

Penn Undergraduate Research Mentoring Program Project Descriptions Summer 2021

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

COMMUNICATION

Andy Tan

Project Resist: Increasing Resistance to Tobacco Marketing Among Young Adult Sexual Minority Women Using an Inoculation Approach

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

The Health Communication and Equity Lab seeks two student research assistants for an NIH-funded study to determine the effects of using a culturally-tailored inoculation approach to increase resilience to tobacco marketing influences among young adult SMW and obtain stakeholders' critical inputs that support later adoption and implementation (Project Resist). The aim of this phase of the study is to evaluate the feasibility and effects of culturally tailored anti-smoking messages on young adult SMW's smoking and quitting intentions.

Under supervision of the faculty member, responsibilities may include assisting with:

- Coding and summarizing qualitative interview transcripts among 10-12 community partners and stakeholders on their perceptions of adopting and implementing tobacco counter-marketing communication interventions in various settings.
- Pre-testing of a survey questionnaire and message stimuli using cognitive testing surveys and interviews.
- Drafting participant recruitment materials, screening, recruiting, and following up with 2000 participants for a national longitudinal online survey.
- Programming online survey questionnaires.
- Conducting literature reviews, data extraction, and summarize reviews.
- Data management, developing codebooks, and data analysis.
- Developing conference abstracts, posters, PowerPoint presentations to summarize study findings and methods.

Students will learn basic qualitative data analysis skills using computer software (NVivo), survey programming (Qualtrics), training in data cleaning and coding, use of mixed-methods research designs in health communication research, and approaches used to measure health message effects among health disparity populations. Students with a keen interest in careers in health communication, health behavior change, and addressing health disparities are welcome to apply.

Arts and Sciences

ANTHROPOLOGY

Theodore Schurr

MtDNA Diversity, Telomere Length and Aging *2nd year applicants only*

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

In this study, we will investigate the influence of the intrauterine environment on telomere length. Telomere length (TL) is associated with the two disease categories that largely define longevity in contemporary humans: cancer and cardiovascular disease (CVD). Various studies suggest that TL is the linchpin in a cancer-CVD tradeoff, and that the link between TL and CVD might partially explain the association of TL with longevity and the observed longer lifespan of females versus males. Research has further revealed wide inter-individual variation in TL, as expressed in leukocyte TL (LTL), across the general population. This variation is largely determined by birth. Thus, intrauterine TL dynamics (TL at conception and its rate of shortening thereafter) appear to be the ultimate determinants of the newborn's TL.

To elucidate prenatal influences that affect LTL in newborns, we will undertake a study that integrates the analysis of key inherent and intrauterine environmental exposures that might affect TL. For this study, we will work with samples obtained as part of the Norwegian Mother and Child Cohort Study (MoBa). We will utilize LTL measurements in 1000 mother-newborn dyads obtained in earlier studies, and sequence the mitochondrial DNA genomes of 1000 of the newborns from the above dyads. At the Laboratory of Molecular Anthropology at Penn, we will prepare libraries of the MoBa DNA samples for mitogenome sequencing, and then send these libraries to the Center for Applied Genomics at CHOP for Quibit quantification and Next Generation sequencing on a Illumina HighSeq platform.

The resulting sequence data will be aligned as Fastq files against the reference sequence and saved as BAM files for further analysis. These files will be analyzed to determine the maternal lineage (haplogroup) to which each mtDNA belongs. The MoBa haplotypes will be compared to existing mtDNA databases to determine their consistency with previous studies of Norwegian and Scandinavian populations. Their phylogenetic status will be determined through comparison with published mitogenome sequences and network analysis with comparative data. In addition, we will statistically analyze the effect of mtDNA haplogroup on both maternal and newborn LTL.

Student Research Efforts: It would be preferable for the student involved in this project to have previous laboratory experience and some background in genetics. Ideally, the student will assist the PI Schurr with the laboratory analysis of the MoBa samples, and also carry out some of the bioinformatics work with the resulting sequences. It may also be possible for the student to assist with the statistical assessment of the mtDNA and TL data sets, depending on the progress with

the analysis over the summer. Should the ongoing pandemic make student research efforts in the lab infeasible, the Principal Investigator (Schurr) will carry out the experimental portion of the study and then work with the student remotely on the data alignment and analysis. Any student involved in this research would contribute to a major collaborative project with Norwegian scholars and advance our knowledge of the biological basis of aging. If the student's contribution is significant enough, he/she will be granted co-authorship on manuscripts describing the data produced and analyzed in this study.

Deborah Thomas

Decolonizing Penn's Anthropology Department

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

This PURM project seeks two students with some coursework in anthropology and some experience shooting and editing video to conduct archival and oral historical research into Penn's anthropology department and, in particular, its relationship to forms of scientific racism (and resistance to these). Students will work with Professor Thomas to make three short films based on this research about Carleton Coon, Daniel Brinton, and Frank Speck. These films would be part of a larger exhibit series (now being organized by graduate students in the department) that addresses the history of the department, and might also be screened during the October 2021 conference at the Penn Museum, "Settler Colonialism, Slavery, and the Problem of Decolonizing Museums." Selected students will thus be participating in and contributing to a broader decolonizing project, and will learn about the discipline's role in both fostering and challenging settler colonial, imperial, and racist processes. This project can be completed entirely remotely, but can also be "hybrid" as conditions improve.

ART HISTORY

Ivan Drpic

Digital Visualization of the Medieval Church at Sopoćani, Serbia

**My project can be completed entirely remotely*

In the course of the 13th century, a series of Serbian churches in the Western Balkans were adorned with what may be described as "fictive" mosaics. The backgrounds of the wall paintings gracing the interiors of these buildings were covered with gold leaf and patterned to mimic mosaic cubes—an expensive and fragile form of decoration only traces of which now survive. The aim of this project is to digitally visualize the original interior of the church of the Holy Trinity at Sopoćani (c. 1265), the best preserved among these monuments. Specifically, the goal is to create a 3D virtual-reality replica of the interior, which will provide the modern viewer with

an approximation of the visual experience once enjoyed by the medieval visitor to the church. By bringing together art history and computer science, the project seeks to complement traditional tools of analysis and visualization, and offer a model of how to study images and monuments that have come down to us in a diminished state.

No knowledge of medieval art history is required for this project. Interested students should have a background in computer graphics. The work will unfold in four steps: (1) conversion of a 3D scan (point cloud) of the church interior into a mesh; (2) mapping and surfacing of photographs onto the 3D model; (3) reconstruction of the gilded areas; and (4) reillumination of the interior based on the evidence of the surviving fragments of the original window glass.

The project can be carried out remotely.

Mantha Zarmakoupi

Mapping ancient Greek maritime networks (Levitha, Greece)

**My project can be completed entirely remotely*

The island of Levitha lies at the intersection of main sailing routes of the Aegean Sea, connecting Asia Minor with the Cyclades and mainland Greece. Literary sources indicate that they are also located at the intersection of historically important sailing routes of the Aegean and local fishermen and sponge-divers have given information about shipwrecks in this area. Despite this, no underwater survey had ever been conducted to trace these maritime routes. Our underwater survey focuses on locating the shipwrecks around the island, so as to document and further investigate these routes. To date we have located a total of eight shipwrecks. Most of the shipwrecks were located at the south and west side of the island and date from the early third century BCE to the sixth century CE, while the majority dates from the early to the second century BCE. I am preparing the publication of our project, which will shed light on the maritime routes of the Aegean Sea. I seek an undergraduate student with drawing skills, who will map the finds from the shipwrecks around the island and visualize the ancient Greek maritime networks of which they are part.

BIOLOGY

J Nicholas Betley

Neural activity in hunger circuits

**My project can only be completed if on-campus activities resume*

What does a hungry brain look like? How does that change when we eat food? In the lab, we are currently interested in understanding the neural activity dynamics in distinct neural circuits. We use rodent models (mice and rats) to monitor neural activity in the awake behaving animal in

distinct cell types. Based on these observations, we perform behavioral experiments to determine if changing the neural activity patterns of distinct circuits changes behavior. In this project, you will learn how to design experiments with proper controls in animal models, will get experience handling and performing experiments with rodents, will learn how to analyze and interpret experiments and will learn about the neural control of food intake. We are looking for students interested in neuroscience and understanding how the brain controls behavior.

Mia Levine

Telomeres on an evolutionary treadmill: causes and consequences of telomere protein evolution

**My project can only be completed if on-campus activities resume*

Specialized proteins package genomic DNA into chromatin. This DNA packaging regulates gene expression, chromosomal inheritance, genome defense, and many other essential, strictly conserved biological processes. Nevertheless, many essential chromatin proteins evolve very rapidly over time. Even closely related species encode essential genes encoded by wildly different DNA sequence. The biological significance of this paradox—conserved cellular functions supported by unconserved molecular machinery—is poorly understood. The Levine Lab aims to address this paradox by studying the causes and consequences of evolution at chromatin proteins that package the very ends of chromosomes—the telomeres.

Genes that encode telomeric proteins are absolutely essential for ensuring that two chromosomes don't fuse together end-to-end. Such chromosome fusions cause both DNA breaks during cell division and mistakes in chromosome inheritance. These aberrations are hallmarks of cancer cells. Using the model fruit fly, *Drosophila melanogaster*, we aim to test the hypothesis that rapid telomeric protein evolution is driven by so-called selfish DNA elements embedded in the ends of chromosomes. We will engineer fruit flies that encode the ancestral versions of the rapidly evolving proteins. To construct these genotypes, we replace the target gene with a version from another species. We will assay this “Frankenstein fly” for various phenotypes related to telomere function. This project offers the opportunity for one undergraduate to learn classical *Drosophila* genetics, evolutionary genetics, cell biology (including confocal microscopy), and molecular biology including cloning and PCR. Students with a keen interest cell biology or evolution are encouraged to apply.

Paul Schmidt

Genetics and evolution of color

**My project can only be completed if on-campus activities resume*

Color and pigmentation vary widely in the natural world--between sexes, among individuals, among populations, and among species. Often these patterns reflect the process of natural

selection and are adaptive, and represent some of the best examples of evolution over contemporaneous timescales. However, we still lack a true understanding of the genetic basis and architecture of color/pigmentation in the wild. Natural populations of the genetic model organism, *Drosophila melanogaster*, vary in color and degree of pigmentation as a function of latitude, altitude, and season. Surprisingly, these patterns can be easily replicated in field experiments over ten generations: color and pigmentation evolve rapidly and predictably, and can be modulated by experimental manipulation of such factors as temperature, density, and sexual conflict. This project will address the mechanistic basis of this rapid evolutionary change in a classic trait. The work involves classical genetics with line crosses and associated analysis, molecular genetics involving cis regulation and RNA sequencing, and experimental manipulations in both the field and laboratory. This work is part of a NIH funded project that involves technicians, graduate students, and postdoctoral associates, as well as collaborators at the University of Florida, University of Fribourg (Switzerland), and Sorbonne CNRS (France).

Corlett Wood

Conflict in the microbiome: tradeoffs between forming mutualisms and fighting infection

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

Nearly all macro-organisms (plants, animals, and fungi) rely on beneficial partnerships with microbes to survive. However, because these mutualisms often require hosts to suppress their immune systems, they can leave hosts vulnerable to infection by parasites and pathogens. The Wood Lab studies how hosts navigate this tradeoff between forming mutualisms and fighting infection. Our goal is to understand how species interactions—especially between hosts and their microbial symbionts—shapes population ecology and evolution.

We study these questions in the plant genus *Medicago*, a group of legumes related to peas, beans, and alfalfa. These plants are excellent models for mutualism because they rely on mutualistic bacteria for nitrogen. Our lab uses a common plant parasite (the root-knot nematode *Meloidogyne hapla*, a widespread agricultural pest) to test how hosts balance mutualism and fighting parasite infection. The next phase of our research program is to conduct experiments to determine how the host's interactions with mutualists and parasites change over the course of host development, and to test whether mutualistic bacteria provide protection from parasite infection.

This project offers an opportunity for two undergraduates to learn the fundamentals of evolutionary biology, the biology of cooperation, and disease ecology. Students will collaborate with Dr. Wood, PhD student Mac Calvert, and lab manager Nuri Yi on all aspects of this project, gaining experience in experimental design, plant and microbiology, data collection (in the greenhouse and possibly in the field too), and statistical analysis. No prior research experience is needed! Students with an interest in evolution, disease ecology, mutualism, or plant biology are encouraged to apply.

CHEMISTRY

Zahra Fakhraai

Simulations of Plasmonics in Nanoparticle Clusters *2nd year applicants only*

**My project can be completed entirely remotely*

When metallic nanoparticles are clustered in certain ways and are placed in close proximity of each other, they present optical properties that are unique. For example, there are no known objects with magnetic properties in the visible light frequencies, but large nanoparticle clusters can produce magnetic dipole moments when packed on a spherical geometry.

We model these unique properties, using a commercial simulation package that solves the Maxwell's equations in time domain and predicts material properties. I am seeking a student who is interested in optics (with some background in electromagnetism) and computer modeling of materials. Experience with Python is helpful but not necessary.

Karen Goldberg

Design and Synthesis of Organometallic Catalysts for Global Energy Solutions *2nd year applicants only*

**My project can only be completed if on-campus activities resume*

We are looking for motivated undergraduates who want to make an impact in energy science! Students will gain hands-on laboratory research experience synthesizing novel transition metal catalysts for energy applications. The focus of the Goldberg lab is on the chemistry of the late transition metals (e.g. rhodium, iridium, palladium, and platinum). We are learning how to use these late transition metal compounds as catalysts to make fuels and chemicals from more sustainable resources. Mentored training will be provided in air-free chemical synthesis techniques (e.g. vacuum line and glovebox). Day-to-day tasks will involve the synthesis, characterization, and purification of organic and inorganic compounds. Students will collect and critically interpret data obtained from a variety of analytical techniques. They will be trained to read the primary scientific literature, as well as prepare publication-quality data. Students will learn how to communicate science through formal poster and Powerpoint presentations as well as informal discussion in the research lab.

Monica McCallum

Exploring the Microbial Chemistry of Sponges

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

The McCallum laboratory is seeking two undergraduate students who are interested in understanding the organic chemistry of the most basic multicellular organisms: sponges. Though these are “simple” animals, they harbor complex communities of microorganisms (the sponge microbiome) and are sources of complex chemicals (natural products) with important uses in human medicine. Research in the McCallum laboratory seeks to connect the chemical structure of these natural products to their biological origin within the sponge microbiome. Because this research is inherently interdisciplinary, undergraduate students will have the opportunity to experience laboratory techniques that span organic chemistry, biocatalysis, molecular biology, and microbiology.

[Basic Responsibilities] Diligent adherence to all safety protocols and laboratory regulations. Maintenance of an organized research notebook with regular reporting to supervisor (Dr. McCallum). Participation in laboratory activities (lab meetings, journal club, organizing supplies, cleaning and maintaining equipment, preparing common stock solutions). Performance of approved experiments using developed approaches. Design and testing of new experiments with direct mentoring from Dr. McCallum.

[Basic Qualifications] Curiosity, interest in the research area or techniques, desire to learn, and ability to work as part of a team. No previous laboratory experience required.

[Skills, Experience, and Opportunities Available] Mentored introduction to the items listed under both basic and project specific responsibilities. Development of effective time management, communication, and organizational skills.

Project 1: Culturing microorganisms from a sponge microbiome.

[Description] Many of the bioactive natural products isolated from sponges are produced by microorganisms. This project will isolate different species of bacteria and archaea from a sponge microbiome, grow them in liquid culture, and analyze them for novel natural products using mass spectrometry. These isolates will then be grown in co-culture to identify natural products important in microbe-microbe interactions.

[Project Specific Responsibilities] Preparation of various microbial growth media. Creation and maintenance of a microbial strain collection. Creation and maintenance of culture extract collection. Preparation of microbial culture extracts for mass spectrometry and analysis of the resulting data.

Project 2: Functional metagenomics of a sponge microbiome.

[Description] Many microorganisms remain “unculturable”, which can limit their evaluation as potential sources of new bioactive compounds. To evaluate the biochemical capabilities of these “unculturable” microbes from the sponge microbiome, this project will isolate the total genomic

DNA from a sponge (the metagenome) and use it to create a library of E. coli expressing pieces of the sponge metagenome. This library will be screened in a series of assays to identify the pieces of the sponge metagenome that have given the E. coli new biochemical activities of interest.

[Project Specific Responsibilities] Preparation of various microbial growth media. Application of standard molecular biology techniques (PCR, molecular cloning, gel electrophoresis). Basic bioinformatics techniques. Creation and maintenance of a metagenomic library. Design and execution of phenotypic screens for the metagenomic library.

EARTH AND ENVIRONMENTAL SCIENCE

Irina Marinov

Ocean physics and ecology: satellite and climate model data analysis

**My project can be completed entirely remotely*

Phytoplankton dynamics and ecology-physics interactions in the ocean: satellite data analysis

Phytoplankton (microscopic ocean plants) are responsible for 50% of photosynthesis on the planet, taking up atmospheric CO₂ and resulting in massive CO₂ storage in the oceans. We will analyze satellite-based light backscattering data to separate small from large phytoplankton. Large phytoplankton are heavier and sink faster, bringing more surface ocean carbon to the deep. We will study the global map of the size distribution of phytoplankton from space, and link it to physical properties of the ocean (temperature, light, ocean mixing).

Southern Ocean and its role in the global climate: climate model projections

Despite its critical importance for the global heat and carbon cycles, the vast ocean surrounding the Antarctic continent is the least understood region of the ocean, because of sparse observations and our incomplete understanding of processes such as sea ice dynamics. Here we propose to analyze output from the latest global climate model inter-comparison (CMIP6), to analyze the role of the Southern Ocean circulation and mixing in the global modern climate.

These are data-analysis projects that require computational background and basic statistical knowledge. Some natural science background and more advanced statistical knowledge ideal. The student is expected to read some primary literature, learn how to read and visualize gridded climate data fields in MATLAB or python and to independently write codes for the required computations, which will involve statistical techniques (e.g. linear regression, correlation analyses, hypothesis testing) and mapping of the results.

Alain Plante

Soil organic matter characterization in African Dark Earths

**My project can only be completed if on-campus activities resume*

Most soils in tropical areas are highly weathered, causing them to be nutrient-poor. Anthropogenic Dark Earth (ADE) soils (like the terra preta found in the Amazon) are a notable exception. Formed by amendment with char, bones and other by-products of human and agricultural life for hundreds of years, these soils are extraordinarily fertile and rich in stable organic matter. So what is special about ADE that makes it so precious and fertile? We are seeking a motivated undergraduate researcher to perform a set of laboratory experiments to characterize the organic matter in a set of ADE and non-ADE soils from Ghana, Liberia and Australia. Experiments will include various physical and chemical methods to fractionate and extract organic matter, characterization of its chemical composition, and analysis of basic soil fertility properties. The goal of this work is to understand how these soils are capable of both storing organic matter over the long-term, while at the same time turning over carbon and nutrients to make them available for plant uptake.

Lauren Sallan

The Role of Predators in Marine Revolutions

**My project can be completed entirely remotely*

The Mesozoic Marine Revolution (MMR), an interval where reef biodiversity increased exponentially towards modern levels, has long been associated with the rise of new swimming predators on reefs and nearshore. These predators include relatives of modern reef fishes, marine reptiles, and rays with crushing tooth plates, sea urchins with grinding mouth parts, snails with biological drills, crabs with strong claws, and many other forms. This increase in predators is thought to be linked with an arms race among their shelled prey, such as clams, snails, and ammonoids, which all show new levels of diversity in their armor. This would mean that classic predator-prey arms races, such as between cheetah and gazelles, scale up over geological time, influencing evolution of life as a whole and entire ecosystems. However, more recent work has raised the possibility that these changes were driven by a loss of predators, specific predators, or other factors such as increased plant productivity or nutrients.

Unfortunately, appropriate data for predator guilds, particularly among fishes, is lacking, leaving the 40-year old hypothesis for the MMR as just that. We have already compiled a host of diversity data for vertebrates, including fishes and sharks, over the Mesozoic (200-65 million years ago), but this needs to be finalized through the inclusion of remaining predators, vertebrate and invertebrate, using the scientific literature and museum collections. We will then test for predator and prey associations within ecosystems and through time, and for linked changes in predator and prey traits suggestive of an arms race. The student will learn to use appropriate statistical tests and models to determine whether predators can be linked to massive increases in

biodiversity over global scales and long time periods. No previous experience with programming, statistics, biology or paleontology is required.

ECONOMICS

Hanning Fang

Evolving Predictive Algorithms: Will Human Biases in Training Data Sets Lead to Biased Algorithms in the Short and Long Run? *2nd year applicants only*

**My project can be completed entirely remotely*

Algorithms are now playing more important roles in an increasingly large number of high-stake decisions, either directly in prescribing decisions, or in assisting humans in their decision making. For example, more resumes are being automatically screened by algorithms; parole or bail setting decisions, traditionally made by judges, are now being increasingly assisted by algorithms that provide a predicted risk score that are used by the decision maker. In future workplace, human-technology interactions featuring algorithmic decision making are expected to become more prominent. A key promise of the algorithm-based decision making is that it may improve upon human decision making by alleviating or even eliminating potential prejudices (or biases). Skeptics, however, argue that algorithms may inherit human biases, a concern that is commonly referred to as “bias in, bias out.” (Mayson, 2018).

The reason for this concern is that any algorithm requires training data sets. Training data sets, at least the initial training data, are typically generated by human decision makers. For example, algorithms used for predicting loan default rates will be trained using data set generated by human loan officers who might have prejudiced against minority applicants. There are two equally important, but distinct, issues related to such training data sets. The first issue is that the sample contained in the training data set is typically not a random sample of the population of interest. In the case of loan applications, the training data set is likely to contain the repayment (or default) decisions of the borrowers whose loans were approved by the loan officers. Because loan officers do not approve loans randomly, they tend to approve loans that according to their judgement, albeit imperfect and subject to potential biases, are more credit-worthy borrowers. Of course, it is possible that we may have access to the data set of all the loan applications, including those that were not approved by the loan officers and thus had missing information about repayment or defaults. This is referred to in the literature as “selective labels” problem (Kleinberg, Mullainathan, Raghavan, 2016). The second problem is that the human decision makers who generated the training data set may be prejudiced (or biased) against certain groups. Again, in the case of the loan applications, the human decision makers – the loan officers – may be biased against minority loan applicants, for example, in the sense that everything else (particularly, creditworthiness) equal, loan officers are less likely to approve the loan applications submitted by minority applicants. One can argue that except for rare cases where the

training data sets are obtained by deliberate randomized experiment, the performances of the algorithms, including predictive accuracy and fairness, must address these two distinct issues.

In addition, algorithms are not static, instead they evolve. The first version of the algorithms is inevitably trained using the training data set; the algorithms can then potentially iterate as additional data arrives. The additional data can potentially arrive for several reasons. First, the algorithm-guided decisions will naturally result in additional data, with a data generating process (DGP) that differs from the DGP of the original training data from human decision makers. Second, to the extent that potential biases from algorithms are recognized, a random sample may be part of the design of the evolving algorithms. Specifically, it is potentially beneficial to inject an element of randomness in the algorithm in the short run for the benefit of having a more desirable algorithm in the long run. This is the familiar “exploitation-exploration” tradeoff.

In this project, I aim to explore the following questions:

1. After obtaining a training data set generated by human decision makers, what should the diagnostic and remedial procedures to be employed regarding the “selective label” and “in bias” problem referred to earlier?
2. How would the old training data and new data supplement coming from the algorithm-guided decisions be optimally combined? How would the combinations lead to evolving performances of the algorithm both in predictive accuracy and fairness?
3. What should be the role of randomization in the evolving algorithms?
4. How would algorithms’ performance in terms of accuracy and fairness evolve in the long run under different data combination methods?

The research tasks for the undergraduate student will involve:

1. Getting familiar with the literature on algorithmic bias, accuracy, and fairness.
2. Simulating data generating processes, training algorithms, and new data from the algorithms.
3. Summarizing research findings using graphs, tables, and visualization tools.

Desirable skills for the undergraduate student: (1) computations skills: familiar in simulations using R, Matlab, or other software; (2). Working knowledge in statistics, and intermediate microeconomics.

The undergraduate student will work with me and a graduate assistant on this project.

References:

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2. Mayson, Sandra (2018). Bias in, Bias Out. *The Yale Law Journal*, 128 (8): 2122-2473.
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Wayne Gao

A Unified Model of Network Formation and Network Bargaining *2nd year applicants only*

**My project can be completed entirely remotely*

This project studies the microeconomic theory of social and economic networks, and proposes a unified framework for analyzing network formation problems (how networks form and evolve) and network bargaining problem (how social surpluses are allocated among individuals or firms in the networks). The framework is then applied to the specific contexts of health insurance industry, labor market, and friendship network.

There is also a separate project, titled "A Partial Order on Preference Profiles", which you can choose to work on if you are interested. This second project studies conflicts in people's preferences in a society, proposes a theoretical framework in which preferences can be compared, and provides a mathematical formalization of individualism.

In either project, you are expected to carry out numerical calculations, check/write mathematical proofs, edit paper drafts and engage in regular discussions with me about the next steps of the project. You will gain first-hand experience on how an economic model is built (and adjusted) to analyze complex social phenomena, and obtain working knowledge of relevant research tools, such as LaTeX, Mathematica and R/MatLab.

Jeremy Greenwood

Numerical Methods for Macroeconomists

**My project can be completed entirely remotely*

The project will develop curriculum for Economics 245, Numerical Methods for Macroeconomists. This is an important course for undergraduate economics majors, especially those intending to go on to graduate school in economics/business or work at institutions such as the Federal Reserve and consulting firms such as Bates White. Economics increasingly employs methods from computer science, mathematics, and statistics. Undergraduate schooling is struggling to keep up with the rapid advance in economic science. This course introduces undergraduates to modern computing in macroeconomics. Specifically, it covers solving nonlinear equations, maximization problems, difference equations, dynamic programming problems, differentiating and integrating functions numerically, interpolating functions, smoothing data, and conducting Monte Carlo simulations on the computer. These are all part of the tool kit of modern economics.

The student researcher will help prepare a textbook on this subject—probably the only one in existence at the undergraduate level. The student will learn the scientific document processor, LyX. This is a TeX based typesetting program that is widely used in the sciences because of its ability to handle mathematics. (TeX is essentially a programming language for documents.) The student will also learn the computer programming language MATLAB. This is widely used to

compute numerical solutions to problems in the sciences, economics, and engineering. This should be a good learning process for any student majoring in economics/business or a stem field.

Margaux Luflade

Neighborhood composition and school segregation

**My project can be completed entirely remotely*

This project studies the determinants and dynamics of school segregation and how they are affected by changes in neighborhood composition. The project will involve mainly working with administrative data from the US, gathering institutional information about school choice in various parts of the country. Some programming knowledge would be useful. Student research assistants will be involved with all aspects of this project and work closely with the faculty member; the project will be an opportunity for the student to analyze data, write a research paper, and apply economic modeling and techniques to real world problems. Students can continue to participate in this project as an independent study in fall 2021 or spring 2022.

ENGLISH

Max Cavitch

Walt Whitman autobiography project--scholarly edition

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

I've been commissioned by Oxford University Press to edit a new, fully annotated edition of Walt Whitman's autobiography, *Specimen Days* (1882), for Oxford's "World's Classics" series. These are paperback editions of "classic" literary works, with specially prepared apparatuses by the editor, e.g., an Introduction, explanatory notes, a timeline of Whitman's life, biographical notes on the people he mentions in the text, etc. The assistance I seek is with some of these apparatuses, and it would involve doing meticulous research on people, places, events, and other details in Whitman's text that a general reader might need further information about; it might also include helping me to write some of the explanatory notes, as long as the candidate has superior writing skills, as well as superior research skills. For an important new edition like this, everything has to be absolutely correct and absolutely clear. It requires very close and careful work, so that the resulting edition can be relied upon by students, scholars, and general readers alike. The opportunities for a student research assistant include learning and refining their archival research skills--which will continue to be of use to you in all of your academic pursuits throughout the humanities--with my guidance and supervision. For students interested in 19th-century America, in Walt Whitman, and/or in autobiography as a genre, this would be an

especially great chance to augment your knowledge and hone your research and writing skills--as well as to be involved in the preparation of an edition of a major literary work that will be read and used by many thousands of readers.

Jed Esty

Hollywood Victorians

**My project can be completed entirely remotely*

Most of the major genres of popular fiction currently enjoyed by American (and not just American) readers and film audiences have their roots in the late Victorian period in Britain. Looking at the westward flow of spy novels, detective stories, alien invasion plots, imperial adventures, treasure quests, historical romances, and science fiction tales, Hollywood Victorians follows the baton pass from one Atlantic empire to another. It is a research project designed to address a central question: how did British notions of imperial destiny come to shape the American mind?

