women who are low income and depressed, depending upon demographics, features of the depression, and other contextual variables. The third part involves respondent decision-making given particular risks and benefits. Both the second and third parts involve contacting and recruiting respondents, designing Qualtrics surveys, distributing surveys, compiling results, and compiling references.

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Veterinary Medicine

BIOMEDICAL SCIENCES

Andrew Modzelewski

The Role of Retrotransposon Reactivation in Development and Disease

My project is entirely in-person.

(Project 1) Nearly half of all mammalian genomes originate from ancient retroviral integrations called retrotransposons. While silenced in nearly all cells, retrotransposon reactivation is a well-known phenomenon in preimplantation embryos and the germline. In these systems, retrotransposons appear to be highly regulated with predictable expression patterns. Disruptions made in the lab have revealed essential function for retrotransposons through impacted fundamental biological processes that lead to arrested development, abnormal phenotypes and implantation defects that resembles human pregnancy complications (Cell 2021). While reactivation is essential and required during development, retrotransposons spontaneously reactivate with unpredictable and damaging effects in cellular contexts where epigenetic mechanism break down, such as aging, neurodegeneration and cancer. This highly collaborative project adapts proteomics, genetics, bioinformatics and CRISPR/Cas9 editing to reveal this overlooked but essential form of regulation in development, fertility, and disease.

(Project 2) As no current cell culture system faithfully represents the preimplantation development, the majority of research at this stage must be done directly in the embryo, and sometimes animal models are necessary. Even with CRISPR/Cas9 gene editing, generating mouse models is cost prohibitive and largely inaccessible. Therefore I developed CRISPR-EZ (CRISPR Electroporation of Zygotes) and showed it at least 3-4x more efficient than the gold standard of microinjection, is inexpensive, works in all species tested, but there is still room to improve (JBC 2016, Nature Protocols 2018). Efforts include the use of AAV, CRISPRa/i (activation/interference), humanized models to study conserved regulatory networks.

Expectations: Student will be involved in planning and conducting ongoing research under supervision of the Principal Investigator (PI) or mentor (TBD). At the start, they will collaborate closely with the PI to learn techniques and experimental set-up. Student will have the opportunity to be trained in various techniques including: molecular biology, molecular cloning, computational biology, and biochemistry, immunofluorescence, immunohistochemistry, quantitative PCR (qPCR), confocal microscopy. The overall goal of the project is to aid in characterization of retrotransposons impact in human cell lines and mouse models, with a goal to discover new therapeutic targets. The student will be mentored in critical thinking, project planning and managing large data.

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CLINICAL STUDIES NEW BOLTON

Kyla Ortved

Investigation of the Chondroprotective Effects of Extracellular Vesicles Isolated from Equine BM-MSCs Cultured in Fetal Bovine Serum or Equine Serum

My project can be modified to accommodate remote activities if made necessary by University policy.

The objective of this proposal is to determine if extracellular vesicles (EVs) isolated from equine bone marrow-derived mesenchymal stem cells (BM-MSCs) have chondroprotective properties, and if those isolated from BM-MSCs expanded in media supplemented with equine serum (ES) have different characteristics and function than those expanded in fetal bovine serum (FBS) supplemented media. Mesenchymal stem cells (MSCs) can modulate the local tissue response and stimulate healing, and equine BM-MSCs have been shown to have immunomodulatory properties. It has been suggested that the robust bioactive properties of MSCs are in large part due to the production of EVs, which are small membrane-enclosed vesicles released by the parent cell into the extracellular environment. EVs contain complex biologic cargo, including proteins, lipids, and nucleic acids, and are extensively involved in cell-to-cell signaling.

The potential use of MSC-derived EVs (MSC-EVs) to modulate inflammation in posttraumatic osteoarthritis (PTOA) has garnered significant interest recently. There are currently no effective treatments for PTOA in the horse, despite the disease's high morbidity and mortality rates. The ability of MSC-derived EVs to regulate inflammation within the joint has been reported in human and murine models. For MSC-EV harvest, MSCs are typically culture expanded in FBS supplemented media until confluent. Then, a 48-hour serum starvation period is instituted to prevent contamination of the sample with bovine EVs, followed by the collection of the cell culture supernatant and isolation of EVs. However, this serum starvation period can cause cell stress, altering the population of EVs released. We propose using commercially available ES for the expansion of BM-MSCs to circumvent the serum starvation period. We hypothesize that MSC-EVs will have chondroprotective properties and that those isolated from BM-MSCs cultured in ES will have superior chondroprotective abilities. These hypotheses will be tested via:

Aim 1: To determine if EVs from BM-MSCs cultured in FBS or ES are chondroprotective using an ex vivo cartilage explant model.