To survey the influence of Victorian popular fiction (Dracula, Sherlock Holmes, The Invisible Man, Treasure Island and so on) on that other English-speaking dream factory, Hollywood, I need a research assistant who can take the initiative to track all the relevant data (including sales and box office) on cinematic adaptations of British source materials, roughly 1925-1975. This will include quantitative research on directors, scriptwriters, and studios who made decisions about when, whether and how to adapt British classics in all the genres noted above. A subsidiary project might involve tracking two popular boy heroes, Kipling's Kim and Twain's Huck Finn, through their critical reception (1900-1980) and cinematic adaptations.

The work can be done remotely though ideally we'd have weekly in person discussions of the research problems and findings together. RA should be able to learn quickly about databases and historical sources, be willing to work with reference librarians and potential Hollywood archivists and publishers in direct correspondence, be able to track and organize both large (quantitative) data and to summarize historical and literary content using some degree of critical judgment.

Jennifer Sternad Ponce de León

Culture, Power, and Radical Movements

**My project can be completed entirely remotely*

How do cultural productions – be these news media, entertainment, games, etc. -- shape how we understand the world? How does understanding the economic bases of the culture industries help us better understand how culture is related to power and to the perpetuation or transformation of social inequalities? How have organizations, individuals, and movements in different parts of the world worked to transform culture towards emancipatory and egalitarian ends? And how have

cultural producers represented histories of, or possibilities for, international solidarity in the 20th and 21st centuries? These are some of the questions my summer research will address. I will be working on two new interdisciplinary book projects and I am seeking a Research Assistant to help me gather, review, and take notes on relevant scholarly and journalistic literature. This can be tailored to a certain degree to best suit the Assistant's strengths. Topics of research may include: cultural policy in different countries, the U.S. film and video game industries, propaganda, sports industries, internationalism in culture, and histories of radical art movements, as well as research on specific contemporary artists and writers. A Research Assistant will work with sources from both the humanities and social sciences and will learn about interdisciplinary scholarship. Applicants do not need to have prior experience working on any of these topics. The ability to work with Spanish, Portuguese, and/or French language texts is a plus, but not required. This project can be completed remotely.

GERMAN

Simon Richter

Explaining Accelerated Sea Level Rise Scenarios and Adaptation Pathways for the Netherlands through Animated Video

**My project can be completed entirely remotely*

This is a public-facing research project. The goal is to create animated videos to inform both the Dutch public and the public at large about the difficult the impact of accelerated sea level rise on the Netherlands and to contribute to the public debate about the best adaptive approach. Because the affected region has a population of over 8 million, contains major cities (Amsterdam, The Hague, Rotterdam), and is the economic engine of the Netherlands, there is considerable resistance in public and private sectors to confront these facts. Since 2018, a handful of climate scientists, landscape designers, engineers, academics, and journalists have tried to jump start a public conversation with mixed success. Based on my experience and advice from key players, there are some things that only a trusted outsider can say. In this project, an undergraduate research assistant and I will consult with Dutch experts in order to produce a series of short videos that will help to advance the public debate in the Netherlands. The videos will be of wider interest insofar as the Netherlands is a test case for radical adaptive solutions, ranging from an aggressive sea wall in the North Sea to sacrificing land below sea level and migrating large numbers of people to higher ground in the East.

As a collaborator in this research project, the student will learn to:

- Grasp the policy and design dilemmas posed by accelerated sea level rise and associated impacts in an exemplary frontline nation
- Engage with experts in the fields of climate science, water management, climate adaptation, engineering, design and architecture, climate policy, and climate journalism

- Develop strategies to intervene in public debates through social media
- Create 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

Students interested in this research should have examples of animated video projects or other video and graphic design experience that we can discuss in the interview process.

HISTORY

Jared Farmer

Philadelphia, Penn, and Fossil Fuel

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

Pennsylvania, America's original fossil fuel state, led the United States toward an energy-intensive economy, a technological pathway with planetary consequences. The purpose of this research project is to perform a place-based historical accounting—and an ethical reckoning—of coal, oil, and natural gas. Students will investigate the local legacies of fossil fuel in connection to two entities: Greater Philadelphia and the University of Pennsylvania. Under the guidance of Prof. Farmer, students will learn how to collect, collate, and synthesize historical evidence from primary sources. Specifically, they will conduct research in one or more of the following: 1) the industrial history of the oil refinery complexes in South Philly and Marcus Hook; 2) the social history of workers and residents in fenceline communities; 3) the business history of Sun Oil; and 4) the institutional history of Penn vis-à-vis fossil fuel. Students will contribute to a multi-year project that will ultimately be made available to the public. If Covid-19 regulations permit, students will do in-person research at the University Archives and Records Center on campus, and/or at the Hagley Museum in Wilmington. If in-person research is not permitted, students will help Prof. Farmer synthesize the thousands of digitized sources he and other students have already compiled. No prior experience in history is required, just a love for research! While based in historical sources and methods, this project intersects with business, finance, policy, environmental science, environmental engineering, urban and regional planning, public health, and social justice.

Melissa Teixeira

Hyperinflation in Brazil

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

This project explores the social, economic, and political experience of inflation and hyperinflation in Brazil under Military Dictatorship (1964-1984) and subsequent transition to

democracy. This project asks research assistant to pull, consult, and organize primary sources and economic data using library resources. Their first task will focus on materials on IMF and World Bank interventions in Brazil. They would also consult the institutional websites of these organizations to pull materials from the 1960s to the 1990s. Students will be asked to digitize and prepare brief summaries of materials, and to organize them into a digital research catalogue. The input of economic data into Excel will be another assignment, as well as making graphs/tables. Given the focus on IMF/World Bank, all sources will be in English. No prerequisites or prior experience necessary, but knowledge of Portuguese or Spanish would be a bonus to allow me to expand the types of sources the student accesses. Students will acquire: 1) experience using research catalogues/databases and digital resources; and 2) skills working with quantitative data and an introduction to Excel (including how to make graphs). The student will also engage with the practices and politics of economic policymaking and acquire familiarity with the institutions that still govern the global economy.

Julia Verkholtantsev

Digital Database: Myths of Origin in Medieval Chronicles of Europe

**My project can be completed entirely remotely*

The project deals with the creation of a digital database to analyze a range of questions about the role of myths of origin in medieval and early modern chronicles and historiographic sources of Europe. “Myths of origin” are legendary stories that describe genealogies of ethnic groups, their social orders, names, and places that they inhabit. The goal of the project is to understand what motivated medieval historians to view myths as “historical material” and how they adopted myth to fit their learned vision of what History should be and how the past of their land should be reconstructed and represented? Many of these myths are built around etymological interpretations of names of people and objects because medieval historians believed that connections between similarly sounding words provided a mystical link to the otherwise unknowable reality of the distant past. For example, the 15th-century historian Pulkava was convinced of the divine origin of his native Bohemia because he believed its name derived from the Czech word ‘Boh’, which means ‘God’, while his early 14th-century colleague from Poland (anonymous) believed that the unusual sexual attraction of the pagan princess Wanda was intrinsically related to her name, which is derived from the Polish word “hook.” I am particularly interested in the internal mechanism of etymologically motivated stories, in which etymologies function as a method of discovery and as the driving force of the narrative.

The project involves working with and helping develop a digital interface to enter data which need to be mined from primary sources and secondary literature.

Skills needed: Demonstrated interest in history and in working with primary sources; strong analytical skills, attention to detail and intellectual curiosity. Advanced knowledge of a foreign language (e.g. French, German, Latin, Spanish, Italian, or other) is a plus but is not necessary. The student research assistant will work with the interface created at the Price Lab for Digital

Humanities for this project, analyze primary sources and mine data for data entrance, and assist with interface and database development.

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.

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.

Nicole Holliday

African American English Phonology and School Discipline

**My project can be completed entirely remotely*

The purpose of this study is to see if there is a link between the perception of African American Language (AAL) and experiences and discipline among children in a high school setting. AAL is among the most well-documented varieties, and much is known about its structure at the level of

grammar. However, intonational features are variation specific and transcribing them requires a lot of time and experience, which has led to intonational research being dominated by larger and more mainstream variations. This study aims to gain more data and information on both the intonational and grammatical features of AAL and how they influence the perception of teachers and students in a school setting. The results of this study broaden the scope of research surrounding the perception of AAL by looking at intonation and grammatical features. This research also addresses the possible discrimination of African Americans in the school system based on their linguistic features. On a broader scale, this experiment provides insight into the perception of different language variants by non-native speakers. From working on this project, a student would derive skills related to experimental design, data collection and management, and sociophonetic analysis. They would also gain experience working with linguistic data in a community setting.

Gareth Roberts

Communication games and artificial languages

**My project can be completed entirely remotely*

The Cultural Evolution of Language Lab studies language change and variation through innovative experiments in which participants learn artificial languages and play communication games with them. Sometimes they play communication games with no language at all, but have to construct a novel communication system as part of the task. The purpose of this is to understand language better by stripping it back to its fundamentals.

This summer we'll be working on more than one project of this nature, including one in which participants communicate with each other by sending color signals. Students can be involved at all levels of these projects, and a goal will be to match students to tasks that suit their abilities and interests. There may also be an opportunity to be involved in designing completely new experiments. Participation can be remote, and students will get hands-on experience not only in how experiments are conducted in general, but also about the particular innovative approach used in this lab. A genuine interest in language and communication is essential, but it is recognized that few students will have a strong background in linguistics, so such a background is not required.

NEAR EASTERN LANGUAGES AND CIVILIZATIONS

Nili Gold

Transmitting a culture and its conflicts to a new context *2nd year applicants only*

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

This project is concerned with the process of transmitting a culture and its conflicts to a new context. The project has two goals: a) a course material anthology of contemporary Israeli literature representing the diversity of Israeli writers in Hebrew and other languages; b) a short scholarly article on political and pedagogical themes. Working with me, the student will gain research experience in a heterogeneous, evolving literary field, and practical experience translating and learning how a professor approaches a new area of study.

In updating my course “Voices of Israel” for Spring 2022, after a gap of almost a decade, I am looking to reimagine it with the most current voices in mind. The first stage of the project is gathering varied literary materials (especially poetry and short stories) of the last 20 years into a small teaching archive. Under my direction, the student will conduct the necessary research to compile this anthology; he/she will have to find materials that have already been translated and identify crucial texts not available in English. In those cases, he/she will translate. Again, under my mentorship, he/she will hone their linguistic and translation skills.

The second, and more substantial, aspect of this project is the article I would produce, with the aid of the research assistant mentee, comprising a scholarly, practical look at the sociopolitical subject matter of the course and the pedagogical concerns of teaching it in the context of another (American) culture and language—for a publication such as Hebrew Higher Education.

PHYSICS & ASTRONOMY

James Aguirre

A High-Altitude Balloon-borne Telescope for Studying Galaxy Formation and Evolution

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

The Terahertz Intensity Mapper (TIM; <https://arxiv.org/pdf/2009.14340.pdf>) is an experiment to study the star formation history of the universe when the star formation rate in galaxies was at its peak. TIM will make 3-D maps in far-infrared light, allowing us to peer deep into the star-forming gas in galaxies. These maps will show galaxies evolving over 4.5 billion years of the universe’s history, providing new insight into the processes shaping the formation and growth of galaxies.

TIM must fly on a high-altitude balloon to get above the majority of the earth's atmosphere, whose water vapor would otherwise absorb far-infrared wavelengths. This flying telescope must be able to record data and point autonomously with high accuracy, functioning much like a robotic spacecraft, complete with a solar power system. TIM flies an array of sensors to measure its orientation and motion (including star cameras, sun sensors, inclinometers, magnetometers, gyroscopes, and GPS) whose signals are collated by flight computers running custom flight software to record the data and control motors determining the telescope pointing.

In the summer of 2021 we will be testing and integrating the pointing sensors with the flight computers, software, and power system to make a complete working prototype of TIM. Conditions permitting, the student will work in the laboratory with Aguirre and graduate students (Justin Bracks, who runs Physics & Astronomy's summer internship training program, and AJ Corso) and other undergraduates in a collaborative environment to construct and test the electronics and mechanical performance of the pointing and power subsystems. If in-person laboratory work is not possible, then design and simulation, as well as remote testing, (as was done successfully in 2020) will still be possible.

In any scenario, the student will learn:

- basics of electronic design, layout, fabrication and testing
- mechanical design (SolidWorks) and machining skills
- programming (Python and C; microcontrollers using Arduino)
- the relevant astrophysics behind the experiment to relate the design requirements of the telescope to scientific goals

Students also receive direct training and mentoring regarding scientific writing, presentation and networking.

Previous experience with computer programming, robotics, electronics, or mechanical design (including CAD or simulation software) highly desirable (please include details in your application) but not required.

Gary Bernstein

Astronomical research with the Dark Energy Survey

**My project can be completed entirely remotely*

Undergraduates will participate in analysis and/or visualization of images from the night sky taken by the Dark Energy Survey. Many uses of these images are possible and a project will be defined based on the interests and skills of each individual student. Professor Bernstein's research includes using these images to measure gravitational lensing---which is the subtle distortion of the galaxy shapes in these images caused by the gravitational pull of dark matter on the light rays---and using them to discover and measure small planets orbiting beyond Neptune. A typical student project will involve writing programs in Python that make new measurements on these images that will improve our knowledge of either the dark matter or of the distant reaches of the solar system. Students will learn data analysis and visualization skills in the

Python context, as well as the astronomical background for their project. Students will be most successful if they already have completed a year of physics and calculus, taken an astronomy course, and have some experience with programming. The work can be done remotely, although if face-to-face interactions are allowed this summer, that will be a better way to learn. Applications from first-generation/low-income students are particularly encouraged.

Mark Devlin

The Simons Observatory Large Aperture Telescope Receiver

**My project can only be completed if on-campus activities resume*

The Simons Observatory (SO) Large Aperture Telescope Receiver (LATR) will be the largest cryogenic camera ever built for studying the Cosmic Microwave Background (CMB). The receiver will be installed in our new telescope in Chile in mid-2022. It will make measurements of the microwave sky with exquisite precision allowing us to extract the fine details of the CMB. The data will inform us about the evolution of the universe over cosmic time. Once installed, it will be upgraded over two years and then observed for at least another five years.

This project involves working with a team of graduate students and postdocs who are in the middle of integrating this very complex piece of equipment. Students will help assemble and disassemble the receiver (and then do it again!). Students will learn about the mechanical, cryogenic, and optical design. They will also learn about the detectors and how we make a camera that will ultimately be able to measure half the sky with micro-Kelvin precision. Of course learning about the CMB in general will be part of what they learn.

I will be the primary supervisor, but the students will work closely with everyone including postdoc Jeff Iuliano

Should be fun!

Jonathan Heckman

Popularize a topic in particle physics 2nd year applicants only

**My project can be completed entirely remotely*

Popularize a topic in particle physics. Project could include updates to a website, or developing a YouTube video.

Charlie Johnson

Nanomaterials Research and Nanosensors for Disease Diagnosis

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

Several possible projects are outlined below.

Graphene DNA biosensors for at-home Quantification of HIV Viral Load

This work will be done in collaboration with Profs David Issadore (Bioengineering) and Ronald Collman (Medicine). The student will be mentored by a postdoctoral fellow and/or a phd student.

We have demonstrated [1] that graphene-based DNA biosensors are suitable for detection of nucleic acids at attomolar concentration without the need for amplification. This makes them potentially suitable for use in a system for quantification of HIV viral load.

The ultimate goal of this project is to create a system that would take in a drop of blood plasma, extract the HIV viral particles, release the viral RNA and quantify the viral load in the sample using a graphene-based sensor. 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, Biology, or Computer Programming is very desirable but not essential for participation in this project.

Scalable Synthesis of Two-Dimensional Materials

The student will be mentored by a postdoctoral fellow and/or a phd student. The work will involve collaboration with colleagues in Chemistry and multiple SEAS departments.

Imagine a material as large as a sheet of paper but only 1/100,000 the thickness of a piece of hair. Examples include graphene (a single-atom thick layer of carbon) and a growing family of 3-atom thick materials known as metal dichalcogenides. These materials can exhibit a variety of remarkable electronic and mechanical properties, making them suitable for integration into new sensor concepts, wearable devices and systems, and many other applications. In this project we 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 as well as new types of biochemical sensors. Course work or experience in Physics or Chemistry is very desirable but not essential for participation in this project.

Electronic Nose System Based on Carbon Nanotubes

The work will involve collaboration with colleagues from the Ovarian Cancer Center and the Penn Vet Working Dog Center, among others. The student will be mentored by a postdoctoral fellow and/or a phd student.

We have developed technologies that duplicate and extend our ability to see, hear, and touch, but for odor detection and analysis, biological systems (e.g., dogs) remain the “gold standard”. The ultimate goal of this project is to develop an electronic nano sensor system capable of similar feats such as the detection of disease by the odor of human blood samples or monitoring of air pollution in real time. Our sensor concept is based on a carbon nanotube technology invented in our lab. Course work or experience in Physics or Chemistry is very desirable but not essential for

participation in this project. Interest and experience in building electronic systems would also be very useful.

Christopher Mauger

Exploring Neutrino Oscillation Physics with T2K

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Neutrinos are the most ubiquitous particle in the universe that we know exists, yet among elementary particles, we know the least about them. Much of what we have learned has been through the study of neutrino oscillation phenomena. These phenomena are quantum interference experiments where the interference pattern is manifest over macroscopic distances. In the case of T2K, the distance is 295 kilometers. In T2K, we must make precise measurements of neutrino energies in order to measure these quantum mechanical phenomena. At Penn, we are responsible for constructing electronics for a new detector for the T2K experiment. The detector will bring significant advances to the reconstruction of neutrino energies in T2K. Working with the Penn PI, graduate students and members of Penn's renowned Instrumentation Group, successful candidates will participate in the design, assembly and testing of these electronics. We have also collected data in prototypes of the detector in a specialized neutron beam. If, due to COVID, we are unable to work in person, successful candidates would be able to complete a data analysis project associated with the prototype detectors.

Robyn Sanderson

The history, composition, and future of the Milky Way galaxy

**My project can be completed entirely remotely*

Galactic dynamics---the study of the orbits of stars in our Galaxy, the Milky Way---can reveal much about the Galaxy's contents and history. In April 2018 a new window opened on Galactic dynamics with the public release of data from the Gaia satellite, which has accurately measured the positions and velocities of 1.7 billion Milky Way stars. This new data, literally a thousand times better than our previous map of the Milky Way, is matched by advances in our ability to simulate the formation of Milky-Way-mass galaxies, from the initial conditions set by the Big Bang up to the present day. The high resolution of these simulations, which require tens of millions of CPU-hours to complete, lets us turn them into simulated maps like the one Gaia has made of the real Milky Way and directly compare predictions to observations.

Participating students will use state-of-the-art simulations of galaxy formation and/or real data to ask and answer new questions about the dynamical state of our Galaxy. Past student projects include searching for close encounters between stars near the Sun that have planetary systems and were observed by Gaia, developing and testing a new way to model the Milky Way's dark matter, and investigating what effect the Andromeda galaxy (the Milky Way's closest big

neighbor) has on stars at the very edges of the Milky Way. Individual projects will be tailored to the student's interests.

Depending on their specific project, students will gain the following sorts of skills: coding in the Python programming language and the Jupyter notebook interface, accessing the Gaia archive, using the Linux operating system and bash shell, using a computing cluster and batch job management system, making and interpreting plots and images, and fitting models to data using an optimizer. Students will also attend weekly research group meetings (involving undergraduates, graduate students, and postdocs) and practice presenting and discussing the results of their projects in a variety of formal and informal contexts.

POLITICAL SCIENCE

Julia Gray

How International Organizations Work: Legal and Practical Aspects

**My project can be completed entirely remotely*

In April 2020, three New Yorkers sued the World Health Organization for failing to monitor China's response to Covid-19. What determines whether international organizations (IOs) like the WHO can be sued by their members? And how can we assess whether IOs are doing their job or not? Answering these questions requires an understanding of two, related phenomena: 1. the bargaining between member countries and IOs as to the legal framework and immunities that those IOs receive; and 2. monitoring how IOs undertake their daily business of attempting to achieve the goals that they set out for themselves.

Researchers for this project will explore the legal and practical aspects of how international organizations work. They will utilize online resources offered through Franklin Library as well as the law library to compile qualitative information on IOs around the world. Because these IOs are global in scope, language skills -- including Russian, Arabic, Spanish, and French -- are an asset. Research for this project can be conducted remotely. I am particularly interested in working with highly aided, first-generation college, and/or underrepresented minority students.

Daniel Hopkins

The Racialization of Contemporary American Politics

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

This research project will examine how racial issues have become so prominent in American political and public discourse in recent decades and how this shift has affected various groups of Americans' political opinions and behavior. It will measure how different sources of public

discourse, including newspapers, television transcripts, press releases, and presidential speeches, have connected or failed to connect racial issues to other political questions. This research project will examine the hypothesis that social media fosters increased attention to racialized issues and events. It will also use a combination of panel data and survey experiments to examine the effects of racialized political issues on public opinion and voting behavior. Research assistants will be involved in various aspects of this project, including: identifying and reviewing relevant content; scrapping and formatting content from various websites; cleaning and analyzing data sets; reviewing relevant research; editing and proof-reading articles written for scholarly and popular audiences; and developing, implementing, and analyzing public opinion surveys. It will also examine other developed democracies including Germany, Switzerland, and Spain.

With respect to skills, I would like a researcher who is highly proficient in R. Other skills including additional program languages (e.g. Python), familiarity with Spanish, German, French, and/or Russian, and interest in in-depth interviewing and/or American elections and public opinion are all assets.

Michael Horowitz

Military power, economic power, and the future of war

**My project can be completed entirely remotely*

This PURM proposal involves in-depth research, focused on data science applications, including but not limited to survey experiments and statistical models, on the international security environment, as well as historical research. It has two focal points. First, what explains the diffusion of key military capabilities for power projection in a given era? Despite research on some aspects of these topics in recent decades, integrated knowledge in academia and the policy world remains limited. This project will analyze new data on global power projection capabilities and the consequences for the security environment. The findings will improve our understanding of the balance of power and provide insights relevant for the spread of military power today, as well as emerging technologies such as robotics.

Second, how do people think about emerging technologies such as artificial intelligence? The focus is behavior research assessing whether people support or oppose the use of AI in life and death circumstances, including the use of military force, autonomous vehicles, and robotic medical assessments and surgery. This research explores a critical area at the intersection of emerging technologies, society, and global politics.

Professor Horowitz is interested in students with data science skills, including data management and statistical analysis, as well as those interested in historical research and international security in general. Additionally, for students interested in careers in Washington, DC, the project is being conducted both for academic purposes and due to interest from the US Department of Defense. Thus, interested students will gain experience doing policy relevant research.

Russia in the 21st Century: Fate of a Former Superpower

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Discussions about Russia have become thoroughly intertwined with U.S. domestic politics as a result of the polarized politics accompanying the rise and fall of Donald Trump. In reality, Russia is an entity with a 2000-year history that includes 70 years as part of a larger multinational entity, the Soviet Union. The Soviet Union became a superpower for more than two decades, and represented the time when Russia, the largest and most important republic within the USSR, reached its peak in terms of global influence and power. Following the fall of the USSR, Russia experienced a period of tremendous chaos, uncertainty, economic decline, and humiliation -- a terrible outcome for a country that had been a core part of a global superpower. For ordinary Russians, the 1990s in particular became synonymous with instability, anxiety, and a period of sharp economic contraction that was at the level of the US Great Depression!

Russia since 2000 has been a mixed bag. It has risen to become a more significant global player with a stronger, more assertive state and a more capable military than in the 1990s. It is both a former superpower and a new rising power, and it has created problems for us in terms of how to engage with Russia. For those who got comfortable with a pliable, compliant Russia in the first decade of transition, a more assertive Russia has been nothing but problematic. But, taking a long view, there is a need for a more complex, more comparative perspective on every aspect of Russia so that we do not let our own politics and policy agendas color our grasp of reality. By using a more historical trajectory and more broad comparative analyses, this project seeks to construct a new lens for making sense of Russia's politics, economic trajectory, natural resources, demographic patterns, and geopolitical maneuvering. In all dimensions, the emerging reality may be neither as "evil" as assumed in Washington, nor as "benign" as asserted in Moscow. The reality is somewhere in between, and the students selected to work on this project will be looking at one dimension of this reality (politics, economic policy, energy politics, etc.) through the lens of comparative analysis to create a more messy but perhaps more accurate portrait of Russia that transcends a black/white view of this former superpower.

PSYCHOLOGY

Delphine Dahan

Interpreting language in conversations

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

When people say something, what they mean is rarely, if ever, expressed unambiguously in their speech. Instead, their addressee must 'guess' (i.e., infer) what a speaker means based on what they say. For example, consider the following question: "Do you have any siblings?" Although this is a yes/no question, it may also be interpreted as a request for more information, i.e., the number and kinds of siblings that the addressee has. What the addressee takes the question to mean is reflected in the way they answer it. By varying factors such as the form of the question (e.g., Do you have any sibling? vs. Do you have a sister?), as well as the context in which the question is posed, and observing people's responses, we can infer what affects people's interpretations and whether people differ in the way they interpret the same question. We can also ask if there is a relationship between what people take their conversational partner to mean and the way they themselves express that meaning. This project collects and analyzes conversations between participants taking part in a communication task, either in a laboratory setting or via Zoom.

Students will be involved in all stages of the research: scheduling participants and recording the conversations, and coding the language used by participants. 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.

Harvey Grill

Investigating the behavioral and neural mediators of the food intake suppressive effect of Semaglutide

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

Our behavioral neuroscience lab studies the effects of neurochemical signals acting on central neural circuits that control energy balance (feeding behavior, energy expenditure and body weight). In evaluating effects on feeding, we seek to resolve whether brain-targeted receptor stimulation has its effect on food intake by behavioral alteration on food motivation (working for food), food seeking (food search), and food reward (hedonics). A current interest of the Grill lab is defining the neural and behavioral mechanisms that mediate the food intake and body weight suppressive effects of Semaglutide, a long-acting glucagon-like peptide 1 (GLP-1) receptor agonist that has attracted considerable attention for its dramatic body weight suppressing effects (15-17% weight loss in published clinical trials) compared to other obesity treatments on the

market. Thus far, our experiments on Semaglutide show that it reduces both food intake and body by enhancing/amplifying the satiating (fullness-inducing) effects of ingested food.

We propose to involve Penn undergraduate students in projects that analyze the neuro-behavioral mechanisms mediating Semaglutide's food intake and body weight suppressive effects. Students will be trained to work with rodent animal models to measure Semaglutide's effects on: [1] feeding motivation by using the progressive ratio test, [2] food seeking by using the conditioned place preference paradigm and the reinstatement paradigm and [3] food reward by using a fiber photometry apparatus that measures brain dopamine secretion in mice engineered to express a dopamine sensor. Students will also use several different behavioral paradigms to evaluate whether Semaglutide treatment conditions a food aversion and if this aversion could be reversed by pre-treatment with anti-vomiting drugs. In addition to participating in these experiments, students are required to read and discuss relevant scientific literature as well as meet regularly with senior members of the lab to discuss their progress. This is an opportunity for a real hands lab experience on topics related to developing treatments for human obesity.

Allyson Mackey

Environmental influences on early childhood brain development

**My project can be completed entirely remotely*

The Changing Brain Lab studies how experiences in early childhood shape the development of brain structure and function, and ultimately influence cognition and academic performance. We are studying both negative experiences, such as poverty and stress, and positive experiences, such as cognitive enrichment and social support. Do such experiences speed up or slow down brain development, and are the effects global or specific to particular neural circuits? What are the effects of developmental timing on plasticity? Can we use what we learn about brain plasticity to improve children's learning?

We are looking for undergraduates in the summer of 2021 for two types of roles. We anticipate that some students will work with the lab remotely, conducting learning experiments with 5- to 7-year-old children over Zoom, or working on data analysis. We also anticipate that we will need help with conducting magnetic resonance imaging (MRI) scans with children on campus, which will include broader measures of children's health (e.g., COVID exposure, energy expenditure, inflammation, and hormone levels).

Experience working with children is required (e.g., babysitting, tutoring). Experience in computer programming languages such as Matlab and Python is helpful but not required. Coursework in Biology, Neuroscience, or Psychology is also helpful. Previously, students in the lab have started by contributing to a large-scale project, and then have developed independent projects that synergize with ongoing lab efforts. Working with our lab is most helpful for students considering careers in research, clinical psychology, education, and health.

Daniel Swingley

Infant learning of language phonetics

**My project can be completed entirely remotely*

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 or French (depending on the student's skills -- native competence required for Mandarin, or fluency required for French). First we will measure characteristics of the sounds in the language, and then we will apply computational models of category learning to mimic the infant's learning process. The results will help tell us how infants can learn languages so quickly and successfully. In this branch of the project, the student will learn skills of

phonetic measurement and computational analysis, some specific to the domain (e.g., speech software) and some quite general (unix scripting, R). Students who are particularly inclined toward computation will additionally learn some speech-technology skills.

(2) by testing infants in (online) 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, and may bear on characterizing developmental language disorders and dyslexia.

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.

RELIGIOUS STUDIES

Megan Robb

Digital History and Gendered Archives: The Transformation of an 18th-century Indian aristocrat into an English lady

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

This digital humanities research project is searching for students with a range of interests - in coding, public engagement, and/or traditional archival or historical research - for collaboration with Professor Megan Robb. The involved students will contribute to a groundbreaking online exhibit providing public access to new research exploring the complicated life of an 18th century Indian woman and the role of gender in colonial history.

On the edge of the Forest of Dean in Gloucestershire, England, a stone church stands in the middle of Newland Village. In one of the church alcoves, there is an elegant memorial stone dedicated to “Elizabeth the wife of Gerard Gustavus Ducarel Esq.” The typical 19th century British gravestone belies the complexities of the woman it commemorates. Elizabeth had been born in the Indian subcontinent to a Persianate Indian family in Purnea (modern-day Bihar) in 1758, and died in Devon in 1822. In the two centuries following her death, traces of Elizabeth hibernated in the archives of her husband’s British family under a few different names: Zaphaniza, the Persian Princess, Mrs. Ducarrol. Although the discovery of each new name has brought with it the promise of revealing more about her, ultimately the layers of names succeed only in obscuring her. On her 1787 certificate of marriage in England she signed her name “Elizabeth Sharafunisa,” a rendering of the Persian epithet Sharaf un-Nisa, “exalted among women,” a common name for an elite, Mughal lady. To her brothers who wrote to her in Persian, she was hamshīrah sāhibah, or the respected sister. Building on previous work that has analyzed the subjectivities of native women who cohabited with East India Company men by reading colonial archives against the grain, this research project brings into view a new archive of Sharaf un-Nisa’s daily writings, material remnants, and the writings of her Indian, British, and French extended family in the latter 18th and early 19th centuries. The suppression of her Persian name was only one sign of the difficulties posed in the process of probing her complicated archival presence and the prominent erasures in the archive. After years of hard work collecting material documenting her life, this project builds on existing work to present an online exhibit that will engage the public and convince them of the significance of this woman's unusual story. Far from simply the story of a single woman, Sharaf un-Nisa's life tells us something about the widespread practice of British men taking Indian women as consorts or concubines - in turn, that gives us insight into the troubling history of colonialism in the subcontinent.

This project has already produced a research article and has received funding to document through photographs all of the images belonging to Sharaf un-Nisa or Elizabeth held by her descendants. University of Pennsylvania libraries has promised to ingest the photographs of Sharaf un-Nisa’s archive, and research assistants will assist in a) coding the metadata for the

images and translations, b) creating a user friendly website making complicated research accessible and c) gain expertise in performing original archival research and/or translations. Unstable Archives project co-hosted by the University of Oxford and the University of Pennsylvania will host a digital exhibit on the project at the end of 2021, giving involved students great exposure. For more information about the project visit: <https://www.unstablearchives.com/>.

This research project can accommodate two research students focusing on either a) digital humanities work (the intersection of computer science and humanistic thinking) and b) classic archival research. While there are three distinct roles described below, please note that this project can only hire two undergraduate research assistants through the CURF program. We will evaluate all available candidates and choose the strongest two applicants. All interested applicants encouraged to apply.

1. The “digital humanities” research assistant will work closely with Professor Robb to:
 - a. Review and correct the metadata for the digital images that have already been created of Sharaf un-Nisa’s archive. While the images have been created, and a draft of the metadata has been created, the metadata needs to be carefully edited and reviewed in consultation with the University of Pennsylvania library staff.
 - b. Provide descriptions and keywords in metadata description: When necessary, this student will need to work with Professor Robb to expand on the description of the image, with will include coding with the University of Pennsylvania libraries to ensure that each image is correctly described so that scholars can search for its content easily on its database.
 - c. Translate free-form translations of Persian and English handwritten manuscripts into a format that can be easily accessed via OCR (Optical Character Recognition). While translations have been completed, they are not yet coded into a standard format for OCR so that they are easily searchable in online databases.
 - d. Skills required: problem solving, attention to detail, effective collaboration skills. Some experience in coding will make the work much easier.
 - e. Skills that you will develop in this project: cataloguing, simple coding skills, awareness of innovations in data science. This position is ideal for a detail-oriented student who wants to improve their ability to catalogue and archive digital material or work at the intersection of computer science and the humanities. The ideal candidate will have an interest in history, gender studies, and computer science – and hopefully will be passionate about being involved in a project that brings the 18th century alive in the digital age.
2. The “public engagement” research assistant will assist the principle investigator Professor Megan Robb to:
 - a. Design a simple, curated online exhibit showcasing the artifacts connected to Sharaf un-Nisa’s life in a way that reflects the latest advances in digital humanities scholarship.
 - b. Work in collaboration with Professor Robb to design a simple online exhibit on a Squarespace website that reflects best practice in the digital humanities.
 - c. Write simple website content (introductory blurbs, captions) in collaboration with the Professor to synthesize complex research into web content that is appealing to the public and scholarly community alike.

- d. Skills required: superior writing skills, passion for history, graphic design, website design experience (ideally using Squarespace). Experience with User Oriented Design ideal. Experience with creating maps ideal. This position is ideal for a student who has interests both in computer science and in the arts, who wants to be involved in a project that brings the 18th century alive in the digital age.
 - e. Skills that you will develop in this project: the ability to apply theoretical concerns of inclusivity and attention to the social construction of race, gender, class, sexuality and nation to practical design of digital environments; the ability to communicate effectively with academics across the world; practice in translating complex research results into accessible digital content.
3. This project is also looking for an “archival research/historian.” The project is looking to hire a student ideally based in India to assist in archival fieldwork in that country. The duties are the following:
- a. If public health conditions permit, the student will visit at least one archive in India, searching for 18th century materials that shed light on Sharaf un-Nisa’s milieu. The archives visited will depend on the student’s location. Ideally, the student will either live in or be able to travel to Calcutta, Delhi, and/or Patna.
 - b. The student will be responsible for working with Professor Robb to identify the best archival documents to target before calling those materials up from the archive.
 - c. If public health conditions do not permit in-person archival research, the student will learn best practices in online archival research across the world, including but not limited to India, searching for and identifying archival holdings remotely. The student will learn to create archival guides to assist scholars in research 18th century Bihar and North India.
 - d. The student will photograph and scan primary source documents, organize them in a shared drive and label the files for easy access.
 - e. This project is particularly interested in research assistants who have any one (or more) of the following languages – Hindi, Urdu, Bihari, Persian, and/or Arabic. For students who have command over any one of these languages, the student will also assist in translating, proof-reading translations, and organizing digital files of primary source documents in that language.
 - f. Required: passion for South Asian history, solid communication skills, organizational skills, the willingness to meet regularly via Zoom to work collaboratively with Professor Robb and the other research assistant if necessary.
 - g. Skills you will gain: writing skills, greater knowledge of South Asian history in the 18th century, experience in conducting primary research in archives both online and in person, experience in writing an annotated bibliography and a front-row view to the development of a cutting edge digital humanities project.

SOCIOLOGY

Benjamin Shestakofsky

Conflicting Logics: Organization-based Gig Work

**My project can be completed entirely remotely*

Digital labor platforms appear to erode the ties between workers and organizations. Yet many gig workers still find themselves laboring inside of organizational settings--even if their boss is now an algorithm, rather than a person. This project draws on ethnographic data to investigate the role of organizations in shaping platform-based workers' experiences. We examine the case of the grocery delivery platform Instacart to understand how workers navigate the logics of app-based algorithmic control within the context of existing organizational settings: the grocery stores in which they shop.

One undergraduate researcher will identify, gather, and analyze content posted by Instacart shoppers on social media sites including Facebook, YouTube, and Reddit. Through this project, the researcher will learn how to read qualitative content as data, generate and apply a coding scheme to the data, and write analytic memos in which they identify patterns that can be used to generate and support theoretical propositions.

This project can be completed entirely remotely. Access to a computer and reliable internet access is required. Previous coursework in sociology or the social sciences may be helpful but is not required. The student researcher will work with the project's co-authors, Drs. Benjamin Shestakofsky and Chelsea Wahl.

Xi Song

Changing Occupational Structure in the United States from the end of the Great Depression to the present

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

This project aims to develop a new data infrastructure (OccLink) that integrates different sources of occupational information and complements data currently available about occupations from the decennial U.S. Census, American Community Survey, and other surveys. The project offers future researchers the ability to utilize longitudinal data from U.S. government archival and administrative sources on occupations, jobs, and workforce (1939-2020). Using the new data, the research team will examine changes in occupational structure, particularly emergence of new occupations and declines of obsolete occupations as the US economy evolved from the 1930s to the 2000s. Furthermore, this project will examine long-term trends in inequality with regard to

changing occupational opportunities for different social, economic, and demographic groups. For more information about this project, please email Professor Xi Song (xisong@upenn.edu).

Melissa Wilde

Digitizing the Census of Religious Bodies

**My project can be completed entirely remotely*

Undergraduate research assistants are needed to digitize four historical volumes of the Census of Religious Bodies. More than a century ago, the US government expended significant resources documenting the financial, material, and human resources of all of the religious organizations in the country, covering more than 200 denominations, and 220,000 congregations. This project aims to make these incredible data accessible to researchers by digitizing the volumes and making them publicly available on the American Religious Data Archive. Undergraduate research assistants will enter and clean the data contained in these volumes. This is excellent research experience for students looking to understand how databases are created, organized, maintained and analyzed quantitatively. A strong work ethic, care and reliability are all that are needed. Opportunities to complete advanced tasks and participate in analysis will be offered as appropriate. Those interested may also be invited to collaborate with the PI and graduate research assistants in the writing process, with the possibility of co-authorship. All work can be done remotely.

Dental Medicine

BASIC AND TRANSLATIONAL SCIENCES

Hydar Ali

Novel Mast cell Receptor in Allergic and Inflammatory diseases

**My project can only be completed if on-campus activities resume*

Mast cells are long-lived tissue-resident immune cells that play important roles in food allergy, anaphylaxis, asthma and allergic rhinitis. These disorders are mediated via the activation of cell surface IgE receptors (FcεRI) on mast cells. Mast cells also contribute to mastocytosis, rosacea, chronic urticaria, atopic dermatitis, allergic contact dermatitis, neurogenic inflammation and pain. Emerging evidence suggests that these disorders are mediated via the activation of a novel G protein coupled receptor known as MRGPRX2, which is expressed selectively in skin mast cells. We plan to utilize biopsy samples from human skin diseases to determine if the expression and activation of MRGPRX2 is enhanced in diseased when compared to normal skin samples. Techniques involve immunohistochemistry and double immunofluorescence studies. In addition, human skin obtained from surgical discards will be enzymatically digested and mast cells will be purified. The ability of neuropeptides and host defense peptides to cause histamine and chemokine release will be determined. These studies will be supplemented with experiments with human mast cell lines and primary mouse mast cells. Two undergraduate students can work on different aspects of this project. In addition to myself, the students will be supervised by one or more postdoctoral researchers and graduate students in the lab (3 postdoctoral researcher and 3 graduate student). No previous lab experience is required and it is anticipated that this project will provide the student with valuable experience in cutting edge research with direct relevance to understanding the mechanisms involved in allergic and inflammatory diseases.

Kelly Jordan-Sciutto

Role of the integrated stress response and RNA binding proteins in neurodegeneration

**My project can only be completed if on-campus activities resume*

Our laboratory is examining mechanisms of neurodegeneration in the context of neuroinflammation associated with HIV infection. We have identified several mechanisms that contribute to neuronal dysfunction including altered activity of the integrated stress response kinase, PERK and the subsequent downstream activation of RNA binding protein containing stress granules. The project will examine the biochemical, molecular and cellular changes in PERK and RNA binding proteins in response to HIV induced neuroinflammation and excitotoxicity to gain insight into their contribution to neuronal dysfunction. Technologies

learned will include primary neuronal and glial culture, immunohistochemistry, immunocytochemistry, western blot, pharmacologic experimental design, fluorescent microscopy, image analysis, data analysis and data interpretations. Students will also receive training in scientifically rigorous experimental design, critical analysis of literature and presentation of scientific data.

PERIODONTOLOGY

Dana Graves

Mechanisms by which diabetes negatively affects wound healing and periodontitis

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

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.

PREVENTATIVE AND RESTORATIVE SCIENCES

Geelsu Hwang

Biofilm formation under hydrodynamic conditions

**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 biofouling 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 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, 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 as 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, its important role is often overlooked. Here, we will develop a new biofilm testing flow system by utilizing 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.

Design

ARCHITECTURE

Andrew Saunders

Urban Relief: A LiDAR and Photogrammetry Survey of the Painterly Effects of the Baroque Facades

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

Reality capture surveying techniques allow unprecedented immediacy to complexities of Baroque architecture. As a new medium for analysis and close reading of Baroque Architecture, they reveal and champion aspects of the work that have been undermined by other more reductive forms of representation. Typically, LiDAR surveying is used as a precise empirical measuring device for verification. Less explored is the potential role of reality capture surveying technology in the long legacy of architectural representation. The act of surveying both precedes and is integral to the creation of geometry (measurement of the earth), architectural drawing conventions, and the linear perspectival innovations of Brunelleschi, all of which are major milestones in the evolution of architectural representation.

In addition to the capacity for precise measurement, current surveying technologies offer architects novel avenues for the reassessment of architectural through its re-presentation. On the most basic level, LiDAR and photogrammetry surveying produce a high-resolution model for the production of many conventional orthographic drawings that have never been produced and serve as as-built documentation for the preservation of the work. On a more innovative level, complete surveys of the work make possible novel representations, expressions and vantage points capable of defamiliarizing the work in unexpected and refreshing ways for both expert scholars and novices experience Baroque Architecture for the first time.

Urban Relief is a research project for the LiDAR and photogrammetry survey of the exterior facades of Roman Baroque Architects Francesco Borromini, Gian Lorenzo Bernini, Pietro da Cortona and Carlo Rainaldi. Italian Baroque Architecture offers some of the most formally complex built work in architecture history. Characteristically, the baroque interior acts autonomously to the exterior as an infinite and expansive world on its own. As an urban interface the exterior acts as a threshold to the inner sanctuary with very little transparency or allusion to interior. Furthermore, Baroque facades embody what historian Heinrich Wölfflin described as painterly qualities. The painterly champions illusive figural traits from baroque painting relying on deep figure on figure relief. Through high-resolution survey techniques, the project will document and catalogue a major collection of Baroque facades for the analysis and re-presentation of the work culminating in a major exhibition and publication.

Robert Stuart-Smith

Architectural research in Robotic Fabrication and Design-Computation

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

The AML lab aims to improve the way we design, construct and use buildings through innovations in robotic fabrication and computation for design and rationalization processes.

Current projects include:

- Robotic fabrication of a prototype house to be constructed on Penn's campus. The project leverages robot hot-wire cut formwork to reduce material quantities, demonstrating a design-for-disassembly, relocatable house that provides a housing solution that skirts land-ownership by temporarily making use of under-utilized land.
- A Design-computation and robotic fabrication approach to adaptive manufacturing with 3d scanning and computer vision in-the-loop for robot Incremental Metal Forming (IMF) and large-format industrial robot Additive Manufacturing (AM) in various materials.

The lab has in-person research roles for working in robotic fabrication, design and prototyping for the above projects in addition to remote contributions in software programming for activities such as Intel Realsense 3d scanning, hand-eye coordination tasks, machine learning, GPU programming, ROS Moveit motion planning and other activities. Applicants need only identify with one of the many subjects mentioned above.

Role may involve literature review, computer programming, participation in industrial robot manufacturing tasks, design and prototyping of fabricated building components. Participants would be gain knowledge in state of the art research and industry methods in architectural design and robotic fabrication. Role may be done either 100% remotely or part on-campus in our robotics fabrication facilities and part remotely depending on Covid19 circumstances.

CITY PLANNING

Francesca Ammon

Analyzing Photographs to Understand Urban Change along LA's Sunset Boulevard, 1960s-present

**My project can be completed entirely remotely*

Students will assist with the development of an urban digital humanities project, "Sunset over Sunset," about which you can read more here: <https://www.design.upenn.edu/news/post/ammon-earns-national-endowment-humanities-grant-study-urban-change>.

Every few years, from the 1960s through the 2000s, artist Ed Ruscha drove a truck down Los Angeles's Sunset Boulevard, photographing the street view of each passing facade. This digital humanities project stitches these photographs together into a virtual panorama and layers multiple layers of address-level historical data (e.g., census, city directories, building permits, real estate records, newspaper articles) in order to better understand the small-scale, everyday patterns of postwar urban transformation.

While a web developer is creating the technical architecture of the website, student research assistants will support the effort by organizing relevant data sets and then using a combination of the digitized photographs and other data sets to research and write case studies about individual aspects of urban change. Case study topics might include building types (e.g., gas stations, ethnic restaurants, music venues, motels), landscape features (palm trees, billboards, intersections), or any range of trends that researchers identify by panning through this vast photographic archive across space and time.

This project is well suited to humanities students who are interested in visually-oriented urban and architectural historical research – including those studying art history, architecture, urban studies, history, or real estate. Candidates should be detail-oriented and enjoy analyzing photographs and other primary sources to identify historical patterns. Students will work independently to gain experience with urban historical research, digital humanities, and scholarly writing.

Akira Rodriguez

Identifying Best Practices of Health and Environmental Specialists in Teacher Unions

**My project can be completed entirely remotely*

This project is part of a larger study to understand the current needs and potential sustainable solutions to designing, constructing, and maintaining safer and more equitable K-12 public school facilities in the US. In partnership with the 21st Century School Fund (<http://www.21csf.org/csf-home/>), a parent-led nonprofit that advocates for more community-based involvement in school facilities planning, this project will serve as a case study for the 2021 State of Schools Report, a comprehensive analysis of K-12 public school facilities in the United States. The primary purpose of the case study is to illustrate the impact and best practices of the role of the Director of Environmental Science and Occupational Safety for the Philadelphia Federation of Teachers.

The Director, who has held the position for 30 years, has helped to standardize and translate technical, environmental data from the school district into accessible information for the public, students, and educators inside school facilities. The advocacy of the Director led to the formation of a Healthy School Alliance (a coalition of policy advocates for healthy school buildings), launched a Healthy School App to document and monitor school facility hazards, and consults with school districts across the country on environmental health and safety. The work is important because Philadelphia is a majority-minority, high-need school population, and the

average age of the school facility is over 40 years. Nearly 80% of the schools have asbestos, used lead paint, or have other hazards such as mold or lead in water feeder pipes. Thus, this project will illustrate some of the environmental justice frameworks that are used to guide facility remediation and budget prioritization.

The case study will be used to advocate for similar positions in teachers unions across the country, and at the national level (American Federation of Teachers and the National Education Association). In the wake of President Biden's America Recovery Plan, which is planning to allocate \$130B to K-12 schools for the purposes of safely reopening buildings, it is critical that we are aware of best practices and institutional supports that are needed to make K-12 facilities safe for all populations.

The student will be expected to:

- conduct semi-structured interviews with the Director, district leadership, district staff, parents, students, and others who have worked with the Director on these initiatives
- conduct semi-structured interviews with national teacher union leadership and congressional staff leaders on school facilities issues
- analyze the raw data from the Healthy Schools App to identify possible spatial or other patterns
- write a brief/case study using the above data (approx 8-10 pages)

The student may also use this as an opportunity to conduct any exploratory research around labor, environmental justice, and education.

Megan Ryerson

The Effect of COVID-19 on Bike Share: Geographic and Social Effects in Washington D.C., New York City, and Philadelphia

**My project can be completed entirely remotely*

The effects of the COVID-19 pandemic on mobility patterns are immense. Previously unthinkable propositions, such as the closure of major roads to automotive traffic, are now in practice in urban areas across the country, while, at the same time, public transit systems face budget crises of epic proportions. Cycling, a travel mode that features extremely low levels of use in the United States, has seen an incredible uptick during the pandemic, due to the recreational benefits of cycling, the relatively "Covid-safe" nature of this practice outdoors, and to commuters and other travelers perhaps replacing travel on public transit with cycling trips. Regardless of the impetus behind this growth the effect has been substantial. In Philadelphia, the use of the area's bike trail network has increased 150% during the pandemic compared to the same time in 2019.

However, the question remains as to who is generating this increase in cycling and what do their travel patterns look like during the pandemic, compared to before the crisis. Public bike share systems, where users pay a fee to check out public bicycles from docks located around an urban

area, provide a unique and robust data source through which to approach this question. Nearly all trips taken on a bike share bicycle can be identified at the point of origin and destination, the time of day, and describe the trip duration. This high-quality data allows the researcher to investigate multiple effects including the ways that trip patterns change over time.

Using bike share data from three major cities on the East Coast – Philadelphia, Washington, D.C., and New York City – this project will look at multiple effects of the pandemic on bike share use. We pay particular interest to how cycling use has changed in low income and communities of color, as these areas have historically seen disproportionately low levels of bike share investment, and, similarly, low levels of cycling. If bike share use has changed substantially in these areas during the pandemic, then this may signal the importance of ongoing policy interventions to support cycling in such communities.

In this project students will be able to work directly with Dr. Ryerson, as well as members of her research team who include doctoral students, master's students, and fellow undergraduates, including former PURM fellows. Dr. Ryerson's lab is a dynamic, creative workspace, where students will be able to engage closely with multiple facets of the research process and benefit from close mentorship from leaders in the field. Dr. Ryerson and members of her lab have conducted fully remote research programs with PURM fellows in the past, and all of the data and tools we utilize are open sourced and publicly available. Regardless of the status of the pandemic in the summer, we will be able to conduct an active research agenda with students. The results of past PURM fellow's summer work has led to coauthored publications and conference presentations with Dr. Ryerson and her team.

Over the summer, students will gain experience in data analysis, visualization, and modeling. In particular, students will have the opportunity to learn and utilize geospatial approach. Students will learn how to use the cutting edge, open-sourced software R. This software is one of the leading platforms in the field of data science and academic research. R is freely available and can be used on any computer. Dr. Ryerson and her team have extensive background conducting research programs in R and have collaborated with leading developers of R packages to conduct equity-oriented transportation research.

Education

APPLIED PSYCHOLOGY & HUMAN DEVELOPMENT

Howard Stevenson

The Black Youth IMPACT Project

**My project can be completed entirely remotely*

Black youth are navigating a contentious sociopolitical climate marked by political unrest due to the 2020 election, a historical uprising for racial justice, and a global pandemic that has disproportionately impacted Black people. With these realities in mind, the Black Youth IMPACT project seeks to identify how Identity, Media, Political Action, and Consciousness support Black youth's ability to Thrive in the face of racism. This summer, we will conduct qualitative interviews with 30 Black youth (ages 14-17) to identify: 1) how Black youth think about racism and social justice, 2) the actions that youth take to cope with and contest racism, and 3) the experiences that shape youth's thoughts, coping and actions in response to racism. Youth will be recruited from across the Philadelphia Metropolitan area through established relationships with youth-serving organizations (e.g., cultural, art, gender-based, and civic-oriented).

The PURM students involved with the project will be mentored by Dr. Howard Stevenson and Dr. Nkemka Anyiwo, both of the Racial Empowerment Collaborative. We are interested in mentoring two PURM students. To develop qualitative skills, our student(s) will receive training on qualitative methods and will work with the research team to review qualitative protocol, transcribe and review transcripts, and analyze qualitative data. Our student(s) will learn research project management skills by working with community partners to help recruit and schedule participants and attended community advisory meetings. Finally, students will have opportunities to help prepare presentations for academic and community audiences.

EDUCATION POLICY

Michael Gottfried

What happens in school when I am diagnosed with a disability?

**My project can be completed entirely remotely*

In this project, we will use large-scale data to examine what happens to my school performance when my school diagnoses me with a disability -- giving me what is known as an Individualized Education Plan (IEP). We will look at whether being assigned an IEP affects the types of courses

I take, my attendance, and whether my parents are more involved or less so. A student who joins this project will have the opportunity to help find prior research studies that have been conducted in a similar area, to help build a literature review. The student would also have the opportunity to meet Dr. Gottfried's graduate students and learn about the opportunities that await in graduate school. No prerequisites are necessary.

Jonathan Supovitz

Leading Through Crisis: A study of school leaders' responses to the coronavirus pandemic

2nd year applicants only

**My project can be completed entirely remotely*

On or around March 13, 2020 every school in the United States closed to ward off the novel coronavirus. Never before had a single calamity shuttered the doors of every school across the entire nation. Between mid-April and Early August 2020, a national group of researchers conducted interviews with 120 principals in 19 states. The schools ran the gamut from America's urban hubs like New York City (ground zero for the original COVID-19 outbreak), Minneapolis (both before and after the death of George Floyd), Denver, and San Diego; to the vast suburban swaths of South Florida, Atlanta, Houston, and southern California; to small town and rural areas including American Indian reservations in Montana and North Dakota, as well as rural areas of southeastern Tennessee, and upstate New York.

The interviews were organized to examine the most pressing issues faced by school leaders; including their instructional responses; challenges for students, families, and teachers; district crisis management and policy guidance; the inequities exposed by the pandemic; and strategies for selfcare and attention to well-being of others. We are now in the process of coding, analyzing and writing up the data from the study using frameworks for crisis management, organizational learning, systemic inequity, and adaptive leadership. We seek a Penn undergraduate to join the research team.

EDUCATION, CULTURE, & SOCIETY

Krystal Strong

The MOVE Activist Archive

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

On May 13, 1985, the city of Philadelphia—with the help of the U.S. federal government—dropped a military-grade bomb on the home of the MOVE organization, a collective of Black naturalist revolutionaries founded in 1972 West Philadelphia. Eleven children, women, and men of the MOVE organization were murdered and 61 Black-owned homes were destroyed after police and

fire personnel intentionally allowed the fire produced by the bomb to burn. The MOVE bombing is a defining moment in the long and ongoing history of state repression of Black radicalism in Philadelphia and of the specific targeting of the MOVE organization. Years earlier, in 1978, police raided and razed MOVE's first communal home. During the raid, nine MOVE members—commonly known as The MOVE 9—were brutally arrested and subsequently incarcerated. Collective understandings of MOVE have been fundamentally shaped by both the criminalization and incarceration of its members and state and media control of the organization's narrative. However, the recent release of the 7 surviving members of The MOVE 9 after 40 years of political incarceration means that MOVE members are now able to share their history on their own terms.

The MOVE Activist Archive is a community archiving project, which preserves the history of MOVE's resistance to state violence and state repression of MOVE activism. A joint project of the MOVE Organization and the West Philadelphia Cultural Alliance, in collaboration with Re/Member Black Philadelphia, a storytelling and archiving project led by Dr. Krystal Strong, the MOVE Activist Archive is a site of organizational history and collective memory, a catalyst for transformative justice, and a guide for social movements, most recently amplified by rising attention to police terrorism and state violence in Black communities.

Over the next two years and beyond, The MOVE Activist Archive will work to: (1) preserve MOVE organizational materials that are privately-held and currently vulnerable; (2) launch a MOVE digital archive; and (3) curate a multimodal exhibition of MOVE history through a series of community programs and immersive experiences. Together, these activities will preserve and amplify the history, memory, and ongoing activism of the MOVE organization and increase public engagement with the historical record and collective memory of one of the most important organizations to the history of Black activism in Philadelphia and global Black freedom struggles.

Student researchers, who join the project team, will learn valuable skills in community archiving. From skilled archivists at Penn Libraries and Archivists for Black Lives, student archivists will receive training to help describe, create metadata, organize, and catalogue a unique collection of MOVE organizational materials. Additionally, students will have an opportunity to work directly with members of the MOVE organization and help collect oral histories about their lived experiences and political work.

These research activities can be modified to accommodate a remote environment.