Aim 2: To determine if EVs from BM-MSCs cultured in ES without a serum starvation period have different characteristics than those cultured in FBS with a serum starvation period before EV harvest.

The participating student will mainly be involved in tissue collection, cell culture, and quantification of cytokines and proteins. The student will work closely with the PI, research specialist, post-doc and PhD student. All work will take place at New Bolton Center located in Kennett Square, PA, and the student will need to provide their own transportation.

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CLINICAL STUDIES PHILADELPHIA

Cynthia Otto

Cognition, Memory and Motivation - What Makes a Detection Dog Successful?

My project can be modified to accommodate remote activities if made necessary by University policy.

Detection and working dogs are used for a wide variety of important tasks, from detection of explosives and accelerants to conservation, where dogs can help track endangered species. Given the increasingly widespread use of detection dogs, it is important to ask - what characteristics define a successful detection dog? In this project, we will examine the similarities and differences in detection dog olfaction, cognition, and behavior to answer this question. We will work with a range of experienced working dogs at the Penn Vet Working Dog Center, as well as citizen science dogs that were recently trained to do odor and detection work. Cognitively, we are particularly interested in is the effect of attention and memory capacity on dogs' ability to learn a novel category of odors, like the scent of pancreatic cancer. Behaviorally, we are interested in understanding and quantifying the differences in dogs' persistence and motivation to complete a task, and how this correlates with their ability to learn an odor category and their odor thresholds. Together, this project will allow the Penn Vet Working Dog Center and other training organizations to better identify dogs that would succeed as detection dogs.

PATHOBIOLOGY

Raimon Duran-Struuck

Generation of Anti-CD34 Monoclonal Antibodies Towards Swine Stem Cells

My project is entirely in-person.

Our laboratory is a translational research laboratory that uses large animal models as a platform to cure diseases for humans and animals. We are focused in the development of immunological tolerance so that organs can be transplanted without the need for immunosuppressive drugs and without developing rejection. The overall goal of the study will be to expand and test a novel CD34 antibody that can be used for stem cell transplants in swine. In addition the student will be exposed and will participate in transplantation immunology projects with veterinary students and a PhD student and be exposed to both hands on animal work and immunology bench work.

Other mentors
1. Nimisha Patada - veterinary student
2. Lidia Flor Cuenca - PhD student
3. Hannah Thomas - veterinary technician
4. Faith Key - laboratory technician

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Michael Povelones

Parasite Adhesion

My project is entirely in-person.

Parasites cause important human diseases, but many important aspects of their life cycles are not well understood. A striking example of this is parasite adherence to the tissue of their insect host, a process that occurs in both vector-transmitted trypanosomatid parasites (dixenous), and those that only colonize insects (monoxenous). This adhesion is essential for proper development in the insect, which is in turn essential for transmission of pathogenic species. Formation of this adhesive structure must be initiated by signal transduction pathways, which then direct the synthesis and assembly of the adhesion itself. Currently, the nature of this process is completely unknown; however, due to the ultrastructural similarities of the adhesion structures from different species, is likely to involve mechanisms shared by all trypanosomatids.

We are studying the process of trypanosomatid adhesion using the model monoxenous parasite of mosquitoes, Crithidia fasciculata. This parasite is closely related to pathogenic trypanosomatids that are responsible for Chagas (Trypanosoma cruzi), Sleeping sicking (T. brucei), and Leishmaniasis (Leishmania spp). It adheres to insect gut tissues in a way that resembles how pathogenic kinetoplastids do in their insect vectors. Remarkably, C. fasciculata will also adhere to culture plates with similar cell biological characteristics found in vivo. This allows detailed molecular analysis of the mechanisms involved in adhesion.

In this project, the student will make us of our transcriptomic and proteomic data sets to identify and characterize proteins involved in the process of adhesion. Proteins of interest will be tagged with fluorescent protein to follow their sub cellular localization in culture and in infected mosquitoes. Candidates will also be disrupted genetically. Parasites with a gene knockout will be tested for defects in adhesion in culture and in mosquitoes.

An undergraduate researcher in his fourth year and who is planning to continue in the laboratory in the summer as a research technician, the lab's current technician, and myself will be involved in advising on the project. This project is also part of a collaboration between my lab and the lab of Megan Povelones at Villanova University. We share a lab meeting for this project and the student will also receive mentoring feedback as part of these bi-weekly meetings.