Engineering and Applied Sciences

BIOENGINEERING

Christopher Fang-Yen

Deciphering neural circuits in a worm

**My project can be modified to accommodate remote activities if made necessary by University policy, My project can only be completed if on-campus activities resume*

Caenorhabditis elegans, a microscopic roundworm, is the only organism that boasts a complete connectome – a map of all neurons and their synaptic connections. However, it is still unclear how these synaptic and electrical interactions generate the worm's basic motor behaviors. To address this question, we will optogenetically stimulate a motor neuron in the worm and measure the corresponding activity in the nearby neurons and/or connected muscles. We will also use an infrared laser system to kill specific cells or sever their processes. This work paves the way for the functional interpretation of structural connectomes that will eventually become available in more complex species. The student will learn to operate a microscope that supplies laser illumination to a targeted neuron while simultaneously recording fluorescence images of all nearby neurons or muscles. Other potential projects in the laboratory involve behavioral assays in microfluidic devices and developing methods for robotic manipulation of worms. Depending on the specific interests of the student, tasks may include data analysis, interpretation of results, and programming. Excellent fine motor skills, ability to keep organized, and strong attention to detail are required.

Michael Mitchell

Polymer-Lipid Nanoparticles for In Vivo mRNA Delivery to Immune Cells for Potent Cancer Immunotherapy

**My project can only be completed if on-campus activities resume*

The induction of a strong cytotoxic T cell response is an important prerequisite for successful immunotherapy against many viral diseases and tumors. Nucleotide vaccines, including mRNA vaccines with their intracellular antigen synthesis, have been shown to be potent activators of a cytotoxic immune response. The intracellular delivery of mRNA vaccines to the cytosol of antigen presenting immune cells is still not sufficiently well understood. In this project, we will engineer and implement a polymer-lipid nanoparticle formulation for the delivery of mRNA vaccines to induce a cytotoxic T-cell response. We will develop nanoparticles encapsulating mRNA coding for various tumor-associated antigens for the transfection of immune cells in vitro and in vivo. The efficacy of the vaccine will be tested in an aggressive mouse model of melanoma. We will also investigate if the immune response can be further increased by the

incorporation of various adjuvants. The resulting polymer-lipid nanoparticle formulations developed in this study will serve as promising vectors for mRNA delivery, ones that are capable of inducing a strong cytotoxic T-cell response required for cancer immunotherapy. Prerequisites: coursework in molecular/cell biology and organic chemistry lecture and labs are highly recommended but not required. Prior research experience in cell culture, molecular biology, and organic chemistry are highly recommended but not required. Students will be mentored by the PI as well as postdoctoral fellows and PhD students within the lab.

Beth Winkelstein

Mechanobiology of Pain

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

Integrating engineering and neuroscience analyses this project will define how pain is regulated by injurious loading, degeneration as occurs from aging, and also has ways to begin to determine treatment approaches to prevent pain. While prior research experience is not required, interest in learning, attention to detail and willingness to engage in cell culture and/or analysis is important. A student involved in this broad project would learn tissue culture, image analysis, mechanical loading and/or data analysis depending on their specific goals.

CHEMICAL AND BIOMOLECULAR ENGINEERING

Bomyi Lim

Quantitative analysis of dynamic gene control in living cells

**My project can only be completed if on-campus activities resume*

My lab has an expertise in using live-imaging based assays and quantitative analysis to examine one of the most exciting problems in modern biology: the nature of transcriptional regulation. The undergraduate students joining my lab will use a combination of molecular cloning, live-imaging, and quantitative analysis tools to determine the spatial and temporal range of transcriptional activity that ensures normal development upon genetic perturbations.

We find that modulating a transcription factor's binding affinity to the target DNA motif in an enhancer regulates both the timing and the amplitude of transcriptional activity. We will perturb the genome by varying the distance between an enhancer and the target promoter, adding more pioneer factor DNA motifs into an enhancer, or changing the transcription factor binding site arrangement within an enhancer. We will quantify how each modification leads to higher or lower transcriptional activity, or faster or slower transcriptional kinetics. We will also measure cell-to-cell variability in each condition to analyze the effect of gene expression heterogeneity in development. By perturbing endogenous gene loci and correlating gene activity with subsequent

phenotypic changes, we will determine the lower and upper threshold of gene expression that guarantees proper development.

As a start, students will learn molecular cloning, such as traditional DNA recombination techniques as well as more recent CRISPR/cas9-based genome editing approaches. Concurrently, they will get a chance to collect live imaging data of transcriptional dynamics, using a cutting-edge confocal microscope in the lab. Finally, students will learn how to write custom-built Matlab codes to perform quantitative image analysis. This whole process will give students a chance to experience various aspects of conducting a research project in the lab. Since the project involves both traditional biological experiments and quantitative analysis, students will obtain insights from multiple disciplines as well.

COMPUTER & INFORMATION TECHNOLOGY

Jianbo Shi

Human pose and motion synthesis with inverse affordance

**My project can be completed entirely remotely*

Conditioned human motion synthesis has many AI applications: predicting human action in a video, generating motion sequences based on sound, textual description. It is a challenging task due to the ambiguity and diversity of human activity. For example, a single piece of music can correspond to a variety of aesthetically pleasing dances. The AI algorithm needs to generate a diverse yet reasonable set of motions, despite only having one training example to learn from.

Our goal is to model the diversity of human motion by understanding the affordance of its environment. Given a setting, such as a kitchen or a baseball court, humans know how we interact with the objects in it. Items like cups or baseball mats carry a strong indication of how they may relate to human action. We plan to do this in two stages: first, predict the key human poses from the environment image, then use a learned interpolation to recover the full sequence.

The main challenge is the lack of suitable manually labeled ground truth for learning. We propose an intelligent 'cut-and-impaint' approach to create a learning set. First, we take images of people in the environment and use off-the-shelf 3D mesh recovery networks to obtain both the person's shape and pose. We use image inpainting techniques to remove the humans from the images and generate only the background environment's images.

COMPUTER AND INFORMATION SCIENCE

Sebastian Angel

Can we formalize user addiction as a security property?

**My project can be completed entirely remotely*

Online services such as social media platforms heavily optimize for user engagement in order to drive up revenue from online advertising. For example, features like infinite timelines ensure that users continue to enjoy the thrill of constant discovery, and periodic notifications give users reasons to come back to the system. In this project, however, our aim is to understand whether addiction to a system is something that (backend) system designers need to worry about, or whether user engagement is purely a property of frontend user interfaces and content.

We have some evidence to suggest that repetitive user engagement influences system design. For example, the way in which we replicate data in social networks, the type of consistency properties that we guarantee, and what we cache presupposes certain behavior on the part of users. But is there evidence that system architectures, beyond offering low latency, influence how engaging a system is? How do "engagement metrics" manifest themselves in back-end system design requirements?

And if it turns out that system designers are in fact responsible for the creation of overly engaging technologies, are there ways that we can formalize the notion of "too much engagement"? We have done similar formalization over the years. For example, we have privacy and confidentiality definitions to characterize "too much sensitive information leaking", and availability definitions to characterize "the system is experiencing too much downtime". But presently there is no equivalent definition for "too addicting" or "too much engagement".

Finally, given such a definition, can we build systems that can provably bound the amount of engagement they compel from users?

As a student, you will be familiarizing yourself with some of the theories on system design, addiction, and financial models of the Web and their incentives. You will also learn about concepts in cryptography and computer security such as privacy, availability, and integrity. This project will be more theoretical than applied. We will aim for understanding rather than implementation, and it will be fairly open ended. The ideal candidate is someone who is comfortable with mathematics and logic, and who enjoys tackling challenging sociotechnical problems.

This project can be completed entirely remotely

Chris Callison-Burch

Develop artificial intelligence that can navigate a virtual environment *2nd year applicants only*

**My project can be completed entirely remotely*

I teach the artificial intelligence course at Penn (CIS 421/521), and I'd like to investigate the VirtualHome simulator (<http://virtual-home.org>). The VirtualHome is a multi-agent platform to simulate activities in a household. I'd like to have a PURM student use VirtualHome to investigate whether it might be feasible to use it as a platform for students to use in our AI class. The goal would be to implement navigation routines like the A* search algorithm that we cover in CIS 421, which would allow the virtual agents to navigate the virtual home. If this summer exercise is successful, then I may use it as the basis for a new homework assignment for CIS 421.

Insup Lee

Modeling and Training Verifiable Sonar Perception *2nd year applicants only*

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy, My project can only be completed if on-campus activities resume*

Analyzing high-dimensional data like camera images is an essential task in modern autonomous systems such as self-driving cars. However, this task, known as perception, is notoriously difficult to perform error-free when it is implemented with neural networks. In fact, there is typically no mathematical definition of what constitutes a correct output or an error. So one cannot precisely check the correctness of such perception or guide its training with precise definitions.

This project seeks to overcome the above challenges by rethinking how perception is built, using formal analysis. Specifically, we aim to develop perception in a modeling and training loop, where we (1) create a mathematical model of the perception's inputs and outputs, (2) train a neural network based on this model, and (3) repeat if we cannot automatically prove correctness using a neural network analysis tool developed in our lab. Tasks (1) and (2) may be completed by one student or distributed among two.

This project is set in the context of sonar-based perception used by an autonomous underwater vehicle to scan a pipeline for defects. Modeling a sonar is particularly convenient because its waves follow well-understood laws of physics, which can be described with trigonometric equations.

The accepted student(s) will gain exposure to academic research in modeling and verification of cyber-physical systems and experience with training neural networks. If successful, this project will lead to a publication in a peer-reviewed conference.

Prerequisites: basic knowledge of high-school trigonometry and familiarity with a high-level scripting language (Python or similar).

Stephanie Weirich

Specification and verification for functional and imperative programs

**My project can be completed entirely remotely*

This project is part of the DeepSpec project, which explores the science of software systems. Software specifications define what it means for a software system to be correct, but where do such specifications come from? And what does it mean for a specification to be good or for a program to meet its specification? This project will focus on the specification and verification of functional and imperative programs, using tools such as interactive proof assistants or property-based testing. The work will be done in collaboration with professors Benjamin Pierce, Steve Zdancewic and Stephanie Weirich as well as their PhD students and postdocs.

This project is intended for students who have previously taken CIS 120 or have equivalent experience.

ELECTRICAL & SYSTEMS ENGINEERING

Pratik Chaudhari

Marvin: an intelligent home robot

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Marvin is an intelligent home robot. He moves around the house, cleans the floor by picking up objects that may be lying around such as toys, socks or shoes, or waters your plants when you are traveling. Marvin uses its camera to detect such objects, deep learning and computer vision algorithms to help it figure out how to do a particular task and motion planning algorithms to drive its robotic arm. You can also teach him new tricks, for instance, you can show an action being performed a few times, e.g., picking up an object, Marvin watches this action being performed and learns to imitate your actions and learn this task. This research will ideally lead to a publication or contributions to large open-source projects such as DuckieTown (<https://www.duckietown.org> (<https://www.duckietown.org/>)). We are open to two students for this project, both will have independent roles.

Skills you will learn

You will learn (a) the basics of deep learning, (b) how to use deep networks for computer vision, and (c) algorithms that drive a real robotic platform.

Skills required

Familiarity with Python and programming at the level of CIS 121. Scope of the project can be modified depending upon interests.

Target audience

This project could appeal to students majoring in electrical/mechanical engineering and computer science with interest in artificial intelligence.

MATERIALS SCIENCE AND ENGINEERING

Ritesh Agarwal

Topological polaritons for robust quantum information processing devices

**My project can be completed entirely remotely*

Quantum information processing devices working in the photonics regime would require spin-dependent routing of quantum information on a robust platform where backscattering due to defects are minimized. Topological photonics in light-matter coupled systems offer the possibility for fabricating tunable optical devices that are robust against disorder and defects. Topological polaritons of hybrid exciton-photon systems will be created to demonstrate scatter-free propagation of optical information along with their manipulation at room temperature in monolayer WS₂ coupled to a photonic crystal. Single photon polaritons will be created to push the limit of the polaritonic system to the quantum regime. The spin-dependent transport properties of the quantum topological polaritons will be studied via optical microscopy techniques. Topological helical polaritons in the quantum limit will provide a platform for developing robust and tunable polaritonic spintronic devices for classical and quantum information processing applications. The work would involve:

a) If normal research activity resumes:

assembling monolayers on photonic crystals, optical measurements and data analyses

b) If research is allowed only remotely:

data analyses of photonic band structures, simulations of exciton-polariton dispersion, electromagnetic simulations.

Liang Feng

On-chip Twisted Light Emission 2nd year applicants only

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Light typically consists of a stream of linearly polarized photons, traveling in a straight line and carrying a linear momentum. However, light carrying an orbital angular momentum (OAM) propagates in a twisted helical way with a corkscrew-shaped wavefront. Such twisted light is characterized by an integer quantum number corresponding to its OAM. It has been recognized that this twisted light can be used as great information carriers since the degree of freedom of OAM is unbounded. The combined use of twisted light with other multiplexing/demultiplexing techniques is expected to enable the entirely new high-speed secure optical communication and quantum teleportation systems in a multidimensional space. The goal of this project is to develop an active scheme for high-power laser emission with reconfigurable OAM. This is considered a key step towards the multidimensional wavelength-OAM division multiplexing. This will involve nanophotonics designs, electromagnetic simulations, and optoelectronic characterizations (if it is possible to conduct in-lab research activities).

Eric Stach

Electrochemical CO₂ reduction reaction catalyzed by electroplated copper nanocatalysts

2nd year applicants only

**My project can only be completed if on-campus activities resume*

We are interested to study how the catalytic activity of electrochemical CO₂ reduction reaction (CO₂RR) by copper (Cu) nanocatalysts is affected by changes in the morphology, structure and surface chemistry of Cu nanocatalysts.

The electrochemical reduction of CO₂ is a promising pathway to remove CO₂ from the atmosphere to produce valuable liquid chemical compounds, such as ethanol, while simultaneously contributing to reduce our reliability in fossil fuels and mitigating global climate change. Copper catalysts are cheap, abundant and exhibit commercially viable catalytic activity towards the CO₂RR, when optimized conditions are can be achieved. However, when Cu nanocatalysts are used in the CO₂RR, their structural and chemical properties change over time due to the electrochemical stress that the catalysts must be submitted to overcome the activation energy of the reaction. Those changes cause catalyst degradation, which impacts both the productivity and the selectivity of the reaction. For example, a higher ratio of corners and edges to facets increases the overall catalytic activity, but the yield towards reaction products with 2 carbon atoms is favored in (111) facets.

The Principal Investigator of this project, Professor Eric Stach, has a Postdoctoral Research Assistant (Rui Serra Maia) using operando Transmission Electron Microscopy methods to evaluate how Cu nanocatalysts evolve during electrochemically driven CO₂RR conditions. However, to fully relate the catalyst properties to their activity, we need to evaluate the catalytic activity of catalysts that have been submitted to different extents of stress and degradation.

We will perform a series of benchtop CO₂RR rate measurements at the same conditions used in the operando Cu stability studies. Cu will be electroplated onto a glassy carbon electrode of a benchtop commercial electrochemical 3-electrode cell. The electroplated Cu will then be subjected to the same electrochemical stress induced in the operando stability studies. The degraded catalysts will be used in batch reactor electrochemical catalytic CO₂RR rate measurements with aqueous solutions pre-saturated with CO₂. For that, we will collect gas and liquid-phase aliquotes over time, which will be analyzed through gas and liquid mass spectroscopy, respectively, to determine the reaction rate and selectivity of the reaction. This method is identical to the method used by Rui Serra Maia in previous studies to study the catalytic activity of H₂O₂ decomposition catalyzed by platinum and methane oxidation to methanol catalyzed by AuPd nanocatalysts.

The undergraduate student will be responsible for running the benchtop reaction rate experiments, mentored by Rui Serra Maia and Professor Eric Stach. The results obtained in this series of experiments will be crucial for developing an in-depth property-activity relationship for Cu nanocatalysts used in CO₂RR. This project will allow the undergraduate student to develop skills on energy conversion chemical reactions and statistical analysis of the measured reaction rates to evaluate how the different catalyst properties affect the catalytic activity and selectivity of the Cu catalysts used in the CO₂RR.

This can only be effectively done with on-site activity.

MECHANICAL ENGINEERING AND APPLIED MECHANICS

Igor Bargatin

Light-driven levitation in Earth's mesosphere and the Martian atmosphere

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

At present, no propulsion mechanism exists that can provide sustained flight in Earth's mesosphere, the region of the atmosphere at elevations of 50-80 km. However, exploration of this zone is important in order to, for instance, accurately simulate carbon dioxide in climate models or comprehensively understand how meteors disintegrate. In the Bargatin Research Group, we are addressing this knowledge gap by developing a novel means of flight called photophoretic levitation, in which bright light is used to cause thin plates to hover in mid-air. Our

models indicate that this technique is optimal for mesospheric flight and even for low-altitude levitation on Mars.

We seek two undergraduate student interns with interest in aerospace engineering and computational modeling who can help us characterize new plate materials and understand the physical forces experienced by these plates. The interns should expect to learn about conducting research experiments, using computer programs like MATLAB or 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.

If on-campus research is permitted for undergraduates over the summer, intern activities will likely include testing levitating samples in our vacuum chamber, measuring optical properties of plate coatings, and fabricating three-dimensional structures using combinations of plates and plate materials. If on-campus research is regrettably not allowed, interns will assist graduate students in analyzing simulated levitation data and modeling the mechanical stress and strain in levitating microflyers.

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.

Jennifer Lukes

Designing Temperature-Responsive Materials for Thermal Management

**My project can be completed entirely remotely*

Future information technology, transportation, and energy systems will require electronics, motors, and batteries that can operate at power levels significantly larger than those presently in use. Unfortunately, severe overheating often occurs at high power density, resulting in poor performance, mechanical failure, and fire. In this project, students will use computer simulations to design heat-sinking materials that can mitigate high thermal loads. Students will develop finite element modeling skills using computer codes widely used in engineering practice.

Law

David Abrams

A Quantitative & Economic Analysis of Crime, Policing & Race in a Time of Change

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

The COVID pandemic has had a massive impact on criminal activity. The changes the pandemic has led to on normal activity, policing, the judicial system and jails may give us insight into how crime is generated and deterred. This project has multiple parts.

First, I plan to examine how crime has changed within cities. I will examine characteristics like racial composition, income, employment, pre-existing crime rates, and others to help obtain a more nuanced understanding of the crime impact of the pandemic.

The second piece of this project stems from the fact that crime declined prior to stay-at-home orders, and happened closer in time to changes in mobility. It raises the question of whether some types of mobility data may be used to predict crime at a local level.

The third piece of the project is the most ambitious. Using data on crime, policing, jails, job loss, and mobility, is it possible to build a structural model that does a good job of predicting crime in a broad range of contexts, well beyond the pandemic? The sudden changes due to COVID may allow the estimation of such a model in a way not previously possible.

There is the potential for multiple students, and each one will not be involved in all different types of work. Experience with programming outside of coursework and/or data analysis (stata or R) is a big plus. For other roles, good oral and written communication skills will be extremely valuable. Student responsibilities include data acquisition, cleaning and analysis. This may include requesting data from various government agencies, and cleaning the data using stata or R. It may also include assisting with websites to communicate results. Students will gain expertise in working with data, interacting with individuals in criminal justice, and in effectively communicating research findings.

Please read www.davidsabrams.com for more information on current and past research.

Claire Finkelstein

Advancing the Rule of Law 2nd year applicants only

**My project can be completed entirely remotely*

The Center for Ethics and the Rule of Law (CERL) is an academic center that unites preeminent scholars and practitioners from around the world to engage in multi-disciplinary discussions and issue policy recommendations on the legal, ethical, and political issues of national security

warfare, and national governance. CERL offers the opportunity for an undergraduate to join the CERL team in summer 2021 and engage in activities that will advance both his/her research skills and subject matter knowledge as well as CERL's mission to promote and preserve the rule of law. The student will work in the two areas below.

Project 1: National Security and the Threat of Violent Extremism

When citizens of the United States consider the threat of terrorism, they tend to think in terms of threats posed by groups and individuals outside of our borders. The 9/11 terrorist attack was by any measure the most vivid example within the United States of the threat posed by external groups. Yet the threat of terrorism does not arise just from members of external groups like Al Qaeda and ISIS. Increasingly, the threat arises from groups within western democratic societies, especially from the resurgence of groups and individuals espousing white nationalism and white supremacy. Dealing with the national security threats stemming from violent extremism pose unique problems for countries with longstanding traditions in law and in practice of political freedom and freedom of speech. CERL will hold a two-day conference to examine the nature and extent of these problems posed by violent extremism and possible tools for addressing them. The student will help CERL bring this conference to fruition through his/her research and recommendations in the subject area and qualified experts as speakers. The student will also be mentored by Richard Meyer, CERL's interim executive director.

Project 2: 20 Years after 9/11: Failed Accountability for Illegal Acts of State and Lasting Damage to the Rule of Law

In the aftermath of 9/11, Congress passed the 2001 Authorization for the Use of Military Force (AUMF) granting the president sweeping authority to "use all necessary and appropriate force against...nations, organizations or persons...in order to prevent any future acts of international terrorism against the United States." That act and the subsequent 2002 Iraq AUMF, led to the invasion of Afghanistan and Iraq; the creation of the Guantánamo Bay Detention Camp (Gitmo); the authorization of a Rendition, Detention and Interrogation program; and other distortions of the law to permit illegal acts, and the United States is still grappling with their consequences. To address the fallout of these past actions, CERL will hold a two-day closed-session conference with a keynote presentation open to the public. The student will help CERL bring this conference to fruition through his/her research and recommendations in the subject area and qualified experts as speakers. The student will also be mentored by Richard Meyer, CERL's interim executive director.

Paul Robinson

The Social Cost of Failures of Justice: Getting Away with Murder

**My project can be completed entirely remotely*

Most criminal law scholarship focuses on identifying and reforming the criminal justice system's rules and practices that regularly produce serious injustice, as perhaps it should. Commonly

ignored by academics are the causes of failures of justice – where the system fails to give serious offenders the punishment they deserve – and the social damage that such regular failures produce.

Because of the difficulty of accurately reconstructing past events, especially if the victim is now deceased, it is inevitable that some murderers will escape punishment. As long as a society imposes a high standard of proof for criminal liability, as it should, especially for a serious offense that has serious punishment consequences, there is little that can be done to avoid these kinds of failures of justice other than by attempting to improve investigative techniques and technology. There can be little dispute that the “beyond a reasonable doubt” standard remains essential to a fair, just, and effective criminal justice system. Without it, the system could hardly earn the moral credibility that leads most people to defer to it and to comply with its demands.

In other areas, however, the criminal justice system has chosen to sacrifice doing justice in order to promote some other interest. Limits on successful investigation can arise, for example, from concerns about personal privacy interests as expressed in search and seizure limitations on the police and limitations on data collection and sharing with police. Limitations on successful investigation can also arise from hostile community norms such as the “stop snitching” movement or from the failure to effectively control witness tampering or intimidation.

Even where the case facts are well established, a number of criminal law doctrines can regularly impede prosecution, thereby producing streams of failures of justice. The exclusionary rule, the double jeopardy rule, the legality principle, plea bargaining, and a host of other legal doctrines and practices commonly bar the conviction of clearly guilty offenders. These rules are not mindless mistakes but rather instances in which doing justice is sacrificed in order to promote some other legitimate interest. Nonetheless, one may ask whether the balance of interests struck by these doctrines is appropriate, especially where the balance was originally struck by unelected judges in an earlier era and, some may argue, today a different balance would better promote society’s best interests.

Finally, even where the case facts are clear and prosecution is successful, many aspects of the current criminal justice system regularly allow the serious offenders to escape the punishment they deserve. Unchecked judicial sentencing discretion, executive clemency and pardon, and special sentencing rules for some offenders, such as corporations, regularly invite failures of justice.

The project will include selecting real-world cases to illustrate the failure-of-justice problem, collecting available public information about those cases and preparing a case narrative for each, as well as collecting academic literature on failures of justice and their social cost. The materials will provide the basis for the course materials in the Law School’s Criminal Law Theory Seminar next year, and subsequently for a scholarly publication.

Medicine

ANESTHESIOLOGY AND CRITICAL CARE

Maurizio Cereda

New imaging markers of inflammatory progression in acute respiratory failure

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

The goal of our research is to find new strategies to attenuate - or prevent - severe acute respiratory distress syndrome (ARDS), with the ultimate purpose of developing more targeted lung protective strategies (including innovative modalities of mechanical ventilation and new drugs). Characterized by diffuse inflammation of both lungs, ARDS is a hypoxic syndrome that has no specific treatment and causes patients to require mechanical (artificial) ventilation to survive: 64% of them will eventually die. Preventing severe ARDS could be the best way to reduce mortality.

Using large animal models of injury, we concentrate on the mechanisms that lead to topographical dissemination of initially localized or mild pulmonary inflammation (e.g. acid aspiration). The combined use of CT and MRI allows us to obtain morphological and functional information on pulmonary responses to lung injury and mechanical ventilation. Our laboratory has perfected a realistic model of early lung injury in pigs, in which we measure injury propagation using multimodal high-resolution imaging. The animals are on a mechanical ventilator in a simulated ICU environment for 24 – 30 hours. Our imaging armamentarium includes serial computerized tomography and hyperpolarized magnetic resonance imaging, in addition with tissue and blood biomarkers of inflammation; we are studying the functional and biologic consequences of illness and therapy. Our studies will enable personalized treatment of patients with acute respiratory failure.

Students will assist in data collection and analysis, with particular involvement in 3D image processing, facilitated by various analysis techniques including deep learning. For those interested, students can learn animal preparation and surgery techniques, manage mechanical ventilation and other life support techniques, run the biological experiments associated with the project, and perform tissue analysis. Importantly, the students will be exposed to a research environment where the focus is to rapidly narrow the gap between basic research and clinical investigation in critical care. Dr. Cereda has extensive experience in mentoring undergraduate students. He has recently supervised Rachleff Scholarship and PURM recipients and has been involved with the BE 400 preceptorships since 2006.

Meghan Lane-Fall

Handoffs and Transitions in Critical Care

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

Post-surgical handoffs of patients requiring intensive care threaten patient safety. Within the hospital, these patients are transferred from one site and team of care to another, and they are often incapacitated and thus unable to participate in their care. Loss of critical information occurring in the transition process predisposes to error and preventable harm. The Handoffs and Transitions in Critical Care (HATRICC) project is employing qualitative and quantitative methods to improve and measure the postoperative handoff process in two Penn surgical intensive care units. This project is a multicenter offshoot of work started at Penn in 2014, with the multicenter component due to start data collection in Spring 2021. In our prior work, we created and implemented a standardized operating room to intensive care unit handoff process. We now seek to spread and scale that work to other U.S. academic medical centers. Students joining the project over the summer will participate in study data collection in Penn hospitals. The student would join a team including other research assistants, a postdoc, and several faculty members.

Responsibilities will include in-person observation of handoffs, collection of survey data, attendance at study team meetings, and other related tasks as needed. Students will learn about qualitative and quantitative research, implementation science, and human factors engineering. There will be opportunities to shadow clinicians (physicians, nurses, and others involved in patient care) from intensive care, anesthesia, surgery, and trauma. This opportunity is ideal for students with some clinical experience (e.g. EMT, medical scribe, hospital volunteer), but we will consider all interested students. Interested students will be able to continue participation in the project after the summer. Seven Penn undergraduates have worked on this project since 2014. Previous students involved in this project have been co-authors on manuscripts, have started their own independent offshoot projects, and have tended to pursue health professions training (e.g., medicine, nursing) after college. For more information about this project, please visit our website at <http://www.hatricc.com>.

Krzysztof Laudanski

Topics in Critical Care and the ICU

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Emerging Technologies in Critical Care

The project explores the existing workflow in the work of the critical care unit. We map the duties and responsibilities of the attendings, advance providers, nurses, and administrative staff. After establishing the workflow and workload using the biosensors and locators, we survey stress-related work in the unit. Finally, we suggest potential in workflow implementation by application of modern technologies, including artificial intelligence-driven algorithms.

Student responsibility will be to conduct a survey assessing the staff's effectiveness and readiness to implement new technologies in their workflow. Also, a student will conduct a TLX survey to assess work demand. Students will learn how to design, conduct and evaluate surveys aimed at improvement of the workflow. They will also conduct a supervised literature search to determine the barriers to implementing modern emerging technologies like artificial intelligence.

Immunological Recovery after ICU

Recovery from sepsis remains a poorly characterized phenomenon. Functional and developmental plasticity of immune systems allows for an optimal adjustment of the immune response to the post-critical care lines milieu. Our study investigated whether persisted activation of leukocytes is responsible for long-term immuno-aberrations in the aftermath of illness. In this project, the individual will be tasked with managing samples from patients using histological and molecular biology techniques. More precisely, students will measure the activation of leukocytes in the brain, spleen, kidney and brain and link them to in vivo traits of immuno-aberrancy. We will focus on both morphological, protein, and epigenetic levels of immune system activation. These data will be correlated to clinical outcomes.

A student will be interviewed to create the best plan for the development of their talents. He/she may be tasked with collecting clinical data, conducting molecular biology techniques, and prepare manuscripts and databases.

Aaron Masino

Machine learning methods and analysis of unstructured electronic health record data

**My project can be completed entirely remotely*

The Masino Lab is co-located within the Department of Anesthesiology and Critical Care, and the Department of Biomedical and Health Informatics. We are computationally focused with an overarching goal of improving child health and healthcare through the development and application of artificial intelligence (AI) methods. Our research utilizes multimodal healthcare data, including structured electronic health record information, radiological images, streaming vital signs, and clinical text, to better understand and diagnose childhood disease.

In all projects, the student will participate in data acquisition and pre-processing, model development, and model performance evaluation. If the specific project is successful, and the results are publishable, the student would be listed as a coauthor on relevant papers.

Project 1: Machine learning analysis of physiological data for adverse event prediction

The objective of this project is to incorporate physiological data (e.g. heart rate) measured every few seconds in operating room (OR) and intensive care unit (ICU) settings into machine learning models that predict specified adverse events (e.g. cardiac arrest, sepsis). Model development and analysis will involve many aspects of applied machine learning research including feature engineering, feature selection, and design of evaluation for model comparison.

Project 2: Trustworthy AI for Pediatric Acute Respiratory Distress Syndrome

The objective of this project is to develop novel deep learning models integrating radiological images and clinical data for automated diagnosis of pediatric acute respiratory distress syndrome. To facilitate clinical adoption, the project also seeks to present explanatory information for individual predictions and to assess the impact of such explanations on clinician trust in the AI system. Model development and analysis will involve many aspects of state-of-the-art deep learning model development and explainable AI methods.

Prerequisite: Students should have competency in Python programming for all projects. A background in machine learning is helpful, but not required.

Huafeng Wei

Intranasal dantrolene for treatment of Alzheimer's disease

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

We are investigating the efficacy, mechanisms and side effects of repurposing dantrolene for treatment of Alzheimer's disease (AD). Dantrolene is the only FDA approved drug to treat malignant hyperthermia. Our preclinical studies in both cell cultures and animal models suggested that dantrolene can be an effective drug treatment of Alzheimer's disease, even as a disease modifying drug. Our recent study further demonstrated intranasal dantrolene increased its brain concentrations and duration, making it more suitable for chronic use in AD patients.

The undergraduate student will be involved in the projects in either cell culture or animal model models. He or she will be working under lab staff supervision on daily cell culture, experiments on cell damage and measurement of intracellular calcium and reactive oxygen species (ROS) concentrations. In animal study, the student is expected to help collect blood and tissue, brain sectioning and histology. The student is also expected to assist data collection, analysis and manuscript writing. Remote learning and work is available.

Ian Yuan

Processing and analysis of EEG data

**My project can be completed entirely remotely*

Overview: Through this project the student will gain experience in signal processing and machine learning of clinical data. I have repositories of time-series EEG (electroencephalography) and Near-infrared spectroscopy (NIRS) data collected from infants and children under anesthesia and sedation. The goal is to apply traditional signal processing techniques (power spectrum, etc...) and modern techniques (machine learning) to analyze these data to correlate with clinical endpoints. The student will be listed for authorship on any publications that include the student's work.

Expectations: The student will be expected to conduct most of the data analysis in Matlab, read research papers to understand analysis techniques, and have bi-weekly meetings to discuss progress.

Skills: Prior programming experience is required, preferably in Matlab. Prior signal processing experience is preferred but not required.

All of the student's work can be done online/remotely.

BIOSTATISTICS, EPIDEMIOLOGY, & INFORMATICS

Yong Chen

Next generation data sharing and evidence synthesis for advancing research on COVID-19

**My project can be completed entirely remotely*

Next generation data sharing of electronic health records data via distributed regressions

With the increasing availability of electronic health records (EHR) data, it is important to effectively integrate evidence from multiple data sources to enable reproducible scientific discovery. However, we are still facing practical challenges in data integration, such as protection of data privacy, high-dimensionality of features, and heterogeneity across different datasets. In this project, we will investigate novel data sharing strategies for integrating EHR data from different data sites within a distributed research network. We aim to develop non-iterative and privacy-preserving algorithms to handle clinical heterogeneity across different sites, as well as non-standard data structure. The methods will be used to real world settings, including PCORnet and OHDSI. For more information, please visit: <https://pdamethods.org/>, or our research website: <https://pennil.med.upenn.edu/>.

Extracting evidence from preprints on COVID-19 research

As of May 23, 2020, there are more than 30,000 manuscripts on COVID-19 published or posted at PubMed, BioRxiv, and MedRxiv on COVID-19 from researchers all over the world. These manuscripts cover a wide spectrum of important topics that can help us to understand the critical aspects of clinical and public health impacts of COVID-19, including the disease mechanism, diagnosis, treatment, and prevention as well as viral infection, replication, pathogenesis, transmission, host-range, and virulence. On the other hand, the amount of information is increasingly overwhelming for clinicians, policymakers, researchers and other stakeholders to process and appraise. A systematic review, which is a type of literature review that uses systematic methods to collect secondary data and critically appraise research studies, can be useful in summarizing the existing evidence of COVID-19 related research findings. We aim to develop novel computational methods to properly extract evidence from preprints in a semi-automated fashion. In particular, we will develop a novel quality score, which can be treated as a weight in the meta-analysis. Study level characteristics will be extracted to construct such quality

score. For more information, please visit: <https://xmeta.org/>, or our research website: <https://pennsil.med.upenn.edu/>.

Dokyoon Kim

Integration of electronic health record (EHR) with genomics

**My project can be completed entirely remotely*

Precision medicine, an emerging approach for disease prevention and treatment strategies based on patients' environmental and genomic variabilities, is moving toward a new era of future medicine. In the past decade, comprehensive collections of disease diagnosis data are becoming available, primarily data from electronic health records (EHRs). The wealth of information within an EHR can be leveraged to improve our understanding of the genetic architecture of human disease by characterizing a landscape of genetic associations across many different measures such as disease diagnosis codes and clinical laboratory tests via Phenome-wide association studies (PheWAS). Dr. Kim's group has analyzed the EHR-linked biobank data to investigate the genetic architecture of many complex diseases. In particular, linking the disease comorbidity patterns to genomic data holds great potential to uncover molecular mechanisms of disease. We have constructed human disease phenotype map to provide a landscape of intra-connections within the same disease classes, as well as inter-connections across disease classes. Our overarching goal is to identify key conditions and shared genetic factors influencing comorbidity, which might constitute new tools for clinical prevention and monitoring. With regard to testing new hypotheses, one of the most significant advantages of our approach is the single-source EHR linked to genomic data; it provides an opportunity to revisit individual-level genotype and phenotype data to design more targeted studies and ask more specific questions. Thus, this goal is very much an emphasis in today's climate of precision medicine, where treatment and prevention are ideally designed to consider an individual patient's variability in genetics, lifestyle and environmental exposures.

In this project, we will construct a disease comorbidity map of 2.1 million patients using longitudinal EHRs in Penn Medicine (Aim 1), construct a disease-gene map derived from phenome-wide association study using Penn Medicine Biobank Participants (Aim 2), develop a novel scoring system using graph-based machine learning method and predict comorbidity risk scores (CRS) for a given disease (Aim 3), and implement an interactive visualization software to allow the research community to explore the relationships between diseases, disease trajectory and causality models between comorbid conditions, and shared genetic variants (Aim 4).

Li Shen

Informatics and Machine Learning Strategies for Analyzing Brain Imaging Genetics Data in Alzheimer's Disease

**My project can be completed entirely remotely*

The central theme of my lab is focused on developing computational and informatics methods for integrative analysis of multimodal imaging data, high throughput “omics” data, cognitive and other biomarker data, electronic health record data, and rich biological knowledge such as pathways and networks, with applications to complex disorders such as Alzheimer's disease (AD). The following are two specific projects designed for two PURM students, who are expected to work closely with myself and my team members to perform integrative analysis of brain imaging genetics data from landmark AD studies.

In Project 1, we will develop and apply statistical and informatics methods to identify genetic factors strongly associated with AD-related imaging endophenotypes. The identified imaging endophenotypes and their associated genes and variants will provide valuable information to help deconvolute mechanistic complexity and lead to a better understanding of disease subtypes.

In Project 2, we will develop and apply machine learning and deep learning methods that integrate genetics and imaging data to predict cognitive and clinical outcomes. Integrating genetics with imaging data can improve the prediction accuracy for clinical outcomes, and enable precision diagnosis and prognosis with reduced cost, invasiveness and scanning time.

Participating in these projects will provide the students experience with brain imaging genetics, bioinformatics, machine learning and AD research. Basic knowledge of computer science and statistics and basic experience with quantitative analysis and programming would be helpful. Both projects can be done entirely remotely. More information about relevant research activities can be found at <https://www.med.upenn.edu/shenlab/research.html>.

Ryan Urbanowicz

Machine Learning Strategies for Mining Complex Patterns from Biomedical Data

**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. The URBS-lab is focused on investigating interpretable ML and artificial intelligence methods that can select features and generate predictive/interpretable models, in the presence of complex associations. Tackling these challenges can improve: our understanding of disease etiology, risk prediction, and personalized medicine.

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.

Expectations: Student(s) will gain experience in ML development, statistical analysis, data visualization, and/or working with clinical/genetic data. The goal is to publish a peer-reviewed publication. Student(s) will be listed as a co-author assuming project is successful and publishable.

Project-1: Implement/evaluate novel feature selection strategies. Expand on our previous work towards better performance in ‘big data’, while accommodating different data types, noise, and complex patterns. Focus will be on improving cores strategies, integrating them as ensembles and/or scaling them up to ‘big data’.

Project-2: Implement/evaluate a novel rule-based machine learning (RBML) algorithm. RBMLs are cutting-edge ML approaches that are uniquely interpretable and sensitive to complex patterns. Focus here on methods that improve interpretability, performance, and ease of use.

Project-3: Develop/apply ML methods and pipeline for biomedical data analysis (genetic and/or EHR). Collaborate on analysis of one or more investigations of clinical/disease outcomes (e.g. graft rejection, pancreatic cancer, obstructive sleep apnea, congenital heart disease, pulmonary hypertension, and addiction).

CANCER BIOLOGY

Lewis Chodosh

Mechanisms of Breast Cancer Dormancy and Recurrence

**My project can only be completed if on-campus activities resume*

The Chodosh laboratory uses genetically engineered mouse models, patient samples and bioinformatics to understand the mechanisms by which cancers develop, progress to more aggressive states, and ultimately contribute to cancer mortality. A broad array of basic and translational research approaches are used to address problems of fundamental clinical importance to cancer patients by elucidating pathways and principles common to human cancers. These approaches encompass genetics, genomics, molecular biology, biochemistry, cell biology, computational biology, functional imaging, animal studies, preclinical trials and clinical investigation. Particular areas of interest include: pathways regulating cancer development, metastasis, tumor dormancy and recurrence; the use of genomics and computational approaches to understand genetic programs in cancer; the impact of obesity on cancer recurrence; the mechanisms by which pregnancy protects against breast cancer; and the use of non-invasive imaging approaches to study tumor biology.

Breast cancer is the leading cause of cancer mortality in women, mainly due to incurable metastatic recurrence arising after initial treatment. Recurrent tumors arise from a presumptive pool of residual tumor cells (RTCs) that persist in a dormant state after treatment. The mechanisms enabling dormant tumor cell survival and recurrence are poorly understood. Hence, identifying the pathways underlying tumor dormancy and recurrence is critical to reduce breast cancer recurrence and mortality. Our laboratory has developed genetically modified mouse models for human breast cancer that recapitulate key steps during breast cancer progression. Transgenic mice that conditionally express the HER2/neu oncogene (MTB/TAN mice), develop mammary tumors upon oncogene induction, and conversely, tumors regress following oncogene down-regulation. However, a small number of RTCs survive oncogene inhibition and persist in a dormant state, and ultimately seed spontaneous recurrent tumors. To explore potential pathways that may be required for RTCs survival, our lab generated gene expression data sets from MTB/TAN derived tumor cells in dormancy. Interested students will have a critical role in validating candidate pathways mediating RTC survival. We are interested in recruiting one student who will be mentored by a graduate student, Brian Benz. The student will learn the basics of cell culture (to perform in vitro dormancy assays), cytometry and digital droplet PCR (to quantify the proliferating tumor cells), and fluorescence microscopy (to define the activation status of signaling pathways in dormancy). Previous lab experience is not a prerequisite; we can adapt the project to the student's skill set and interest.

Roger Greenberg

Protein quality control in DNA replication

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

DNA replication is essential for the genome maintenance in all dividing cells. Errors in DNA replication are responsible for a wide range of human diseases, spanning development, autoimmunity, and cancer. DNA replication forks contain an estimated 500 different proteins. This astounding number of proteins is thought to be necessary to maintain replication fork stability and prevent errors in DNA synthesis that cause DNA damage. Using a protein purification approach, we identified a four-membered protein complex that consists of two triple AAA ATPases. This complex works as a molecular machine to unravel DNA replication proteins and allow proteases to cleave them into smaller fragments. This novel mechanism of protein turnover is necessary for DNA replication and genome stability. Mutations in one of the genes for this complex occur in a human developmental syndrome, attesting to its importance in human disease. Undergraduate students will work on the cellular and biochemical features of this complex that allow it to recognize substrates and denature then for protease mediated cleavage.

Sandra Ryeom

Lung Metastasis and the tumor microenvironment

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

Our lab is utilizing human lung organoids (mini lungs in a dish) to understand how normal lung endothelial cells and fibroblasts are activated in response to tumor-derived media to generate a pre-metastatic niche, a hospitable site for circulating tumor cells to colonize and expand in the normal lung. A summer project will include screening tumor conditioned media for exosomes and other extracellular vesicles and generating human lung organoids.

Junwei Shi

Development of new CRISPR toolkit for genome engineering

**My project can only be completed if on-campus activities resume*

Our lab contributes to the scientific community by designing CRISPR based tools and methods to further study and manipulate the human genome. We are looking for a student to work alongside an MD/PhD candidate in the lab over the 10-week summer, and we are hoping that this will transition into a long-term commitment. We have an excellent track record of students and techs entering graduate programs and medical school after their time in our lab, and we hope that this experience will provide longitudinal mentorship.

CRISPR is a gene-editing technology that couples the elegance of base complementarity with the enzymatic activity of a DNA nuclease, and this technology has been engineered to knock-out genes, conduct cancer screens, insert functional sequences, and inhibit RNA expression. We are designing tools in several of these areas. While working alongside a MD/PhD candidate, the student will learn basic laboratory techniques, such as tissue cell culture, flow cytometry, CRISPR knock-out, plasmid purification, and cloning. While this summer will focus on the development of these techniques, we hope that a student will be capable of working independently and taking on their own project in the future with less supervision.

Qualified applicants will have a strong scientific background, excellent organizational skills, and a desire to be a team player. While students from all schools and all majors are welcome, we are particularly interested in STEM major students who are looking for a long-term research commitments.

CARDIOVASCULAR MEDICINE

Sharlene Day

Hypertrophic cardiomyopathy: disease mechanisms and developing new therapies

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

The Day lab is interested in genetic heart muscle diseases. We have a translational research program that focuses on hypertrophic cardiomyopathy. We want to understand the primary effects of sarcomere gene variants in cardiac muscle cells and how we can reverse the effects of these variants to develop new therapies. This project uses cardiac myocytes derived from inducible pluripotent stem cells and also mice to identify members of the heat shock protein 70 family that regulate levels of myosin binding protein C, which is the major gene mutated in hypertrophic cardiomyopathy.

Anjali Owens

Characterizing the Frequency of Familial Dilated Cardiomyopathy in a Population of Patients with End-Stage Heart Failure

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Familial dilated cardiomyopathy (FDCM) is an increasingly recognized cause of end stage heart failure. Current data suggest that the majority of FDCM is undiagnosed at the time of listing for heart transplantation. Diagnosing FDCM in individuals has significant implications in terms of the need for cardiovascular risk assessment and stratification for the family members of these individuals. Penn has a robust clinical program for the care of patients with end stage heart failure including advanced therapies such as left ventricular assist devices and heart transplantation and offers renown expertise in cardiovascular genetics and inherited diseases.

In this project, the student(s) will work with a team of investigators (physicians, nurses, genetic counselors, research coordinators) to characterize the frequency of FDCM in the Penn population of patients who are awaiting and have undergone heart transplantation. In collaboration with team members, the student(s) will elicit family history information from patients and help construct 3-generation family pedigrees. Based on these results, the student(s) will assist the research team in identifying at-risk family members who would benefit from clinical cardiovascular evaluation. The student(s) will gain experience working in a multidisciplinary health care setting, and this project has the potential to significantly impact clinical practice. The student(s) will learn clinical research skills including observational study design, cohort creation, record retrieval, and phenotyping. The student(s) 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. Along with Dr.

Anjali Owens, Nosheen Reza, M.D., an advanced heart failure and transplant cardiologist and emerging translational researcher, would be involved in mentoring the student(s).

Victoria Vetter

Sudden Cardiac Death Prevention in Youth: Heart Safe Schools in Philadelphia

**My project can be completed entirely remotely. 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. SCA is the third leading cause of death in the United States (US), with over 350,000 out-of-hospital sudden cardiac arrest/year, one every two minutes. In addition, SCD claims the lives of approximately 7000 US children and adolescents yearly. Sudden cardiac death can be prevented by using cardiopulmonary resuscitation (CPR) and automated external defibrillators (AEDs), small portable computerized devices that deliver an electric shock (current) to the heart to restore the normal heart rhythm. While survival in the community is only 10-12% after a SCA, survival in a school with an AED and emergency response plan can be over 85%.

Youth Heart Watch (YHW) is a sudden cardiac arrest and sudden cardiac death prevention program at the Children's Hospital of Philadelphia (CHOP) whose aim is to prevent sudden cardiac death among children and adolescents by serving as a resource to help schools develop AED programs and save lives. The Heart Safe School program certifies schools who have a program in place to save lives from SCA.

In Philadelphia, all public high schools, middle schools and elementary schools have AEDs, but many do not have AED programs with the necessary procedures, policies, and training to make their schools heart safe. Pennsylvania State Law (ACT 35: 2014) mandates that schools report the presence and status of their AEDs. While schools in the School District of Philadelphia (SDP) have AEDs, many do not have a Cardiac Emergency Response Plan (CERP) outlining the policies and procedures with steps to have in place to be prepared to respond to a cardiac emergency. Despite COVID, the SDP has been meeting virtually with Youth Heart Watch with plans to implement our Heart Safe School (HSS) program. This HSS program incorporates a CERP and a Cardiac Emergency Response Team in each school. The SDP aims to be the largest urban school district to have all their schools Heart Safe by the Fall of 2021.

This year, we are focusing on having the schools comply with a set of criteria that would include a CERP in their AED program to become Heart Safe Schools. Using the template of our REDCap (scientific database), the SDP has a database of all schools' AEDs. These data can be exported to our REDCap database for further analysis and evaluation. The student will participate in entering data into REDCap and evaluating the data. The student will help with implementation of the Youth Heart Watch School AED Program in these schools as we use these data to determine best practices for our program. Under our supervision, the student will interact directly with the SDP health and athletic office leadership and when needed, with the individual

schools to determine the current status of their AED and AED program to determine the determine if the school meets the HHS criteria. This is an ongoing activity and the student could participate in virtual visits to the schools to see how an AED based Emergency Medical Program in the schools is implemented.

The student will learn CPR and AED use and assist in instruction in the schools for which we have a virtual template until in person visits are possible. In addition, the student would have the opportunity to shadow pediatric cardiologists in their clinics at CHOP, learn how to read electrocardiograms, and learn about cardiac conditions that are associated with SCA and for which AEDs may be needed (SCD Curriculum with 10 lectures). The student will also learn research study design, data entry and collection and data analysis. While the district is willing, there are many steps necessary to complete this effort. The PURM summer student will work with the District Leadership HSS committee and YHW to document the necessary steps. They will record all the required criteria in REDCap and identify the Barriers and help create solutions so all our Philadelphia schools will be Heart Safe Schools. If COVID permits, we will travel to school to help them implement their plans, but if not, we have and will create videos to illustrate the steps in this process. We plan to identify a Pennsylvania state legislator who will support introduction of a Bill to require all Pennsylvania school entities to become Heart Safe and to have a Cardiac Emergency Response Plan. While PA does not have a law mandating AEDs, a school cannot become Heart Safe without an AED. The PURM student will learn about the legislative processes involved in sponsoring a bill such as the Heart Safe School bill. They will learn advocacy skills, how science can be the foundation of legislative efforts, and how public health reaches far beyond the medical office.

This study could accommodate 2 students.

DERMATOLOGY

Todd Ridky

Sex Differences in Cancer

**My project can only be completed if on-campus activities resume*

For most cancer types, incidence and mortality are higher in males than in females, even after controlling for known epidemiologic risk factors. Although this sex difference has been appreciated for at least 70 years, the mechanism(s) responsible are only now emerging.

Recent discoveries in our lab indicates that sex steroid signaling through nonclassical receptors is likely a major driver of the disparate cancer outcomes between males and females. These previously understudied estrogen and testosterone receptors are expressed in most cancers, but their function is not well defined, and there are no approved drugs that target them. The overarching goal of this PURM project is to contribute to our effort to define molecular and

cellular mechanisms underlying sexual dimorphisms in cancer, in order to develop safer and more efficacious sex-specific therapeutic strategies. In one early example of the potential utility of the approach, we worked with the Penn Center for Innovation to launch a new biotech company, Linnaeus Therapeutics, that has now advanced a new small molecule from our lab to phase II trials in people with advanced cancer. That effort started as a Ph.D. thesis project for one of our Penn grad students who is now VP of Research for the company he cofounded. Trainees in the lab have opportunity to experience and actively participate in some aspects of preclinical drug development.

For much of our preclinical studies, the Ridky lab uses new experimental melanoma platforms that have the potential to dramatically improve our understanding of cellular processes driving the progression from normal cells to malignancy. Because most current models used in cancer research do not include human cells within intact human tissue, they often provide misleading results that fail to translate into meaningful advances for cancer treatment and prevention in people. For this PURM project student will learn to engineer entirely human, 3-dimensional, genetically defined (3-D) tissue models of cancer progression that are more faithful, cheaper, faster, and higher throughput than many current cancer models. Engineered cancer tissues will be designed to reflect the actual mutations and genetic changes that occur frequently in tumors from patients. This new experimental platform will be coupled with bioinformatics approaches to comprehensively identify and functionally validate critical elements necessary for cancer progression and to identify factors that differentially affect cancers in males vs females. Students will work with Dr. Ridky and lab trainees to gain hands on experience with primary cell culture, tissue engineering, as well as more conventional cancer models.

Prerequisites include a genuine interest in scientific discovery, curiosity about the natural world, keen skills in observation, and strong work ethic. Introductory courses in biology, chemistry, and genetics are helpful but not absolutely required. Unfortunately, this type of work can't be done remotely. It is hoped that successful students will start in the summer and then continue in the lab for their remaining years at Penn.

John Seykora

Mechanisms regulating early skin cancer

**My project can be modified to accommodate remote activities if made necessary by University policy, My project can only be completed if on-campus activities resume*

This project will involve investigating the roles of specific genes that promote the early stages of skin cancer. The studies will involve examining the impact of a number of immunoregulatory genes including TSLP and IL-15. Studies on gene families known to be mutated during the early stages of skin cancer will also be performed. Students will be asked to assist with a range of standard and specific experimental procedures used in the laboratory. Students will receive training from experienced lab personnel. Students will become familiar with how to investigate disease mechanisms of skin cancer and will see how new therapeutic approaches to this common disease are developed.

EPIDEMIOLOGY

Blanca Himes

Effects of Air Pollution and Environmental Variables on 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, COPD and COVID-19. 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) to identify relationships among environmental and health-related variables. Data analysis will be performed 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.

Anne Marie McCarthy

Disparities in endometrial cancer outcomes

**My project can be completed entirely remotely*

Students will have the opportunity to begin a brand new research project in cancer epidemiology, mentored by Dr. Anne Marie McCarthy. Dr. McCarthy's expertise is in breast cancer screening, evaluating risk of aggressive breast cancers, and disparities in the risk of breast cancer. The student research assistant will help to expand this work into the realm of endometrial cancer by researching disparities in diagnosis and outcomes between African American and Caucasian American women. Primary duties will involve conducting literature reviews on endometrial cancer disparities and assisting with data analysis by pulling descriptive statistics, running statistical models using STATA software, and preparing tables for publication.

This research will contribute to our understanding of the epidemiology of endometrial cancer, its risk factors, and reasons for the disparity of outcomes between Black and white women. As this research will be conducted using existing data from breast cancer research studies, there is also an opportunity to better understand the links between breast and endometrial cancer. This opportunity is suitable for students interested in public health, health disparities, and data analysis.

Students will gain significant knowledge and skills in epidemiological research, including an understanding of the basic descriptive epidemiology of endometrial cancer, racial/ethnic disparities in endometrial cancer, basic principles of epidemiologic study design, familiarity with STATA statistical software and statistical models, and experience interpreting results of

statistical analyses. Students will also gain general professional experience working in a research environment and working as part of a research team. This project can be done remotely.

GENETICS

Zhaolan Zhou

Modeling Neurodevelopmental Disorders in Mice *1st year applicants only*

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

We have two projects aiming to gain insights into the pathophysiology of Rett syndrome and CDKL5 Deficiency Disorder

Rett Syndrome (RTT) is a neurodevelopmental disorder characterized by developmental regression, motor dysfunction, and cognitive deficits. The majority of RTT cases are associated with mutations on an X-linked gene encoding MeCP2, a methyl-CpG binding protein involved in organizing chromatin and modulating gene expression. To understand the molecular pathogenesis of RTT, we have developed mouse models recapitulating RTT-associated mutations. In this project, we seek an undergraduate student to join our team to investigate how an RTT mutation disrupts the molecular function of MeCP2 and leads to RTT-like behavioral phenotypes in mice. A variety of molecular and cell biology and microscopy techniques will be gained from this study.

CDKL5 deficiency disorder (CDD) is a disorder caused by genetic defects in the X-linked gene encoding cyclin-dependent kinase-like 5 (CDKL5). Patients with CDD show early onset intractable seizures and severe neurodevelopmental impairment, and are frequently diagnosed with a number of disorders including Infantile Spasms. To gain insight into the pathogenic mechanisms underlying CDD, we have developed mouse models in which the CDKL5 gene can be ablated or rescued in a spatial and temporal controlled manner. In this project, we seek an undergraduate student to join our team to characterize the behavioral phenotypes associated with CDKL5 gain or loss, and to understand the nature of seizure development in these mouse models. Behavioral neuroscience and cellular neuroscience techniques will be gain from this study.

MEDICAL ETHICS AND HEALTH POLICY

Norma Coe

End of Life Care: Estimating the Effectiveness of 20 Years of Health System Reform

**My project can be completed entirely remotely*

End of life (EOL) care is intensive, expensive, and highly dependent on where one lives. Using a mix of claims, surveys, and hand-collected database of financial and health care system integration, this study will help explain the geographic variation in EOL care, identify which of our policies have the most influence over patients and providers, and uncover important variation by disease. The impact of this work will be identifying where future efforts for behavior change should focus in order to match patients' preferences to the care they receive at the EOL.

I am looking for a tenacious student who is comfortable conducting comprehensive internet searches, literature reviews, and reviewing state and federal websites that document health system reforms. In addition, students will have the opportunity to learn or expand their knowledge of programming in STATA, R, or SAS. The student will look for and synthesize information across the aims of the project:

Aim 1: Create and disseminate a database of health system reforms – at the insurer, hospital, local, and federal level.

Aim 2: Measure the effect of the health system reforms in changing the delivery of EOL care.

Aim 3: Separately estimate the effect of the health system reforms on planning vs. communication vs. facilitation of providing less-intensive EOL care to those who want it.

If the student is interested and available, there may be an opportunity to help with peer reviewed publications after the summer program has ended.