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Wharton

BUSINESS ECONOMICS & PUBLIC POLICY

Santosh Anagol

Household Finance in Emerging Markets

My project can be completed entirely remotely.

The first student will contribute to my research agenda on understanding the development of household financial markets in India, potentially including real estate, mutual funds, stocks, credit, insurance, taxes, and payments (e.g. paytm). Across these sectors I am studying regulatory and business developments. The work may include research policy changes in developing countries, collected data, proofing papers, etc.

This position would be a great fit for students interested in emerging markets, looking to get exposure to the basic process of research in economics (collecting data, programming, conducting literature reviews). Students will build their practical knowledge of the household financial markets listed above.

Experience working with data in Python, Stata or R would be great but not necessary. Please include this information in your application.

MANAGEMENT

David Hsu

Entrepreneurial Ecosystems

My project can be modified to accommodate remote activities if made necessary by University policy.

This summer, we are looking to recruit 1-2 students to assist in researching material for a book project on the emergence of entrepreneurial ecosystems around the world. This is a collaborative effort with an industry practitioner, who is a venture capital investor, Paul Axel. He and I will serve as mentors for this project. We want the material in the book to be data driven, and so the ideal candidate will have data science skills in addition to strong interest in the topic. The book manuscript will also contain comparative analyses, and so we encourage individuals with strong interest in the topic and social science/business interests, regardless of data skills, to also apply. Detail orientation and strong follow-through skills are important.

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Samir Nurmohamed

Exploding Offers: How Time Pressure to Accept an Offer Impacts New Hires

My project can be completed entirely remotely.

Finding a job is full of stress, anxiety, and uncertainty. However, for many candidates, it does not end after receiving a job offer. In fact, many candidates who receive offers experience time pressure to make a decision. Although practices such as exploding offers are common, their effects are unclear. Some companies suggest that imposing time pressure is necessary to ensure they select candidates who identify with their organization and are committed to the job. However, time pressure may also result in candidates making suboptimal decisions and experiencing regret. The effects of time pressure to accept an offer are important to understand because it may result in a mismatch between organizations and employees. The purpose of this research project is to use field and experimental data to study the effects of time pressure to accept a job on subsequent performance and commitment in organizations.

Leandro Pongeluppe

Political Risk Assessment through a Cross-country Comparative Institutional Analysis Tool

My project can be completed entirely remotely.

Political risk has reemerged in the news after the war in Ukraine started in February 2022. However, there is a tradition of studying the topic in management, mostly considering the effects political risk can have on the definition of governance structures of multinational firms and the impact it has on the political and economic performance of countries.

This project aims to organize a simple dataset with variables related to economic freedom and political constraints of several countries across time and create a Cartesian visualization able to display the relative and intertemporal position of countries, this has been called the Comparative Institutional Analysis (CIA) framework (Pongeluppe, 2022). The project also aims to map specific cases in which the CIA framework helped to predict political risk and potential institution strengthening and weakening.

A student with the ability to work with secondary data in excel, and with some level of ability in python would be ideal. The ultimate goal is to have the framework available to use on the professor's webpage. The work of students will be properly acknowledged and referenced there, generating visibility for the student.

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MARKETING

David Reibstein

Nation Branding

My project can be modified to accommodate remote activities if made necessary by University policy.

I have been conducting over the last seven years a global survey to ascertain perceptions of approximately 80 countries on 78 different attributes. The perception of a country is what I refer to as the brand or image of a country. I look at how the brand of a country contributes to the economy of the country, that is, its gross domestic product (GDP). I then rank the country based on the strength of the brand's impact on the GDP.

In this data, I have also collected numerous demographic data from the respondents. As such I can test the countries' perception for various different groups, e.g., millennials vs. middle aged vs. senior citizens, or by region of the world. Given I now have seven years of data, it is possible to see how the perceptions of countries have changed over time. For example, how the perception of Russia has changed since its invasion of Ukraine and how this change in perception differs across the different countries in the world.

I need a research assistant to assist in the data analysis. This will really require mastery of Excel and perhaps some other software programs. I will also need help putting together presentations and support in identifying relevant research.

OPERATIONS, INFORMATION, & DECISIONS

Steven Kimbrough

Climate Decisions Lab

My project can be modified to accommodate remote activities if made necessary by University policy.