Harald Schmidt

Covid-19 vaccine allocation and social justice

**My project can be completed entirely remotely*

Covid-19 has had a disparate impact on disadvantaged groups, in particular, Indigenous, Black and Hispanic communities. Equitable access to Covid-19 vaccines can mitigate some of these disparities, but inequitable access will maintain, or worse, increase them. Building on an analysis of states and cities initial allocation plans (see: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3740041) there is more work to assess how allocation plans address equitable vaccine allocation. One particular area of interest is to clarify more fully the extent to which statistical measures of disadvantage (such as the CDC's Social Vulnerability Index, or the Area Deprivation Index) that have been noted in the Biden-Harris

administration's National Strategy for the Covid-19 Response and Pandemic Preparedness as well as a report on equitable vaccine allocation by the National Academies of Science, Engineering and Medicine, and in prior work of mine (for broader context, see: <https://onlinelibrary.wiley.com/doi/10.1002/hast.1113>) can mitigate inequities. The research will most likely be desk-based document review and be focused around applying a structured evaluation matrix. Depending on students' skill sets, interests and the progress of ongoing work with collaborators, research may also entail analysis of federal, state or city level data to assess vaccine coverage rates relative to disadvantage. A further related angle has to do with a review of the range of different types of disadvantage indices, and how these can inform post-Covid healthcare delivery (whether in rationing situations, or under regular resource allocation constraints).

MICROBIOLOGY

Kellie Jurado

Negative Regulation of Antiviral Immune responses

**My project can only be completed if on-campus activities resume*

Ironically, controlling inflammation is essential for survival of both host and pathogen. Millions of years of evolution has refined intricate immune regulatory networks in both host and in pathogen that are intended to prevent overt inflammation during infection for two very different purposes: to limit immune-mediated damage for host and to prevent eradication for pathogen. It is the main objective of my research group to define biologically-honed immune regulatory networks in both host and in pathogen, with aim to identify novel tactics for immunomodulation of disease at large. My research program at Perelman School of Medicine at The University of Pennsylvania focuses on negative regulatory networks that control antiviral immune responses. We do this from both a host and pathogen perspective. From the pathogen perspective, we use emerging viruses to understand how they manipulate host responses to aid their replication and cause pathogenesis. From a host perspective, we study specific tissues that have evolved intricate immune control mechanisms to prevent overt inflammation during infection due to their centrality to survival, such as the nervous system or placenta and our work aims to understand the mechanisms that underlie these phenomena.

The role of the student would be to assist a postdoctoral fellow in their work toward defining mechanisms of immune evasion by proteins expressed by viral pathogens. This would involve learning and applying cell and molecular biology techniques (nucleic acid extraction, western blot etc.).

Michela Locci

Long non-coding (lnc) RNAs regulating the biology of T follicular helper cells

**My project can only be completed if on-campus activities resume*

T follicular helper (Tfh) cells are a type of lymphocytes specialized in regulating high-affinity, long-lasting antibody responses against pathogens. The differentiation of Tfh cells is a complex multi-stage, multi-factorial process tightly regulated at the gene expression level. Long non-coding RNAs (lncRNAs), emerging as crucial modulators of gene regulation, are involved in a variety of biological processes and diseases. However, no studies have identified yet lncRNAs acting as specific regulators of Tfh cell differentiation. We have recently generated mice lacking selected lncRNAs that are specifically expressed by Tfh cells, in order to study the role played by such lncRNAs in the regulation of Tfh cell biology in vivo after immunization or viral infection.

The student involved in this project will perform experiments and contribute to the characterization of Tfh cell and antibody responses in various lncRNA knock-out mice after immunization with model antigens. By doing so, the student will learn various techniques required for mouse in vivo work (immunization, sample collection) as well as routine flow cytometry analyses. Moreover, by working under the supervision of a postdoctoral fellow, the student will familiarize with data analysis/interpretation and will learn to present data during weekly group meetings. This project will offer the opportunity to acquire basic immunology knowledge by working in a young and vibrant group.

We welcome a motivated student with good communication skills and work discipline. No particular prerequisites are required besides a strong interest in immunology. This project can be carried out only if in-campus activities are allowed.

Jay Zhu

Pathogenic bacteria-gut microbiome interaction

**My project can only be completed if on-campus activities resume*

Bacterial pathogens must have versatile gene expression profiles to adapt to environmental changes. During infection, pathogens sense various signals and adjust their virulence regulatory networks to overcome the colonization resistance of commensal microbiota. This project will use *Vibrio cholerae* as a model system to dissect the relationship between *V. cholerae* and other gut micro residence.

NEUROLOGY

Jay Gottfried

The Fine Structure and Function of the Human Olfactory System

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

Research in our lab focuses on the most unheralded yet most mysterious of the senses: smell. There are two unique and singular properties of the olfactory system. First, the olfactory system is virtually synonymous with memory, emotion, and decision-making, with projections from the nose terminating directly on limbic brain regions such as the amygdala, entorhinal cortex, and insula. These anatomical connections likely explain why smells are so often associated with memory "flashbacks" that reactivate potent emotional and autobiographical memories. The second intriguing property is that smell loss is often the very first symptom of neurodegenerative diseases such as Alzheimer's or Parkinson's, even before the emergence of overt symptoms and signs.

This PURM project will focus on characterizing the anatomy, circuitry, and gene expression profiles in human olfactory tissue samples obtained from autopsy patients and from patient biopsies. Students will have an opportunity to gain direct hands-on experience with sectioning human brain specimens, using immunohistochemical assays to stain the tissue, imaging the tissue slides on a confocal microscope, and analyzing the digitized data. These experiences should provide students with a solid conceptual and methodological foundation in wet-lab neuroscience and neuroanatomical techniques. Dr. Jay Gottfried, MD, PhD, is the PI of this project, and he and his colleagues, including research associate Dr. Lulu Korsak and research technicians Sarah Kwon and Sepideh Cheheltani, will all be directly involved mentoring the students. No prior experience is necessary, other than having an interest and curiosity in doing basic science research on human brains!

Roy Hamilton

Transcranial Alternating Current to Enhance Working Memory in Mild Cognitive Impairment and Early Alzheimer's Disease

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

The Laboratory for Cognition and Neural Stimulation (LCNS): The mission of the LCNS are to use noninvasive neuromodulation techniques in humans to better understand structure-function and network-function relationships in the brain that relate to cognition, and to use these insights to develop novel interventions for patients with neurologic diseases.

Project Description: Among cognitive abilities, working memory (WM)—a short-term memory process that enables the online maintenance and manipulation or reorganization of information that is no longer present in the environment—is fundamental to everyday functioning. WM plays

a critical role in everyday decision-making, problem solving, and goal-directed behaviors. While it is well understood that WM declines with advanced age and is affected in persons with dementia, it is often relatively preserved in comparison to other memory abilities in persons with amnesic MCI and early AD. Evidence also suggests that WM abilities may be amenable to training and other interventions. Importantly, because WM and related executive functions can potentially be employed flexibly to compensate for deficits in other cognitive domains, effective WM interventions may not only improve cognition within the domain of WM itself, but may also preserve overall cognitive and functional performance in persons with MCI or early AD.

The objective of this pilot proposal is to test the impact of a novel intervention combining a noninvasive brain stimulation (NIBS) technique, transcranial alternating current stimulation (tACS), with cognitive training in WM on neurophysiological electroencephalography (EEG) biomarkers underlying WM performance and behavior in a cohort of older adults with MCI or mild AD. We will specifically assess the efficacy of frontotemporal gamma tACS paired with WM training on the enhancement of theta-gamma phase amplitude coupling (PAC), gamma spectral power, and WM behavior in these patient populations. To do this, we will conduct a within-subject pilot study of active versus sham tACS paired with adaptive, computerized WM training. Behavior (mean accuracy and response time) and EEG during WM task performance will be assessed at baseline and post-intervention. Our central hypothesis is that active gamma-tuned frontotemporal tACS will significantly improve theta-gamma PAC and gamma spectral power over sham. We posit that this will associate with significantly enhanced WM performance in the active condition over sham from baseline to post-intervention.

Undergraduate Experiences in the LCNS: Students in the LCNS are generally expected to learn to administer brain stimulation, experimental behavioral measures, and neuropsychological tests, collect and analyze behavioral data, and participate in the interpretation and reporting of results. Undergraduates engaged in the project described above will be trained to deliver tACS, perform assessments of WM, and collect and code behavioral data. While there are no specific academic prerequisites, interest in cognitive neuroscience is strongly encouraged. Familiarity with statistics would also be advantageous. In the event that research cannot be conducted on campus due to the ongoing COVID-19 pandemic, the student's work will focus on coding, analysis, and reporting of previously collected behavioral data. In addition to acquiring the practical skills needed to implement their projects, students in the lab are also expected to read and summarize articles related to their research topic each week and to report their progress on their projects in lab meetings on a bi-weekly basis. Of note, undergraduates have co-authored a number of manuscripts in the LCNS and have been sponsored to present posters and platform presentations at regional and national scientific meetings. Finally, students in the LCNS receive career mentoring from the lab director and from advanced trainees (post-docs, graduate & medical students) in the lab.

Corey McMillan

Bioinformatics & Data Science Approaches to Heterogeneity in Neurodegenerative

Diseases 2nd year applicants only

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

The overall mission of the Penn Bioinformatics in Neurodegenerative Disease (BiND) Lab is to use multimodal and bioinformatic approaches to improve our understanding of the biological basis of age-associated neurodegenerative conditions. We focus on two disease spectra:

Alzheimer's disease (AD) and Primary Age-Related Tauopathy (PART): conditions that share common tau pathology but are differentiated by the presence or absence of amyloid pathology;

Frontotemporal Degeneration (FTD) and Amyotrophic Lateral Sclerosis (ALS): conditions that share common TDP-43 pathology and but present with a range of clinical syndromes.

By testing biologically-grounded hypotheses with the use of novel analytic and multimodal approaches, the Penn BiND lab integrates neuroimaging modalities with genomics and clinical datasets to address the biological basis of heterogeneity within these aging disease spectra. In the course of this work, our lab also develops robust biomarkers including novel neuroimaging techniques that can be used to better diagnose neurodegenerative diseases, accelerate drug discovery of disease-modifying agents, and define essential clinical trial endpoint measures for emerging therapeutic trials.

Example Project Areas include:

BIOLOGICAL AGING MECHANISMS ASSOCIATED WITH TAU PATHOLOGY AND NEURODEGENERATION

Another goal of our research is to use genetic approaches involving biological aging to understand the risk factors for the accumulation of neurofibrillary tau tangle (NFTs) pathology found in AD and PART. To date nearly all aging has defined age-related neuropathological risk in chronological measurements (i.e., years since birth). However, the rates of actual "biological" aspects of aging appear to differ between individuals, with some individuals displaying features of aging that are accelerated (biological age older than their chronological age) or delayed (biological age younger than their chronological age). The goal of this work, currently funded by a R01 (AG066152), is to investigate several genetic sources of biological aging mechanisms underlying risk and severity for NFT and A β molecular pathology and associated neurodegeneration. Our lab recently provided the first clinical and first genetic characterization of PART that distinguishes it from AD. A significant proportion of the aging population has varying levels of molecular pathology and this research will help establish mechanisms by which heterogeneity in biological brain aging impacts the development and progression of neuropathology and neurodegeneration.

NEUROIMAGING BIOMARKERS FOR THE DIAGNOSIS AND LONGITUDINAL EVALUATION OF NEURODEGENERATIVE DISEASES

Neuropathological studies have identified four major molecular sources of neurodegenerative disease, including TDP-43, misfolded tau protein, amyloid, and alpha-synuclein pathology. As we enter an era of clinical trials for disease-modifying agents it is critical to develop screening tools to facilitate the in vivo diagnosis of the molecular pathology causing disease in an individual patient. Several studies in our laboratory highlight the role of multimodal neuroimaging of grey matter with MRI and white matter with DTI for discriminating between pathological sources of disease. We also demonstrate the consequences of co-pathologies (e.g., alpha-synuclein and amyloid) on regional distributions of disease. Our studies also use cross-validation to evaluate reliability in novel cohorts and we often validate our neuroimaging observations of autopsy-proven samples with neuropathological analyses of tissue in the same regions. We are currently also pursuing several imaging studies related to detecting the earliest anatomic alterations in pre-symptomatic forms of familial FTD and ALS and evaluating novel PET tracers and high-field 7T MRI techniques for state-of-the-art in vivo characterization of neurodegenerative conditions.

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 the primary mentor, Dawn Mechanic-Hamilton, Ph.D. (neuropsychologist).

Xilma Ortiz-Gonzalez

Preclinical Drug screen in a zebrafish model of TBCK encephalopathy 2nd year applicants only

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

We are characterizing a zebrafish model for a pediatric neurodegenerative disorder, TBCK Encephaloneuronopathy. We anticipate having preliminary data to support a motor phenotype by summer 2021 using zebrafish automated behavioral characterization, which is currently occurring in our lab. We propose to test supplementation with branched chained amino acids in

vivo and characterize its effects in the motor phenotype of tbck-null zebrafish. This will be an ideal summer project as we anticipate the model will be established and it will be a learning opportunity for the student about preclinical animal studies

David Raizen

Finding genes that regulate sleep

**My project can only be completed if on-campus activities resume*

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. 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.

NEUROSCIENCE

Shinjae Chung

Neural circuit mechanisms underlying sleep and emotional regulation

**My project can be modified to accommodate remote activities if made necessary by University policy, My project can only be completed if on-campus activities resume*

Good quality sleep is essential for our mental health. Patients suffering from chronic stress or psychiatric disorders are often plagued by disrupted or insufficient sleep, and disturbed sleep has been shown to increase the risk of developing psychiatric disorders suggesting that the neural circuits controlling sleep are tightly inter-connected with circuits involved in emotional regulation and psychiatric disorders. The goal of the project is to identify the molecular and neural mechanisms controlling sleep and sleep homeostasis, and to understand how these are interconnected with the neural circuits regulating emotional states in health and disease.

Students will learn how to analyze sleep data obtained from stress experiments and optogenetic manipulation, and perform histological experiments to examine connectivity between different brain regions regulating sleep and stress. The student will develop a thorough understanding of neural circuit research using in vivo electrophysiology, circuit mapping and optogenetic techniques.

John Dani

Synaptic plasticity in the reward pathway and negative affect during opioid withdrawal

2nd year applicants only

**My project can only be completed if on-campus activities resume*

The goal of this project is to further our understanding of the physiological and behavioral consequences of chronic opioids. More than half of patients being treated for opioid use disorder relapse within a year of treatment initiation. Non-opioid treatments that target negative emotion during extended opioid abstinence could be a major improvement for patient outlook. This project will uncover neural mechanisms that underlie negative emotion after opioids and reverse them to alleviate lasting symptoms of withdrawal. We use a rodent model to investigate these topics and experiments will include behavioral assays for withdrawal behavior, slice electrophysiology and pharmacological intervention.

The student will assist and be mentored by Ph.D student Daniel Kalamarides. Over the course of the summer, there will be opportunities to learn a variety of experimental techniques including rodent handling, pharmacological injections, and behavioral paradigms that test for physical withdrawal, negative affect, anhedonia, anxiety and more. Applicants are not required to have research experience but should have a strong understanding of basic neuroscience principles. In addition to hands-on experience, the undergraduate researcher will perform blinded (non-biased) behavioral scoring and data analysis that is integral to scientific rigor.

Amelia Eisch

Hippocampal Circuitry in Brain Health, Injury, and Disease *1st year applicants only*

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

Six Eisch Lab “mini-projects” are available to PURM students during Summer 2021, all supervised by Dr. Eisch (weekly-basis) and by a lab member (daily mentor, indicated in parentheses). Questions these projects ask: How does the hippocampus control the ability of mice to 1) learn “video games”? (Sanghee Yun, PhD, AssistProf and Dr. Eisch’s “lab partner”); 2) socially-dominate other mice? (Fred Kiffer, PhD, NASAPostdocFellow); and 3) resist (or succumb to) stress-induced-depression (Yun)? How do hippocampal 4) immune cells change in response to early-life development or ischemia? (Danielle Barber, MD-PhD, NINDSPostdocFellow); and 5) new neurons regulate cognition (Yun)? Finally, 6) what is the role of the hippocampus in addiction? (Yun,Eisch).

Projects are in-person but will pivot to remote/virtual if necessary; indeed, in Summer 2020 we hosted 8 students for successful virtual experiences. Even if remote, Summer 2021 trainees will: gain neuroscience knowledge (neuroanatomy, behavior testing) and science skills (find and read scientific papers, listen to a scientific talk, think through experimental design, use electronic notebooks); be part of a team (that meets 1-3x/week to discuss project); be supported by Dr. Eisch and all lab members via weekly “all-lab” meetings and trainee-specific help sessions;

become confident with the goals and hypothesis of their project; learn to make and present a poster/oral presentation; and see what science research is like on a day-to-day basis. All training is provided. Desired but not expected: brain/neuroscience knowledge; rodent handling experience; familiarity with Python, R, Anaconda, and/or Illustrator or similar.

Franz Weber

Dissecting the homeostatic mechanisms regulating REM sleep

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

Rapid eye movement (REM) sleep is a distinct brain state characterized by an activated electroencephalogram (EEG), paralysis of skeletal muscles and vivid dreaming. In the lab, we combine various methods including electrophysiology, optogenetics, calcium imaging, and modeling to study the neural and homeostatic mechanisms controlling REM sleep in mice and its function in health and disease. REM sleep is under strict homeostatic control: If we lose REM sleep due to sleep deprivation, the lost amount will be exactly recovered the next time we sleep. But the mechanisms or even brain areas regulating REM sleep homeostasis are still largely unknown. In this project, we aim to discover brain areas and the involved neural cell types controlling REM sleep homeostasis.

The project has an experimental and analytical (programming) component. Depending on the background and interests of the student we can focus on either of these components. Students will perform (REM) sleep deprivation experiments in mice in combination with chemogenetic manipulation of specific neural cell populations and will analyze and model electrophysiological and behavioral sleep data. Over the course of the project, students will develop a thorough understanding of electrophysiology, chemogenetics and the modeling of behavioral data, and will learn about the neural and homeostatic control of sleep in the mammalian brain.

NEUROSURGERY

Zarina Ali

Enhanced Recovery After Surgery

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

Low back pain is one of the most common health problems worldwide and affects as many as 80% of people at some point in their lifetime. Despite surgical, technological, and medical improvements, spinal surgeries can still be associated with poor outcomes, including prolonged hospitalization, limited functional improvement, and high opioid consumption.

To address this, the neurosurgeons at Penn have developed a unique patient-centered ERAS care pathway that optimizes patient experience at each phase of surgical care and has the potential to result in improved outcomes. ERAS, which stands for Enhanced Recovery After Surgery, is a protocol that incorporates several pre-, peri-, and postoperative evidence-based interventions, all designed to promote an expeditious surgical recovery.

Preoperatively, the ERAS protocol focuses on optimizing the patient to ensure that he/she is as healthy as possible going into surgery. Perioperatively, pain control is performed via an opioid-sparing regimen. Patients are mobilized within six hours of surgery and ambulated as early as the same day. Lastly, patients are recommended routine follow up with the primary care provider within two weeks of surgery, in addition to follow up with the surgeon, to maintain continuity of care.

The ERAS protocol has been implemented at two Penn Medicine institutions. So far, the results show that the ERAS pathway significantly decreases the use of a post-operative Foley and greatly improves post-operative mobilization and ambulation. More importantly, the ERAS protocol reduces opioid use both in the peri-operative period as well as at one, three, and six months after discharge without increasing average patient pain. Our team is continuing active efforts in understanding opioid needs after spinal surgery and developing guidelines for prescribing after spinal surgery.

We truly believe that a comprehensive ERAS pathway like ours has the potential to significantly improve the spine surgical patient experience as well as clinical outcomes. Students interested in this project will be required to review patient data and surgical outcomes and assist with statistical analysis and manuscript preparation under the mentorship of a research team.

OBSTETRICS AND GYNECOLOGY

Rebecca Hamm

A standardized labor induction protocol to reduce primary cesarean and racial disparities in labor outcomes

**My project can be completed entirely remotely*

Nearly 1 in 3 deliveries in the United States occurs by cesarean section, with unacceptable racial disparities impacting that rate. Protocols to standardize care have been shown to decrease adverse outcomes across medicine, including in obstetrics. In addition to improving outcomes overall, studies in non-obstetric populations have demonstrated that care standardization can considerably reduce racial disparities in health by reducing care variation. Labor induction, one of the most common procedures in obstetrics, varies widely in practice patterns by provider and site. Thus, we propose a novel means of reducing the cesarean rate, as well as racial disparities in obstetric outcomes: standardization of labor induction. We plan to test our hypothesis by

studying the effectiveness of a standardized labor induction protocol, while simultaneously collecting process implementation data in a prospective cohort design. We will compare obstetric outcomes two years pre- to two-years post-implementation of the labor induction protocol into routine care at two diverse sites in the UPHS system. We will also determine if the induction protocol reduces racial disparities in these critical obstetric outcomes.

As a part of this project, an undergraduate student will gain a basic understanding of obstetrics and labor induction. The student will be trained in basic study design, chart review in the electronic health record (EPIC), and chart abstraction into a database management system (RedCap). A student can also expect mentorship and sponsorship related to medical education, academic medicine, medical research, and women's health. This experience can be performed entirely virtually.

OPHTHALMOLOGY

Jessica Morgan

Adaptive Optics Imaging to Understand Vision and Retinal Disease

**My project can only be completed if on-campus activities resume*

The Morgan laboratory in the Department of Ophthalmology studies the structure and function of the human visual system using adaptive optics, a technology which permits visualization of individual light-sensing cells—rod and cone photoreceptors—in the living retina. With the ability to noninvasively observe the photoreceptor cells comes the ability to quantify parameters of the cell mosaic 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 cone densities at several retinal eccentricities and quantify abnormalities in cone density in patients with known retinal pathology. 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.

Using the same imaging technology as described above, we also can probe the limits of vision by presenting small light stimuli confined to single or small groups of cones and investigate visual system function both in normal sighted individuals and in patients with retinal disease. Two overarching goals of this ongoing project are (1) to link cellular-scale structure and function in patients with inherited retinal degeneration, and (2) to better understand how the retina and brain convey information about the world by studying the percepts elicited by stimulating individual

neurons in the retina. Student will have the opportunity to participate in data collection and analysis and will be responsible for investigating how eye/pupil movement affects the delivery of the visual stimulus to the retina. During this project, the student will participate in state-of-the-art ophthalmic research, interact with research subjects, and learn optics and retinal anatomy. Motivated individuals with an interest in bioengineering, clinical research, psychology, biology or neuroscience are encouraged to apply. Prior experience with using Matlab is preferred but not required.

Kenneth Shindler

Evaluation of Neuroprotective Therapies in Models of Optic Neuritis and Optic Nerve Trauma

**My project can only be completed if on-campus activities resume*

Optic neuritis, an inflammatory optic nerve disease that occurs in multiple sclerosis patients, leads to some level of permanent visual loss in 60% of patients due to retinal nerve cells (RGC) damage. Identifying novel therapies that prevent RGC damage therefore has potential for preventing visual loss. We found that both intraocular injection and oral administration of the naturally occurring polyphenol compound resveratrol prevents RGC loss in mice with optic neuritis in part due to its ability to activate a deacetylase named SIRT1. Resveratrol is detectable in eyes after oral administration, but high doses are required to prevent RGC loss, raising concern for systemic side effects. Recently, we found that intranasal delivery of proteins leads to high concentrations accumulating in eyes and optic nerves; thus, this represents a novel drug delivery strategy to treat optic nerve disease. In addition, recent studies use gene therapy technology have demonstrated that overexpressing the SIRT1 gene specifically in RGCs reduces RGC loss following traumatic injury.

Current projects aim to examine whether intranasal delivery of resveratrol leads to significant accumulation of drug in the eye, and to determine optimal dosing to achieve similar levels as seen after oral drug administration. Ongoing gene therapy studies are targeting expression of SIRT1 and its downstream signaling molecules to RGCs to reduce neuronal damage during optic neuritis and optic nerve trauma. The student working on these projects will learn all applicable methods, including how to work with laboratory mice, oral and intranasal drug administration, injection of gene therapy vectors, collection of tissue samples to measure drug levels, and data analysis. The student will work directly with the PI, Dr. Shindler, and will have assistance from a post-doctoral Research Associate, Dr. Reas Sulaimankutty, as well as a Research Associate, Ms. Kimberly Dine. Interested students must be willing to learn to work with mice, and take required University training courses (2-4 hours total) prior to starting these projects.

ORTHOPAEDIC SURGERY

Nathaniel Dymant

Mechanobiology of stem cell differentiation in tendons and ligaments

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

Injuries to tendons and ligaments often do not heal on their own and can be difficult to repair surgically. Because of this, people with these injuries often cannot move their arm or leg without significant pain, leading to poorer quality of life. One of the main focuses of our research program is to define cells at different stages of the lineage within tendons and ligaments (i.e., stem/progenitor cells to mature tendon fibroblasts). We also study the roles that mechanical forces, either from muscle loading or cell contraction, have in development and repair of these tissues. Additionally, we have discovered a resident macrophage population within the growing tendon and are currently investigating the crosstalk between these intrinsic immune cells and tendon fibroblasts. Students interested in stem cell biology and cell lineage tracing will likely enjoy this project. Students will learn novel cell culture, histological, and imaging techniques using fluorescent GFP mouse models. Current PhD students in the laboratory will serve as the students' mentors. Ideally, students will continue on with us after the PURM program has ended to continue their training and mentorship.

Foteini Mourkioti

Unique morphological properties of stem cells regulate regeneration responses in aging and disease

**My project can only be completed if on-campus activities resume*

Muscle stem cells play a major role in muscle regeneration. Following muscle injury, muscle stem cells become active, proliferate, and fuse with the surrounding tissue, allowing for the full regeneration within a few days. Pax7 is a marker of muscle stem cells that is conserved across many species, including humans. To look at muscle stem cells in vivo in a live animal, a Pax7EGFP mouse model was generated by inserting an enhanced green fluorescent protein (EGFP) cassette in the Pax7 gene (Tichy et. al., Skeletal Muscle, 2018). This allowed for the expression of EGFP driven by endogenous promoter and regulatory elements. Using 2-photon microscopy, we were able to visualize for the first time muscle stem cells in vivo and have identified unique and novel properties of these cells that have never been reported previously (Ma, et. al. currently in revision). We recently identified the molecular pathway that controls these properties and have generated knockout mice to study their function.

We are seeking a motivated individual to work closely with a talented graduate student in the lab (Nuoying Ma) in the characterization of these mice. Work will include several techniques, such as tissue handling, stem cell isolation, histology, immunochemistry and quantification using an

imaging software. As a result of these efforts, the student is going to be a co-author in any publication, which will utilize these experimental efforts. Moreover, the study of muscle regeneration has primarily relied on retrospective analysis of static images from tissue section histology. Our experimental system allows for longitudinal studies of muscle regeneration in a substantial reduced number of experimental animals and gives us the opportunity to test therapeutic interventions to reveal how early pathological symptoms correlate with later disease outcomes.

Ling Qin

Control of bone by a novel type of bone marrow adipose cells

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Osteoporosis and low bone mass are major public health problems with substantial economic burden. Bone, a dynamic tissue, constantly remodels and adapts. Bone marrow mesenchymal stem cells (MSCs) are critical to bone dynamic by constantly producing bone-forming osteoblasts and marrow adipocytes, all within a supportive vascular network. Osteoporosis is often accompanied by diminished bone formation, increased bone resorption, and impaired marrow vasculature. By carrying out large scale single cell transcriptome analysis, we recently computationally defined the hierarchy of bone marrow mesenchymal lineage cells and delineated the in vivo differentiation process of MSCs through multiple intermediate subpopulations. Interestingly, we identified a new subpopulation of cells situated after proliferative progenitors and before classic lipid-laden adipocytes along the adipogenic differentiation route of MSCs. Those cells, abundant in young mice, form a ubiquitous 3D network in the marrow cavity to support vasculature and to regulate bone remodeling.

This project aims to characterize this newly identified adipose type of cells, which does not exist in other adipose tissues, and study their regulatory function in bone. Student researchers will be paired with a lead postdoctoral fellow and be included in all aspects of this project, including mouse handling, cell culture, histology, and advanced 3D imaging analysis. At the end of this mentoring period, students will gain sufficient knowledge in mouse genetics, molecular and cell biology, and advanced laboratory techniques. Students will participate in all aspects of the lab, including lab meetings, journal clubs, departmental seminars, and social outings. Alternatively, if remote working is desired, the student researcher can assist us with single cell transcriptome analysis of datasets generated in the lab.

OTORHINOLARYNGOLOGY

Jason Brant

Living Electrodes for Hearing Rehabilitation

**My project can only be completed if on-campus activities resume*

This project involves the application of bioengineering and regenerative technology for the development of novel methods for hearing rehabilitation and restoration. Neuronal constructs are being developed that act as ‘living electrodes’ for stimulation of various levels of the auditory pathway. Specifically, aggregates of neurons are cultured in custom developed constructs. These are fabricated to allow the axons to grow along pre-formed pathways while the neuronal cell bodies remain in a fixed location. These constructs are then implanted such that the axons interact with a location of interest along the auditory pathway, while the cell bodies remain accessible for stimulation or recording - creating a ‘living electrode’. The project will involve: cell culture, animal surgery, histology, data acquisition and analysis.

Elizabeth White

Human Papillomavirus-Host Cell Interactions

**My project can only be completed if on-campus activities resume*

The White laboratory works at the intersection of virology and cancer biology. We are a collaborative team of students and staff working together to study the molecular biology of human papillomaviruses (HPV), which cause 5% of human cancers worldwide. The ability of HPV to cause cancer depends on the activity of two of its proteins: E6 and E7. These proteins act together to cause changes in cells that lead to increased cellular proliferation and decreased cellular differentiation. Both increased proliferation and decreased differentiation are hallmarks of cancer.

We are interested in host cellular targets of the HPV E6 and E7 proteins, and how virus-host interactions promote cellular proliferation and restrict cellular differentiation. The student selected for this project will work closely with a current Penn PhD student or postdoctoral fellow on experiments related to this question. The student will perform cell culture-based experiments and will learn to use cellular and molecular techniques to study cancer-related signaling pathways.

Candidates should have completed at least one undergraduate biology course with lab. They should be collaborative and willing to learn new techniques. A summer of research in the lab will provide students with the opportunity to learn cutting-edge techniques in virology and cancer biology, to develop their molecular and cell biology skills, and to gain experience in an active research lab environment. There is the potential for longer term research in the lab after the summer project is completed.

PATHOLOGY

Will Bailis

Investigating Lymphocyte Metabolism

**My project can only be completed if on-campus activities resume*

When cells undergo change, we typically focus on how they turn off and on genes to make new networks of proteins, however for those changes to occur cells must also alter their chemical makeup by rewiring their metabolism. Immune cells undergo rapid and marked changes to their cell biology upon activation and we now know that metabolic rewiring is part and parcel of that process. My research group has found that one way that T cells change their chemistry in order to activate is by increasing their NAD⁺ production more than any mammalian cell studied. NAD⁺ is an important molecule for a wide variety of reactions that occur inside cells and the loss of NAD⁺ stores is thought to be a major driver of aging. We are working to understand why T cells make so much NAD⁺ and how they are able to do so, in hope of learning not only more about immune cell metabolism, but how to allow other cells in the body to increase NAD⁺ levels and reverse the aging process.

Undergraduate researchers will have the opportunity to perform and learn techniques including flow cytometry, real-time quantitative PCR, Western Blotting, ELISA, and tissue culture, as well as immunology and cellular metabolism. Students will be mentored by Dr. Bailis and work directly with a PhD graduate student in the lab.

Paul Gadue

Using Human Pluripotent Stem Cells to Model Blood Development

**My project can only be completed if on-campus activities resume*

The use of human model systems to study human biology and disease is critical as animal models, while being an invaluable resource, can sometimes fail to recapitulate human physiology and disease due to species differences in biology. Therefore, the Gadue laboratory uses human embryonic stem (ES) cell and induced pluripotent stem (iPS) cell model systems. ES/iPS cells can be expanded in vitro while maintaining the ability to differentiate into all cell types in the body. We are using this system to model disease processes and developmental pathways with the goal of developing new therapies for human diseases.

The summer student will work with a Research Associate in my laboratory to study blood cell development, focusing on red blood cells which carry oxygen and megakaryocytes which generate platelets which are required for blood clotting. Skills that will be learned include molecular biology to generate the DNA constructs to test the roles of various genes in blood cell development such as KLF1, tissue culture to maintain and differentiate stem cells and assays of megakaryocyte and red cell development and function. The students will also be trained to

critically interpret data and make conclusions based upon their results. Overall, this project will help define how megakaryopoiesis and red cell develop and have implications for therapeutic strategies in treating a variety of blood diseases.

Michael Marks

Melanosome biogenesis in pigment cells 2nd year applicants only

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

Our laboratory is interested in understanding the molecular mechanisms that control intracellular trafficking steps that are required for the maturation of cell type-specific lysosome-related organelles. These include a variety of secretory organelles that have important physiological functions, including blood clotting, lung function, immunity, and skin and eye pigmentation. Some of these organelles are malformed in patients with one of a group of genetic diseases called the Hermansky-Pudlak syndromes, in which specific components of the membrane trafficking machinery required for their formation are missing due to genetic mutations. We use melanocyte cell lines from mouse models of the disease and molecular, biochemical, and imaging approaches to understand how these components work and cooperate to deliver necessary “resident proteins”, such as melanosomal enzymes and their regulators, to maturing melanosomes.

If allowed to work in the lab, students will work under the guidance of a PhD student or a post-doctoral researcher on an ongoing project dissecting the function of one such component called BLOC-1. BLOC-1 is a protein complex required for the formation of membrane tubules that emerge from endosomes and extend towards melanosomes to deliver key melanosomal enzymes and transporters required to make melanin pigments. In BLOC-1-deficient melanocytes, these tubules do not form, and consequently the melanosomes cannot make melanin. We are studying proteins and lipids that interact with BLOC-1 to understand how the complex works. Specific projects might be to visualize fluorescent-tagged BLOC-1 in various mutant cell lines by live cell fluorescence microscopy to understand what controls its association with membranes, or to dissect BLOC-1 subunits that interact with its various effectors using mutagenesis approaches. Students will learn to work with recombinant DNA, to transfect cells, and to either analyze cells by fluorescence microscopy or identify protein:protein interactions by one of a variety of techniques. Basic chemistry and biology are necessary prerequisites; classes in organic chemistry and cell biology would be great but are not required.

If the pandemic prevents students from working in the lab, students will work either under the guidance of a PhD student or a post-doctoral researcher or directly with Dr. Marks to read the literature on BLOC-1 function in melanocytes and to devise a proposal that might be used to fund research when it becomes allowable. This will allow the student to gain valuable skills in reading and critiquing papers and in devising and constructing a sensible research proposal.

PEDIATRICS

Christopher Cielo

Obstructive sleep apnea in infants and children

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Sleep-disordered breathing is common in children, ranging from snoring to sleep apnea, and can affect daytime function as well as other measures of health. The CHOP Sleep Center has a number of ongoing clinical studies aimed at better understanding the risk factors and impact of sleep apnea and its treatment in otherwise healthy infants and children as well as those with Down syndrome, craniofacial conditions, and other disorders. Studies range from small observational pilot studies of novel diagnostic modalities to large multi-center clinical trials: <https://www.research.chop.edu/sleep-center>

Interested students would have the opportunity to choose a research project to join, work with different members of the research team, and attend weekly interdisciplinary lab meetings. Sleep Center faculty also see patients in our multidisciplinary clinic and interprets sleep studies in our sleep laboratory, and students would have the opportunity to participate if interested.

Aime Franco

Molecular profiling of pediatric thyroid tumors

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

Pediatric versus adult thyroid cancers behave very differently, despite sharing many of the same driving mutations. We are seeking to understand the molecular differences that drive the different behavior. In this project we will be performing RNA seq analysis on pediatric thyroid tumors with known genetic drivers. Additionally, we will be determining the stromal content of these tumors through immunohistochemistry of archived patient samples. Complementary to the patient samples, we will profile the molecular landscape of pediatric murine thyroid tumors and determine the stromal content of murine tumors through flow cytometry. Students will be involved with learning basic cell and molecular biology skills in the laboratory including culturing of primary cell lines, RNA extraction and sequencing and data analysis of large genomic datasets. Additionally students will present their work to lab members during lab meeting, utilizing advanced oral and written communication skills. We are a multidisciplinary laboratory that works closely with the clinicians treating thyroid cancer. Team building is a critical component of our research program, and learning to work with diverse groups of individuals with diverse talents and expertise.

Riccardo Gottardi

Cartilage Tissue Engineering for Laryngotracheal (Windpipe) Reconstruction

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

There is a lot of engineered cartilage developed in labs around the world, but very little finds its way to the patients. We have adopted a fast translation approach to reach the clinic in the next 3 years. Our priority target is engineering cartilage for laryngotracheal reconstruction to enable infants and children with subglottic stenosis to breath again without a tracheostomy. 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 3D printing/bioprinting, cell culture, and materials fabrication. 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 us in our research journey.

Some of the techniques we routinely use 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 trainee 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

Audrey John

Antimalarial drug development

**My project can only be completed if on-campus activities resume*

New antimalarials are urgently needed to treat malaria, caused by infection with the parasite *Plasmodium falciparum*. Ongoing studies in our lab have identified a series of antimalarial compounds that target unusual parasite enzymes that do not have human homologs. In this

project, students will advance development of these antimalarial compounds by determining their cellular, genetic, and enzymatic mechanisms-of-action. Students will learn to culture malaria parasites, perform metabolic profiling, purify recombinant proteins, and perform assays of enzyme function. If more than one student participates, each will work on a separate series of promising antimalarial compounds. Students will participate in weekly lab meetings and journal clubs, to develop both critical thinking and presentation skills. We welcome students who would be interested in a longitudinal research experience during their undergraduate years. Many former undergraduates from our lab have contributed to published manuscripts, including first-author publications.

Yael Mosse

Immunotherapeutic Targeting of ALK

**My project can only be completed if on-campus activities resume*

Our discovery of gain-of-function mutations in ALK as the genetic etiology of familial NB provided the impetus for this project. These same mutations are the most frequent somatic single nucleotide mutation in this disease and have been shown to act as oncogenic drivers by promoting ligand-independent ALK tyrosine kinase activity. This project is focused on the development of highly specific antibody-based approaches to target cell surface anaplastic lymphoma kinase oncogene (ALK) on neuroblastomas and other ALK-expressing pediatric cancers.

Lisa Schwartz

Behavioral Oncology Research with Survivors and Youth with Cancer Predisposition

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

The clinical research lab of Dr. Lisa Schwartz in the Section of Behavioral Oncology at the CHOP Center for Childhood Cancer Research focuses on self-management of adolescents and young adults impacted by cancer (those with cancer predisposition, on active treatment, or survivors). Current studies with volunteer opportunities include: 1) a multisite study tracking self-management of AYA survivors, 2) evaluation of implementation of survivorship care plans, and 3) longitudinal tracking and outcomes of families with youth tested for cancer predisposition.

Dr. Schwartz also conducts digital health research (apps, text messages) and has some related grants pending funding. Possible projects/tasks include: 1) Detailed electronic health record reviews to assess accuracy of patient knowledge, and document health history and recommendations. This would include expanding the current “manual” created to standardize EHR reviews for these purposes and entering data. 2) Participate in and code structured interviews with patients and parents about impact of cancer predisposition. 3) Assist with

tracking patients in longitudinal studies and making follow-up calls for data collection (online surveys) at various time points. 4) Assist with literature reviews and writing tasks related to grants, papers, and abstracts.

Students are also expected to attend all lab/research related meetings, meetings with the larger Behavioral Oncology group (faculty and staff), and any didactics of interest in the Cancer Center or throughout CHOP. The research is very multidisciplinary with close physician and nursing collaborators. The lab also includes clinical research coordinators, postdoctoral fellows, and collaborators, all of whom are committed to mentoring. We welcome the opportunity to work with the PURM student to create a tailored summer experience that matches the interest and goals of the student within the parameters of current studies in the lab.

We are looking for exceptional students who are committed to gaining more experience conducting research in a pediatric setting and with interest in the areas of psychology, medicine, nursing, public health or other health-related disciplines. Interested students must also have a strong desire to gain experience with clinical research and excellent organizational, communication and writing skills. Students will gain valuable experience conducting multidisciplinary clinical research with adolescents/young adults and families impacted by cancer. Given the many projects at various levels (from conception to completion), and postdoctoral fellows conducting other related projects in the lab, the student will also learn all aspects of the research process, from formulating ideas for new grants, collecting and analyzing data, and disseminating results. Depending on interest and participation, students may also co-author abstracts or papers.

PHARMACOLOGY

Elizabeth Heller

Pharmacological activators of Nr4a1 for the treatment of cocaine use disorders *2nd year applicants only*

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

Despite the prevalence of cocaine use disorder, there is currently no medicine available to treat this disease. Using fundamental approaches, we recently discovered that activation of orphan nuclear receptor, Nr4a1, suppresses cocaine reward behavior in mice. The project will include confirmatory experiments to produce conclusive data on the promise of Nr4a1 agonists as medicines to treat substance use disorders.

This project is designed to validate Nr4a1 as a novel target for cocaine addiction using small molecule activators of Nr4a1, Csn-B and C-DIM. We hypothesize that Nr4a1 agonists cross the blood brain barrier to induce Nr4a1 expression and suppress cocaine behavior. In all studies we will apply cocaine self-administration, the most well-established mouse paradigm for modeling

core features of human addiction such as drug motivation and reward saliency. Our work will go beyond all published data to validate novel Nr4a1 agonists in reducing volitional cocaine behavior following abstinence, in both male and female mice. The first aim of this proposal will determine the therapeutic potential of Csn-B in addiction. Aim 1 tests the hypothesis that Csn-B activates Nr4a1 expression and suppresses cocaine behavior. We will first determine the optimal dose of Csn- B for maximal Nr4a1 activation. We will measure Csn-B and metabolite concentration in brain and plasma, and Nr4a1 protein levels. Next, we will validate Csn-B in suppressing cocaine seeking and conditioned place preference (CPP) following abstinence. The second aim of this proposal will determine the therapeutic potential of novel C-DIM compounds. C-DIMs are well tolerated in vivo, penetrate the blood brain barrier, modulate neuronal activity and regulate neuronal homeostasis. There is, however, no study of these compounds in cocaine addiction. To address this gap in knowledge, we will quantify the concentration of C-DIM metabolites in plasma and brain and Nr4a1 activity. Finally, we will determine the efficacy of of C-DIM in suppressing cued cocaine seeking and CPP following cocaine abstinence.

Steven Thomas

Neuromodulatory Signaling in Normal Cognition, Aging and Alzheimer's Disease

**My project can only be completed if on-campus activities resume*

Various projects in the lab examine neuromodulatory signaling in cognition, with an emphasis on learning and memory in the hippocampus. The goals of these studies are to enhance our understanding of how memory is affected by acute stress, by neurodegenerative diseases such as Alzheimer's and Parkinson's, and by neuropsychiatric disorders that include post-traumatic stress and depression, with the ultimate goal of developing novel therapeutic approaches for these disorders. Toward these goals, the lab utilizes mouse genetics, neuropharmacology, chemo- and optogenetics, viral transduction, electrophysiology, imaging and biochemical approaches.

PHYSICAL MEDICINE AND REHABILITATION

Michelle Johnson

Motor and Cognitive function of People Aging with HIV and/or STROKE 2nd year

applicants only

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

As people living with HIV (PLWH) continue to age, they face challenges associated with the chronic management of HIV including acute brain changes from HIV-associated CNS injuries that can result in a range of physical, cognitive, and mental health-related issues that

detrimentally impact their ability to perform instrumental activities of daily living (IADLs). IADLs such as managing finances and medication management are critical activities that often require people to simultaneously engage both cognitive – especially in the executive function domain – and motor areas. We seek to apply innovative objective assessment strategies to quantify the effect of HIV on IADL function in older adults and to investigate effects on motor performance of “IADL-like conditions” characterized by systematically increasing cognitive demand in the executive function. The student will support the investigators by learning to work with our robot systems, work with participants to test motor and cognitive function, and help to implement new assessment activities

PSYCHIATRY

Rinad Beidas

ARCH Lab Research Projects

**My project can be completed entirely remotely*

Adolescent Suicide Prevention in Routine clinical Encounters (ASPIRE)

Firearms are the second leading cause of injury-related death for young people in the United States. Unlocked firearms in particular are associated with higher odds of both suicide and unintentional injury. The promotion of safe firearm storage is a promising but infrequently used strategy to prevent youth firearm injury and death: despite the existence of an evidence-based program to address this problem (Safety Check), clinicians rarely discuss safe storage with families. To address this disconnect, our team has adapted Safety Check to optimize its effectiveness and promote its implementation in pediatric primary care based on stakeholder feedback. ASPIRE is a randomized controlled trial testing various methods to promote implementation of the adapted Safety Check program in pediatric primary care, with the aim of preventing suicide by firearm in children and teens. In the trial, we are seeking to determine which implementation strategies are most effective for encouraging pediatricians to deliver the firearm safety program to their patients during the well-child visit. In supporting this project, the PURM research assistant would help with this mixed-methods research project. Day-to-day work may include entering data, cleaning data, transcribing qualitative interviews, and helping to design and prepare program materials. This project is well suited for those interested in healthcare, policy, and public health. Students will receive mentorship from Dr. Rinad Beidas, who has experience mentoring previous PURM research assistants.

Center for AIDS Research (CFAR) Supplement

Philadelphia County has prioritized the Ending the HIV Epidemic (EHE) Initiative, with the goal being that 91% of all people living with HIV (PLWH) are virally suppressed, meaning that the amount of HIV in the blood is low enough to prevent further spread of the virus. Managed

Problem Solving (MAPS) is an evidence-based practice (EBP) with a long-term impact on viral suppression. It is a five-step process of identifying barriers to patient adherence to antiviral therapies, brainstorming solutions, developing a plan of action, implementing the plan, and modifying as needed. As an implementation science lab, we seek to increase the uptake of EBPs in order to improve client care and outcomes. In this study, we will qualitatively interview stakeholders at Philadelphia clinics providing HIV care to learn more about the barriers and facilitators of their use of MAPS. Then, through a collaborative process called implementation mapping, we will use what we've found to create a menu of best strategies for clinics to use MAPS in their work. To support this work, the PURM research assistant will help compile and analyze the data from our qualitative interviews and implementation mapping. This may include literature searches, data organization and processing, mixed methods skill building, transcribing interviews, and other tasks. This project is well suited for those interested in healthcare, health disparities, and public health. Students will receive mentorship from Dr. Rinad Beidas, who has experience mentoring previous PURM research assistants.

Jennifer Goldschmied

Investigating the role of slow-wave sleep and impaired plasticity in major depressive disorder

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

Major Depressive Disorder (MDD) is the most prevalent mental illness. However, standard treatments for MDD typically take at least 2-3 weeks to take effect. Emerging research suggests that an underlying mechanism of MDD involves impaired neuroplasticity. The overall goal of this project is to test the hypothesis that disrupting slow-wave sleep can increase neuroplasticity, and improve mood in MDD. Forty males and females with MDD, and a group of twenty controls will spend two nights in the laboratory: one baseline night of sleep, and one night where slow-wave sleep will be disrupted. Following each laboratory night, markers associated with synaptic potentiation and plasticity will be assessed.

This study provides ample opportunities for the involvement of undergraduates. Undergraduates will have the opportunity to participate in the development of materials to enhance recruitment, i.e. developing advertisements for posting, utilizing social media, etc. in addition to participating in phone screening. All undergraduates will be trained in appropriate methodology to phone screen both healthy participants and clinical patients, in addition to being trained in HIPAA compliance during phone screening. All undergraduates will be trained in how to work with study participants, including how to review a consent form with potential participants and professional conduct in a research environment. If in-person research is permitted, undergraduates will also receive training in several areas of sleep research including but not limited to, how to administer a hearing test, how to administer study surveys using the online resource, RedCap, how to administer the neuroplasticity task battery and waking EEG task, thereby becoming familiar with using the E-prime software suite. Students will be responsible for administering and explaining the use of sleep diaries and actigraphs to all participants, and

for determining adherence using these methods. Undergraduates will also be involved with the facilitation of the project by performing operational tasks including orienting all participants to HUP and the sleep lab, testing study equipment to ensure appropriate operation during the protocol, and the removal and cleaning of EEG electrodes following the study overnight. At the end of the undergraduate's time in the lab, they will have a keen understanding of the essential components of conducting sleep research, and working with clinical populations.

Matthew Hocking

Social Problems in Youth with Neurofibromatosis Type 1 2nd year applicants only

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

Youth with neurofibromatosis type 1 (NF1) often have difficulties with social functioning (e.g., getting along with peers) that are similar to those seen in youth with autism spectrum disorder (ASD). The objective of this study is to compare the cognitive and affective functions (CAF) abilities of youth with NF1 to typically developing (TD) youth and youth with Autism Spectrum Disorder and to establish associations between CAF abilities and social adjustment outcomes in youth with NF1. A secondary objective is to describe the neurobiological mechanisms underlying the CAF abilities of youth with NF1. Study procedures will include measuring CAF abilities, including executive function, facial processing, social attention and perspective taking, and evaluating metrics of functional brain connectivity both at rest and during a social processing task using fMRI.

Student duties would include participant recruitment, screening, and facilitation of data collection (potentially engaging in unstructured social task with participant), scoring of measures, data entry and management, literature searches and reviews, and participation in lab meetings. Student will develop small, independent research project based on other data available in lab. No prerequisites required.

Jena Tronieri

Understanding Individual Differences in Weight Loss with Lifestyle Modification and Treating Non-Responders with Pharmacotherapy

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

The Penn Center for Weight and Eating Disorders is seeking 1-2 summer students to work on studies related to individual differences in weight loss under primary supervision of Dr. Jena Tronieri. The students will work on a trial that is examining individual behavioral and biological characteristics that may predict weight loss with lifestyle modification. The study is also evaluating the benefit of adding an FDA-approved weight loss medication, phentermine, for individuals with slow early weight loss (a strong predictor of total weight loss with lifestyle modification).

This position is designed to provide mentorship and experience in clinical research (including direct patient contact) for students interested in careers in medicine, psychology, public health, nursing, social work, or related fields. Successful summer mentees will have the opportunity to stay in the lab and to do additional individual mentored research projects during the academic year.

The students' training activities may include: conducting phone screening interviews with potential study participants (including collection of medical and psychiatric history); assisting with patient assessments (behavioral and biological testing) and appointment check-ins; attending weekly study team meetings to learn about the workings of clinical research; gaining exposure to study measures, assessment procedures, and data management; and opportunities for direct observation of medical assessments and behavioral treatment visits. The students will receive direct mentorship from Dr. Tronieri in clinical research, obesity medicine, and cognitive and behavioral treatments. Students also are invited to attend and participate in all center-wide meetings, lectures, and research presentations. Previous coursework in research methods, psychology, public health, medicine, nursing, social work, epidemiology, or similar fields is preferred.

PULMONARY, ALLERGY, AND CRITICAL CARE MEDICINE

Nuala Meyer

Sepsis-Associated Organ Failure; COVID-19, other viruses, and bacterial pathogens

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy, My project can only be completed if on-campus activities resume*

This project provides the opportunity for a focused clinical or molecular research experience with the Meyer lab, which directs a large cohort of human subjects with severe infection and organ failure (“sepsis”). We capture very rich clinical data from the electronic medical record, characterize infection(s) and organ failures, and pair this with high dimensional molecular data including genomics, whole blood transcriptomics, proteomics, metabolomics, and cytometric data. Our team’s overarching goal is to identify unique patterns of host response to sepsis that correspond to both inherited factors and environmental factors such as the infecting organism. If we can understand the biology of this individual response, and validate strong markers to detect aberrant biology, then we hope to realize the goal of precision therapy for sepsis.

The student will be responsible for extracting clinical data from the electronic medical record into specialized electronic case report forms and occasionally conducting cognitive surveys by phone for subjects who have been discharged from the hospital. In recognition of the COVID-19 pandemic, the experience can 100% virtual. IF conditions allow, on-site work within the hospital could also occur.

Pre-requisites: interested applicants should be enthusiastic to learn about and participate in patient-oriented research, work well as part of a team, and willing to ask questions.

John Reilly

Clinical and Molecular Risk Factors for Acute Respiratory Distress Syndrome in Critical Illness

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

Acute Respiratory Distress Syndrome (ARDS) is a form of respiratory failure that results from the breakdown of the barrier between blood in blood vessels and the alveoli or air sacs of the lung, leading to fluid buildup in the alveoli and impairment of gas exchange. ARDS occurs in the setting of a significant precipitating illness such as severe traumatic injury (e.g. motor vehicle accident or gun violence) or severe infection (e.g. pneumonia, COVID-19, or bacteremia). Our group is focused on clinical and molecular studies of ARDS risk factors in two critically ill patient populations; patients after severe trauma admitted to Penn's level I trauma center surgical intensive care unit (ICU) and patients with sepsis admitted to the medical ICU at the Hospital of the University of Pennsylvania.

This project is a great opportunity for students interested in clinical and/or translational research or clinical medicine focused on acute critical illness. Student's will gain experience in the operations of observational cohort studies, basic understanding of sepsis (the dysregulated host-response to infection that causes organ dysfunction), ARDS, and trauma, and, if interested, will have the opportunity to learn molecular techniques to measure plasma proteins in samples collected from critically ill patients.

The project focuses on ongoing cohort studies in two critical illness populations. The first prospective cohort study is the Penn Trauma Outcomes Study (PETROS), a study of severely injured trauma patients who present to Penn's Level 1 trauma center. The second prospective cohort study is the Molecular Epidemiology of Sepsis in the ICU (MESSI), a study of critically ill patients with sepsis presenting to HUP. In both studies, patients are followed for the development of ARDS with extensive data collected to examine clinical and molecular risk factors. Our current research focuses on ARDS risk factors we previously identified including the ABO histo-blood type A and chronic exposure to elevated levels of ambient air pollution. Additionally, we have ongoing research into genetic variants and plasma proteins important in ARDS.

Students involved in this project will have the opportunity to: screen and enroll patients that meet inclusion criteria for PETROS and/or MESSI, learn to extract and record medical information related to patients' injuries or infections, medical history, physiologic state, and response to treatment from the medical record, assist with chest X-ray interpretation, and participate in lab meetings, data analysis, and manuscripts in progress. If more interested in a laboratory experience, students will also have the option to focus on a translational experience, including learning techniques such as DNA extraction and plasma protein measurements. Students will

have direct interaction with ICU physician investigators and will have an integral role in the research team comprised of research coordinators and lab personnel. Opportunities will also be provided to shadow physicians working the ICU setting.

Prerequisites: Students should be enthusiastic about biomedical research, professional and adherent to patient privacy standards, and interested in clinical/translational research.

RADIATION ONCOLOGY

Surbhi Grover

Longterm toxicity and outcomes of patients with cervical cancer with or without HIV treated with chemotherapy and radiation *2nd year applicants only*

**My project can be completed entirely remotely*

Cervical cancer is the most common cancer in Botswana due to high prevalence of HIV and limited screening programs. Funded through various grants including NCI K-08 and U54, we have a large database of cervical cancer patients with or without HIV who have been treated with chemotherapy and radiation. In our previously published work, we have shown that patients with or without HIV have similar survival outcomes at 2 years if they receive adequate chemotherapy and radiation. However, it remains unknown if long-term treatment toxicity and survival outcomes are similar between the patients with or without HIV. In this current project we aim to use our previously collected data and evaluate long-term treatment toxicity and outcomes in patients with cervical cancer with out without HIV.

For this project, a student would work with our research team in Botswana using data in Redcap to code toxicity variables, prepare the data for analysis, work with the statistic team and myself in doing the analysis and then work with me in developing the manuscript. This project can be done completely remotely if needed since the data in on redcap. Data that is not on redcap can be coded by the team in Botswana and shared by a secure platform (Pennbox).

Interested student should have a keen interest in global health and medicine. No prior research experience necessary, but preferred.

RADIOLOGY

Farouk Dako

Factors Mediating Lung Cancer in Never Smokers Identified from Advanced Imaging and Epidemiologic Analysis

**My project can be completed entirely remotely*

Lung cancer in never-smokers (LCINS) accounts for 10-20% of lung cancer deaths and is the seventh leading cause of cancer mortality in the world, with increasing incidence. There has been a changing biology and epidemiology of lung cancer with an increasing prevalence of adenocarcinoma (versus squamous cell and small cell) and an increasing proportion noted in never-smokers, particularly in females. Evidence suggests that LCINS may be a distinct disease entity with tumor molecular changes and treatment response that differ from smoking related lung cancer. Research into imaging features associated with LCINS is lacking and could improve understanding of the biology of LCINS. In addition, research into risk factors for LCINS has yielded conflicting and inconclusive results. More extensive query of large datasets could provide new insight into risk factors and biology of LCINS

The Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial is a large population-based randomized trial of approximately 155,000 participants in the United States enrolled between 1993 and 2001. Our study utilizes the PLCO dataset, containing almost 64,000 never-smokers, as an epidemiologic and imaging resource to identify risk factors and imaging features of LCINS. We aim to (1) perform in-depth analysis of the PLCO database to identify epidemiologic and imaging predictive factors for LCINS and creation of risk models (2) create an institutional database of lung cancer chest CT and PET-CT imaging studies with pathology correlation for quantitative image analysis (3) explore deep learning approaches to cross-sectional imaging analysis for prediction of LCINS. Our study would provide new insight into the risk factors and biology of LCINS which is critical for designing prevention and surveillance strategies, improving early diagnosis and preventing the approximately 20,000 annual deaths in the U.S. attributed to LCINS

Student Expectation: No prior research is needed. The student(s) will be responsible for data management.