I have directed the Climate Decisions Lab since August 2020, mentoring mostly undergraduates but some graduate students. The work of the lab is ongoing. Its premise and motivation may be described succinctly as follows. It is conventionally agreed that three related but distinct activities/actions are required to meet the challenges of climate change. These are: mitigation (removing or reversing the causes of global warming, principally emissions of greenhouse gases), adaptation (preparing to handle flooding, fires, and extreme weather events), and transition (planning and undertaking the thoroughgoing changes we need to make in order to effect mitigation and adaptation. The lab from its inception has focused on decision making pertaining to transition issues. We have spent most of our efforts on state and local policy making, where I am well connected and engaged with policy makers and activists. (For example, I sit on the Lower Merion Environmental Advisory Council (EAC).) We have and we will engage with national and international policy issues, but for this calendar year our primary focus is on state and local policies.

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A simplified workflow for the lab goes like this. (1) Identify a consideration set of policies. (The lab has identified 50+ such policies. The EAC is grappling with 57 policies at the moment.) (2) For each policy, undertake scholarly research to ascertain the state of knowledge pertaining to the policy and produce a report, called a policy brief, that documents this. (Examples: induction stove cooking and composting. Penn has a pilot project going on composting, growing out of the lab's work.) (3) For each policy, conduct education, surveys and interviews to discover public views on the policy, especially in comparison with other policies. (4) Develop a provisional list of evaluation criteria for the policies and find ways to score individual policies on the criteria. (5) Use and advance MCDM (multi-criteria decision making) concepts to support deliberation (e.g., for prioritizing, for assembling portfolios). (6) Engage with decision makers and the public in order to communicate results and revise the analysis. Rise and repeat: this is an ongoing process.

To date, the lab has prototyped each of these steps, with gratifying upshot. Going forward, we deepen and refine the concepts and the work. It is to be expected that research reports will be produced. Participating students will be fully credited.

Maurice Schweitzer

Is it Better to be Polite or Rude in a Negotiation?

My project can be modified to accommodate remote activities if made necessary by University policy.

Is it better to be civil or rude during a negotiation? In this project, we will use a Negotiation chat bot that is programmed for civility (politeness) or incivility (rudeness). We will conduct experiments to determine how people respond both in terms of the text and offers they make in negotiations to different types of negotiation counterparts. Fellows working on this project will deepen their understanding of negotiations, chat bots, and experimental design. Fellows will participate as part of a larger research team in weekly lab group meetings to learn about related projects. They will collaborate with the lead professor and Ph.D. students to (1) work with the bot, (2) run laboratory studies, (3) analyze text data from negotiations, (4) read relevant research, and (5) present findings in lab group meetings.

STATISTICS & DATA SCIENCE

Dylan Small

The Effect of a Girl's Father Dying When She Is a Tween or Young Teenager

My project can be completed entirely remotely.

The tween and young teenage years are crucial in a person's development. The loss of a parent during this time can be devastating. In particular, a clinical psychologist has observed that a group of women patients of his who lost their father when they were in their tween and young teenage years have a tendency toward not feeling good about themselves and having unstable relationships. We hypothesize

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that a girl's father dying when she is a tween or a young teenager has negative effects on a girl's later life mental health and relationship stability. The goal of the project will be to test this hypothesis using a large publicly available data set(s) such as the Health and Retirement Study. A student working on this project will learn skills about research design, preparation of a data set for statistical analysis and statistical analysis.

Bingxin Zhao

Building a Cloud Computing-Based Platform for Online Genetic Data Analysis

My project can be completed entirely remotely.

As deep phenotyping and genomic data from large-scale biobanks become increasingly accessible, genome-wide association studies (GWAS) are rapidly revealing the genetic architecture underlying a variety of complex traits and diseases. Published GWAS typically make their summary-level data publicly available, which allows for further investigation of the genetic overlaps between phenotypes collected from different studies and cohorts. However, systematic analysis of high-dimensional GWAS summary statistics for thousands of phenotypes can be logistically challenging and computationally expensive. My team and I are developing a website that provides unified data analysis pipelines and centralized data resources for cross-trait analyses using GWAS summary statistics. We will develop a framework for implementing statistical genetics tools on a cloud computing platform, in conjunction with massive preprocessed GWAS data resources. Through our platform, users can upload data, submit jobs, and share results, providing the community with a convenient tool for aggregating GWAS data and generating new knowledge. Our website will be similar to this one: https://fuma.ctglab.nl/.

One or two research assistant(s) will contribute to our project by assisting with all aspects of the website-building process, which may include data management, data processing, data analysis, and web development, etc. The research assistant(s) may also provide general assistance for writing our manuscript and website maintenance. Applicants should be interested in computer science/web development, biomedical data science, genetics, statistics, or bioinformatics. Familiarity with Python, PHP, Linux, cluster computing, and/or cloud computing is beneficial but not required.

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