Benefits: Experience in data management and analysis. Exposure to artificial intelligence principles such as deep learning. Experience in literature review if interested.

James Gee

Multi-scale Molecular Mapping of the Female Reproductive System

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

The major area of research at the Penn Image Computing and Science Laboratory (PICSL, <http://picsl.upenn.edu>) is in the field of Biomedical Image Analysis, with particular focus on computational methods for quantifying the ways in which anatomy can vary in nature, over time, or as a consequence of disease or intervention. A primary goal is to translate into practical tools and make freely and publicly available cutting-edge image analysis methods that are essential for extracting the most information from medical imaging data. This research is also complementary to the laboratory's educational activities, which focus on training that is at the interface between medicine, engineering, and the computational sciences.

As part of this research experience, undergraduate students will learn about medical imaging and analysis of the female reproductive system in MRI and ultrasound. This work will contribute to the Penn Center for Multi-scale Molecular Mapping of the Female Reproductive System that is part of the Human BioMolecular Atlas Program (HuBMAP) funded by the NIH. Students will carry out segmentation (labeling) of the uterus and ovaries in clinical images and use image registration tools to align models of these organs from multiple 3D imaging modalities, which will help construct a multi-scale map of these organ systems in healthy human subjects.

Drs. James Gee (Radiology and Computer and Information Science) and Alison Pouch (Radiology and Bioengineering) have regularly mentored undergraduates at PICSL, many of whom pursued graduate-level education or careers in medicine, biomedical engineering, and/or computer science. Undergraduate mentees have had the opportunity to learn about the fundamentals of computational image analysis tasks like image segmentation and registration and how such tasks apply to clinical medicine. An interest in learning about image analysis and its applications to medicine are desired. Introductory experience in computer programming would be helpful but not required.

Stephanie Jo

Precision medicine approach to Osteoarthritis

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Osteoarthritis (OA) is widely prevalent in the aging population, affecting over 30 million people in the United States alone and having far-reaching public health implications. The prevalence of OA is expected to increase in an aging and obese population. OA is a late adult-onset disease that has multifactorial pathogenesis including genetic predisposition affecting the age of disease onset and the disease severity. Numerous genes and their single nucleotide polymorphisms (SNPs) have been associated with increased risk of OA. However, these studies are based on

radiographic findings at a single time point. Furthermore, study comparing the multiple SNPs to identify the most important ones has been lacking. This project proposes to assess both the SNPs and MRI morphometry from the existing Osteoarthritis Initiative (OAI) database to identify biomarkers for population at high risk for OA disease progression. The OAI is a clinical, imaging, and biospecimen database of OA with genomic DNA and multi-year follow up of knee MRIs. The overarching goal is to utilize the results of this project to guide imaging surveillance of high-risk patients and direct subpopulation analysis of future clinical trials on OA interventions. Student(s) involved in the project will participate in MRI annotations and SNP genotyping.

Jie Nguyen

Characterization of pediatric bone sarcomas to improve patient care

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Osteosarcoma and Ewing's sarcoma account for over 90% of primary malignant bone tumors in children. While preoperative neoadjuvant chemotherapy and better surgical techniques have improved prognosis, disease-free survival ultimately depends on en bloc tumor removal as relapse is associated with a bleak outcome. Surgical decision-making relies on imaging, which includes conventional MRI (to characterize margins) and PET (to determine viability), although both lack bony detail. While CT complements conventional MRI by delineating sites of lytic change (a marker of viable tumor) and dystrophic calcification/ossification (a marker of necrotic tumor), CT is often avoided in children due to radiation concerns. Our research team has developed and optimized a standardizable, objective MRI-based diagnostic method to quantify tissue microstructure change, which correlates with histopathologic tumor margin and intra-tumor dedifferentiation. The current goals are to develop and validate more efficient post-processing methods to pre-operatively measure treatment response and to better define tumor margin for operative planning. Our group has a diversity of retrospective and prospectively projects relating to bone sarcomas and patient outcome with the ultimate goal of improving patient survival.

Experience with data analysis, MatLab, 3D Slicer, and python are very helpful, but not necessary. Our team composed of a multidisciplinary group of physicians, surgeons, pathologists, clinical scientists, research scientists, fellows, residents, medical students, pre-med, and undergraduate students. Mentorship and research responsibilities are individualized and dependent on each student's strengths and weaknesses.

Chamith Rajapakse

Radiology Applications in Orthopaedics, Surgical Planning, and Artificial Intelligence

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Multiple projects involving medical imaging (MRI, CT, X-ray, and PET) in the following technical areas are available: Orthopaedic Engineering; AI/ML/Deep Learning; Image Analysis; Augmented reality; personalized medicine; Bio 3D printing; Medical record data collection. Disease specific projects involve: osteoporosis, osteoarthritis, atherosclerosis, HIV, HCV, oral disease. No experience is needed and training will be provided. Computer programming skills would be useful for some 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.

SURGERY

Kristoffel Dumon

Designing innovative devices and simulations for minimally invasive surgery

**My project can be completed entirely remotely*

The percentage of surgeries that are done using minimally invasive technologies continues to grow. It has been shown to reduce incision size, patient pain, and hospitalization times amongst many other benefits. However, minimally invasive surgery is not without its own challenges that require innovation to overcome.

The Dumon research group engages in research designed to not only overcome these challenges but also advance the teaching of minimally invasive surgery techniques. The group is currently working on designing a voice activated hands free laser pointing device for visual communication during laparoscopic surgery. Additionally, the group is working on developing surgical simulations integrating innovative robotic and material components that provide user feedback. We seek a team of undergraduate students with a desire to exercise both the creative and analytical mind to forward our research efforts. This student will have the opportunity to learn about minimally invasive surgery and collaborate with attending and resident surgeons. They will also be exposed to electrical engineering, computer programming, and robotic engineering as applied to the field of surgery. The group aims to create surgical devices for market as well as innovative simulations for publication and implementation in the Penn Surgery training program.

The student will be mentored and work closely with Dr. William Yi, a board-certified general surgeon and current simulation and education fellow in the Penn Department of Surgery.

There are no specific pre-requirements for students who would like to participate in this program. The main aim of the project is to introduce the students to surgical skills training and the current technology available in the field. The students engaged in this project will be closely mentored by Dr. Yi, who will provide close guidance during the entire project. The main aim is to have a functional design project by the end of the program. To the extent that the student has an interest, the skills that the student can acquire during this course include research skills such as basic study design, product design, working with semi-synthetic materials, 3D printing, basic programming skills using C # and arduino boards. Many aspects of the project can be completed remotely. The aim is to maintain a close collaborative working group through daily zoom meetings if the student decides to work on the project remotely.

The strength of the project is the collaborative nature. Previous participants have gained a better understanding of surgical skills training, had the opportunity to work closely with clinical surgeons and develop a connection to the surgical field, as well as the field of surgical education. The program therefore benefits both students with an interest in innovation and product development as well as students who want to explore the medical field.

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 Natural Language Processing with renowned dementia researchers at Penn and Drexel. This project offers a thorough introduction to research. Students will collect and input data using REDCap, a notable research database software. Students will 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 developer of COPE, Care of Persons with Dementia in their Environments, is 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.

Students will receive mentorship from Dr. Hodgson and her Research Project Managers – Sarah Bujno, MSW, MPH, Sonia Talwar, and Emily Summerhayes.

Sarah Kagan

The Virtual Supportive Cancer Care Research Study

**My project can be completed entirely remotely*

The Virtual Supportive Cancer Care Research Study investigates the experience of both receiving and providing virtual supportive care for people living with and after cancer. The study recruited people receiving care across all sites within the Abramson Cancer Center (ACC) in Penn Medicine. Clinicians across all disciplines who provide supportive care to patients and their families in any of the ten sites within the ACC were also recruited to participate. Anyone participating had the option to complete surveys on telehealth, participate in a semi-structured interview, or both. Currently, we are finalizing qualitative analysis and undertaking quantitative analysis in this mixed methods QUAL-quant study using Dimensional Analysis and Realist Synthesis. Opportunities for students to participate in this research include helping to finalize and display qualitative data analysis, complete descriptive quantitative analysis, and mix QUAL-quant analyses. In addition, opportunities to disseminate findings exist and include drafting manuscripts for team review, negotiating co-authorship, and managing submission under the

direction of the Principal Investigators, Clare Whitney PhD, MBE, RN and Jane Evered PhD, RN for the clinician arm and the person living with cancer arm of this study.

Lea Ann Matura

Feasibility of Cognitive Behavioral Therapy vs. Bright Light Therapy to Treat Insomnia and Fatigue: an RCT

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

People with pulmonary arterial hypertension have lots of symptoms including sleeping problems and fatigue. A common sleep problem is insomnia. Insomnia is when a person has trouble falling asleep and/or they have trouble staying asleep. When problems sleeping such as insomnia are not treated, they can cause other symptoms such as fatigue and depression. People can feel sleepy during the day affecting their ability to do the things they need and want to do. While sleeping pills are used by some people to help them sleep, in pulmonary arterial hypertension sleeping pills could interact with medications used to treat their pulmonary arterial hypertension. Finding other treatments that patients can use on their own and that will not interfere with pulmonary arterial hypertension medications are needed. One treatment that has been used in other illnesses to help with insomnia is called Cognitive Behavioral Therapy. Patients who use Cognitive Behavioral Therapy work with a therapist to understand what is causing the trouble with sleeping and work on those things. The other part is working on how to get better sleep habits. Some of the draw backs of Cognitive Behavioral Therapy is that it can cost a lot and patients may not have someone near them who can provide the therapy. Another possible treatment could be Bright Light Therapy. With Bright Light Therapy the patient wears glasses that put out light that may help with their fatigue. Bright Light Therapy may also be easier to do than Cognitive Behavioral Therapy.

In this study we will have three groups of patients with pulmonary arterial hypertension who have insomnia and fatigue. One group will receive Cognitive Behavioral Therapy where they will work with a therapist for about 1 hour each session. There will be one session every week for a total of 8 sessions. The first session will be at the clinic and all the other sessions will be provided by the therapist over the computer and/or phone. Another group will receive Bright Light Therapy where they will wear special glasses for 30 minutes each morning that put out bright light for 8 weeks. The third group will receive the care that they usually receive from their doctor. Patients will fill out surveys about their sleep and fatigue. They will also wear a wrist actigraph for 7 days to look at their sleep and daytime activity levels. These surveys and procedures will be done before the treatment begins and after the 8-week treatment period. We believe the results of this project will show that patients with pulmonary arterial hypertension will find the treatments easy to use and helpful. We expect that Cognitive Behavioral Therapy and Bright Light Therapy will improve insomnia, fatigue and physical activity levels compared to the usual pulmonary arterial hypertension care.

FAMILY & COMMUNITY HEALTH

Melanie Kornides

Misinformation about the COVID-19 vaccine on social media

**My project can be completed entirely remotely*

Misinformation is false or incomplete information that is often shared over social media with good intentions. In this project, you will work with Dr. Kornides to evaluate posts found in different social media sources (for example, Twitter, Facebook, Youtube and Instagram) for misinformation about the COVID-19 vaccine. You will evaluate each post and enter information about the post into a pre-developed data extraction tool. You will work with Dr. Kornides to analyze the findings, including compiling a list of myths and common themes found across posts. Academic and professional skills you will gain include experience with content analysis, qualitative data coding, data extraction, and content expertise in vaccine hesitancy. The project is an exciting opportunity for a student interested in any of the following: vaccination, anti-vaxxers, public health research using social media, COVID-19. No prior research experience is needed!

Start Date: June 1

End date: 10 weeks

Weekly Schedule: 10am-5pm, Monday through Friday, We will meet 3-5 times a week for 1 hour a day. Your schedule outside of our meetings is flexible but you are expected to complete 35 hours a week on the project.

Location: Remote

Coursework: Take up to 1 CU, let me know your schedule for this

Time off: We are flexible, let me know in advance if you need time off and we can adjust the schedule.

Jianghong Liu

Early health risk and protective factors on sleep, emotional, and behavioral development

**My project can be completed entirely remotely*

My overarching research aims to understand how early health risk and protective factors impact sleep health, emotional, and behavioral development in children and adolescents, why this occurs, and what measures we can take to enhance development. Factors include prenatal/postnatal risk factors, early nutrition, and environmental exposure and sleep behavior. Currently our team has several ongoing projects. The student will conduct extensive literature searches, read, analyze published literature, and make a synthesis on the following relevant topic.

The student should have good organization ability and effective communication skills. They are comfortable working independently and in a group setting. Training will be provided.

Project 1: Nutrition and sleep

Sleep problems are a public health issue across the lifespan, affecting 60% of the population. Poor sleep has many negative health outcomes ranging from metabolism and cardiovascular health to cognition and behavior. Recently, diet has been implicated in sleep outcomes. The purpose of this project is to understand the role of dietary pattern, and specific nutrients in sleep health.

Project 2: Prenatal and postnatal factors in sleep, neurocognition and behavior

The purpose of this project is to investigate how prenatal events (e.g. maternal smoke exposure, birth complication, or depression) and postnatal factors (e.g. ACE, environmental exposure) affect childhood sleep patterns and their subsequent effect on neurocognition and behavior in children/adolescents.

Project 3: Early health factors on adolescents' positive psychology

We know very little about what are the early health factors associated with adolescents emotional well-being (e.g. happiness, self-control and grit), and what are the mechanism of action. These protective health factors could be nutrition, sleep and maternal emotional status during pregnancy.

Project 4: Environmental exposure, neurocognition, and adolescents mental health outcomes

The purpose of this project is to investigate how Environmental toxicants exposure (e.g. lead exposure) affect neurocognition, psychophysiology and emotional and behavioral outcomes in children/adolescents.

Laura Starbird

Implementing PrEP for Women Who Inject Drugs

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

The goal of this research is to prevent HIV among women who inject drugs (WWID) through organization-level change in the way pre-exposure prophylaxis (PrEP) is delivered to this population. WWID are among the most vulnerable to acquiring HIV due to the dual effects of both unsafe injecting and sexual practices. PrEP is effective and recommended to prevent HIV infection among high-risk groups, including WWID, but PrEP uptake among women is lagging. This study will incorporate patient, provider, and organization perspectives to improve PrEP uptake among WWID in urban and rural clinics.

This summer, we will conduct qualitative interviews with WWID to understand their opinions about how PrEP is delivered to them. We will also develop a quantitative survey for clinicians and clinical leadership to understand the barriers to providing PrEP to WWID in primary care

and women's health practices. In the long term, these findings will inform an organization-level implementation strategy to improve PrEP delivery to WWID in primary care and women's health clinics.

Students will be immersed in gender disparities in HIV prevention and substance use disorder, gain exposure to a marginalized patient population, and consider complex issues with an implementation science lens. Students are expected to attend team meetings and acquire skills in qualitative interviewing, directed qualitative content analysis, survey development, and quantitative data collection.

The successful student will have very strong interpersonal skills, manage their time well, and demonstrate cultural sensitivity towards vulnerable populations. This project can be modified to accommodate a remote environment if needed.

Veterinary Medicine

CLINICAL STUDIES NEW BOLTON

Kyla Ortved

Investigation of the immunomodulatory properties of equine MSC-derived extracellular vesicles

**My project can only be completed if on-campus activities resume*

This project seeks to evaluate the immunomodulatory properties of extracellular vesicles (EVs) derived from equine MSCs cultured under different conditions. EVs are derived from cells and carry important biological cargo, including RNA, lipids and proteins, involved in cell signaling. Since our laboratory is focused on developing cell-based therapies for joint disease, we are specifically interested in understanding and optimizing the immunomodulatory properties of MSC-derived EVs in the context of osteoarthritis. The student will be involved in cell culture, EV isolation and some assays used to probe the immunomodulatory properties of EVs.

Student will need to provide their own transportation to New Bolton Center, Kennett Square PA.

Wharton

BUSINESS ECONOMICS & PUBLIC POLICY

Judd Kessler

Transitional Grants and Loans for Teachers

**My project can be completed entirely remotely*

In 2015, 2016 and 2017, our team of researchers randomized the amount of transitional funding (grants and no-interest loans) that was offered to individuals admitted to Teach For America, a large teacher-placement program. Our research found that, for those in the most financial need, small increases in the amount of funding offered to them had big impacts on the likelihood they joined Teach For America. The effects did not depend on whether the funding came in the form of grants or loans, suggesting that these potential teachers were facing liquidity constraints that prevented them from starting careers in education. We are now engaged in research following up on these individuals (e.g., to see whether they have stayed in the teaching profession) to better understand the effects of liquidity on career choice and to further investigate the potential benefits of liquidity as a solution to the U.S. teacher shortage.

MANAGEMENT

Mary McDonnell

Corporate Political Activity

**My project can be completed entirely remotely*

I am looking for some help ramping up an exciting new project exploring corporate political activity. Most specifically, I'm interested in exploring the predictors and consequences of increasing corporate spending on judicial elections (ie, the elections that decide who serve as judges on state appellate and supreme courts). The project would involve helping me to code up information on legal cases against firms in states that have elected judges. We will be collecting case data from Westlaw, the primary database that lawyers use for legal analysis. The project should be especially useful for students who are interested in corporate policy, corporate non-market strategy, or business law.

Tiantian Yang

Status-pay trade off? Gender Patterns in Engineers' Job Applications

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Work is often distinguished within occupations in terms of status. Some types of occupational work often receive more deference than others, implying a status differentiation across sub-occupational specialties. For example, in the law, scholars argue that there are “two hemispheres” of law distinguished in terms of status. There’s high-status corporate law, and there’s low-status, personal plight (family law, personal injury law). These status distinctions are widely-accepted within the legal profession and mobility across these two hemispheres is largely constrained (e.g., Abbott 1981; Heinz and Laumann 1982; Rider and Tan 2015).

Scholars have argued that such intra-occupational status differences have important labor market implications. In particular, backgrounds in higher-status occupation work are likely to send positive signals about workers’ skills. Therefore, workers benefit from having such backgrounds, particularly early in their careers when uncertainty about workers’ quality is highest (i.e., Bidwell et al. 2015). However, we understand less about how such purported benefits of high-status affiliations influence workers’ job-search behavior.

In this paper, we argue that if doing high-status work benefits workers’ careers, workers should be more willing to forgo income for such work than for low-status work (Stern 2004). Because workers benefit from doing high-status occupational work in the long term (i.e., as such work enhances their career prospects), they should be willing to sacrifice income in the short-term for the opportunity to do such work. Further, because the main benefit of doing high-status work is its signaling value (i.e., high status work sends a positive signal about the candidate’s quality), workers’ willingness to trade-off income for status is likely to be highest when uncertainty about the candidate’s quality is highest. Thus, workers with little high-status work experience are likely to be more willing than others to trade off short-term income for the opportunity to do high-status work.

I would love to work with undergraduate students on this project. Their potential roles include reviewing the literature and collecting the data. The data collection will be carried online. Essentially, we will recruit workers on Upwork to fill out a survey. The undergraduate students who work with me for this project will check each applicant’s application and make sure that they are eligible for the survey.

Jonah Berger

Why Do Things Become Popular?

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Why do some songs, books and movies catch on and become popular while others fail? Why do some online articles suck us in and get lots of engagement while others don't? We're interested in using natural language processing, machine learning, and automated textual analysis to help answer these questions and related questions.

Ongoing projects involve analyzing song lyrics to predict Billboard rankings, analyzing movies scripts to plot the emotional arc of narratives and predict ratings and ticket sales, and analyzing online content to understand why certain articles get longer versus shorter reads. Students will work with Professor Jonah Berger and potentially some graduate students in our group. Ideal applicants will have strong programming skills, be highly motivated, and able to work independently as well as within a team.

While not required, ideal candidate will have some experience with at least some of the following: experience programming in Python and R, especially with processing large amounts of text data. Experience in one or more of the following packages: Pandas, seaborn, NLTK, spaCy, numpy, scipy, scikit-learn, and statsmodels or their R counterparts (dplyr, ggplot, tidytext, etc.). Coursework in one or more of the following, or similar courses: statistics (STAT 417, 476), machine learning (CIS 519, 520, 521), computational linguistics (CIS 530), linguistics (LING 449). Bonus if you have: Experience with jupyter notebooks, for prototyping, exploratory data analysis, and reporting; experience in sentiment analysis and/or automated assessment of text readability/quality; bash scripting (e.g., for computing on Wharton's High Performance Computing Cluster); Git for version control

Ron Berman

A/B Testing and False Discovery Analysis 2nd year applicants only

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Companies use A/B testing often to make decisions about their websites, apps, etc. However, many companies still use technology that was developed in the late 19th and early 20th centuries which is inadequate for today's online world.

The project will involve learning how A/B testing (online experiments) work and how companies use them. The goal is to design web apps such as the one in www.testandroll.com to help companies implement new research results about A/B testing and False Discovery Rates.

Knowledge of the R programming language is required, but prior experience with web or Shiny development is not needed and the project is designed to teach that.

OPERATIONS, INFORMATION & DECISIONS

Steven Kimbrough

Climate Policy Deliberation Modeling

**My project can be completed entirely remotely*

The summer project will continue an ongoing project, which can succinctly be described as follows:

The transition to net-zero emissions energy and to a sustainable, resilient society is necessary and inevitable. It is also terribly complex. This great transition requires implementation of a very large number of programs and policies. These programs will be selected from a much larger set of possibilities.

Organizations of all sizes--civic organizations, state and local governments, small, medium and large commercial firms, national governments, and international treaty organizations---have to grapple with decisions of which programs and policies to implement, and how. They are doing so today and will continue to need to do so at scale.

These circumstances raise the issue of how best to deliberate and decide on which programs should be implemented, when, and with what level of investment. That is the general subject of the Climate Policy Deliberation Modeling project.

The overarching goal of the project is to undertake broadly decision theoretic modeling in support of deliberation pertaining to the great transition. To this end, we are focusing initially on programs and policies that can be implemented by any of these target institutions:

- i. state governments
- ii. local governments
- iii. academic institutions

The project aims to:

- A. Obtain and maintain a comprehensive list of programs and policies that the target institutions can implement.
- B. Create a repository of documentation pertaining to the identified list of programs and policies.
- C. Produce reports assessing the various programs and policies.
- D. Assemble data and develop decision theoretic models for comparative evaluation of transition policies and programs, both individually and in portfolios.

Among the highest priority program and policy areas we shall focus on are: green financing and green banks, municipal composting, building electrification, electric buses and other service vehicles, lawn care electrification, research on green building codes, health-related studies, e.g., on health consequences of burning natural gas for cooking and heating (mainly air pollution).

Katherine Milkman

Behavior Change for Good

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

The Behavior Change for Good Initiative (BCFG) at the University of Pennsylvania is led by Professors Katherine Milkman, Angela Duckworth and an interdisciplinary team of 125 world-renowned economists, computer scientists, doctors, and psychologists. BCFG specializes in conducting large-scale field experiments designed to promote sustained behavior change. We have formed partnerships with some of the world's largest organizations to reach millions of their customers and students. Learn more about BCFG at bcfg.upenn.edu or through this Freakonomics podcast describing BCFG's founding vision: <http://tinyurl.com/bcfg2017>.

The Research Assistant will contribute to research conducted on this platform by assisting with all aspects of the research process, which may include conducting literature reviews and power calculations, preparing research materials, performing data analysis, and preparing reports and presentations. The Research Assistant may also provide general assistance for BCFG's work. Applicants should be familiar with social science research methods and data analysis (particularly in STATA and R). Familiarity with the Qualtrics survey platform is also helpful.

Serguei Netessine

Global Supply Chains: disruptions and cross-border taxation

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Global supply chains are becoming increasingly more complex for a myriad of good reasons, such as e.g. taking advantage of lower manufacturing costs and/or favorable tax regimes in other countries. The growing complexity, however, also exposes the supply chains to substantial sources of risk that can have a negative impact on the firms' profitability. As more and more data regarding inter-firm relationships and supply chain strategies become available, we aim to study the effect that global disruptions have on supply chains while trying to understand how firms trade-off their exposure to global risks with cost savings and tax advantages.

The project will involve handling large data sets on firm-level imports/exports as well as linking this data to firms' financial performance data and running regression analysis to understand the causal relationships between firms' strategies and financial performance. Skills required for this project include deep knowledge of R or Python for data analysis, data visualization, ability to handle large amounts of structured data and some regression analysis skills such as panel data analysis and event study analysis. Student involved in this project will learn about structure of global supply chains, data sources available to analyze inter-firm relationships as well as latest

research on global supply chains. While I have several specific data sources in mind, we will set exact research question and agenda as we progress, with the student's input.

Rebecca Schaumberg

Is guilt good? Experimental and survey research on moral emotions and moral judgments

**My project can be completed entirely remotely*

Spend the summer immersed in experimental and survey-based research on moral emotions (e.g., guilt, shame, and pride) and moral judgments.

Current research topics include:

1. How does witnessing someone experience shame affect our own decisions and behavior?
2. How does the expression of guilt, pride, or shame strengthen or change cultural norms?
3. How does a propensity to experience guilt or shame affect people's work-related outcomes? Are their environments in which people who experience these emotions thrive and others in which people flounder?
4. How do we think about people who forgive or do not forgive moral transgressions for which people do or do not express guilt?

While working on these research topics, you will develop or strengthen skills related to:

1. Experimental methods: How to set up an experiment, manipulate complex constructs, recruit subjects, organize and analyze data.
2. Survey methods: How to generate effective questions for surveys, administer surveys and understand survey data.
3. Literature reviews: How to leverage Penn's great library resources to identify relevant research studies. How to synthesize and organize this past research to generate predictions from it.

Skills and background.

- * Past exposure to experimental research through your coursework, readings, or research
- * Familiarity with identifying and reading academic research articles such as through Google scholar
- * Familiarity with Qualtrics and Stata or R helps, but it is not a must.
- * Creativity. Designing experiments often involves creativity. For instance, in the past, research assistants have recorded fake zoom meetings to manipulate expressions of shame to test how being shamed affects people's judgments and decisions. Research assistants have created fake company profiles to manipulate information about a company's moral culture to test its effect on applicants' interest in the company. Research assistants also have generated fake tweets to test when advocating for a social cause generates moral praise and when it does not.

This research assistantship would fit well with anyone interested in social psychology, behavioral economics, and judgment and decision-making.

Maurice Schweitzer

The Social Incentives Driving the Spread of Conspiracy Theories

**My project can be completed entirely remotely, My project can be modified to accommodate remote activities if made necessary by University policy*

Why do people share conspiracy theories? Interestingly, people may share conspiracy theories even when they know or suspect them to be untrue, but the widespread dissemination of a conspiracy theory ultimately shapes beliefs. In this research project, we investigate social forces, such as social exclusion and social feedback that influence the spread of conspiracy theories. Fellows will help run laboratory studies, analyzing data, present results in research lab meetings, and read relevant research. I hope to hold in-person meetings all summer, but this work can be completed remotely.

STATISTICS

Dylan Small

Racial Disparities in Gun Homicide Risk

**My project can be completed entirely remotely*

Substantial racial disparities exist for gun homicide deaths in the US: the 2003 to 2017 age-adjusted rate was 7.4 times higher for Black individuals than for White individuals. In a previous project, we found for a fixed socioeconomic status of a US Census tract—high, medium or low—US Census tracts with a higher proportion of Black residents have higher gun homicide rates (Cheon, C., Lin, Y., Harding, D. J., Wang, W., & Small, D. S. (2020). Neighborhood racial composition and gun homicides. JAMA Network Open). In this project, we will study whether at an individual level, Blacks of the same socioeconomic status as Whites are at higher risk of gun homicide and if so, how this relates to neighborhood characteristics. The results of the project will be useful in formulating policies to reduce racial disparities in gun homicide risk. The project will involve working with data from the National Violent Death Reporting System and the Gun Violence Archive. A student working on the project will gain knowledge and experience in statistical methods for data analysis as well as knowledge and experience in using the statistical computing software R. It is hoped that the work will result in an academic publication and the student would be a co-author for the publication. This project can be completely remotely.