Penn Undergraduate Research Mentoring Program
Project Descriptions

Summer 2022

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.

Annenberg

COMMUNICATIONS

Andy Tan

Project SMART - Social Media Anti-Vaping Messages to Reduce ENDS Use among Sexual and Gender Minority Teens

**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 evaluate the effectiveness of an SGM-tailored social media intervention to prevent vaping initiation among SGM youth ages 13-18 years. The current phase of this study will focus on exploring salient beliefs and cultural tailoring preferences related to vaping initiation among SGM youth, development of social media anti-vaping messages, and identify promising anti-vaping messages and cultural tailoring strategies to reduce vaping initiation among SGM youth. Under the supervision of the faculty member, responsibilities may include assisting with:

- Analyzing survey responses from 240 youth to compare vaping-related beliefs between SGM and non-SGM youth participants.
- Coding and summarizing qualitative focus group transcripts among 48-64 SGM youth on their beliefs that are related to vaping initiation that are salient to SGM youth, social contexts of their vaping behavior, and their cultural tailoring preferences.
- Develop and pretest a variety of SGM-tailored anti-vaping messages on social media.
- Drafting and programming an online survey questionnaire for a discrete choice experiment to inform selection of the optimal messages for SGM youth.
- 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 qualitative data analysis skills, survey programming, training in data cleaning and coding, use of mixed-methods research designs in health communication research, basic quantitative analyses, and approaches used to measure health message effects among health disparity populations. Students with a keen interest in health communication, health behavior change, and addressing health disparities are welcome to apply.

Arts & Sciences

ANTHROPOLOGY

Lauren Ristvet

Excavations in Azerbaijan from ca. 1200-800 BCE

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

During summer 2022, we are planning to excavate an Iron Age settlement in Naxcivan. This site, Sederek settlement, is located on the valley floor below a large Iron Age fortress, Sederekqala, which may represent the eastern edge of Urartu-- an empire that was Assyria's main rival in the first millennium BCE. Artifacts from Urartu were part of a large cultural sphere-- stretching from Etruscan Italy to Iran. Almost no settlements from this period are known in the South Caucasus (Armenia, Georgia, Azerbaijan) and Eastern Turkey, making this site extremely important. Work on a midden here has shown that it was occupied for 600 years (1300 BCE to 750 BCE). Jason Herrmann (CAAM) conducted a geophysical survey that found several houses lying underneath the surface. In 2019, we excavated part of a small house wall here-- and found pottery, obsidian, and animal bones.

The 2022 excavation will investigate both how ordinary people lived before the rise of Urartu-- and how this empire's conquest of Sederek affected (or did not affect) daily life. This bottom-up approach to empire-- which investigates colonialism on the frontiers as an always evolving process-- has the potential to provide new insights into this age of empire in the Middle East and Mediterranean. This period-- the Early Iron Age-- is an important research frontier from Italy to the Caucasus. The excavation would be interesting to anyone who wants to learn more about ancient history, Mediterranean archaeology, Near Eastern archaeology or just archaeology and anthropology in general.

The excavation will take part over 4 weeks in late May-early June. Students will excavate (supervised by professional archaeologists and graduate students) small houses and the midden. They will be introduced to a range of scientific and archaeological techniques and also have a chance to formulate their own research questions. Following the excavation, students will work on further analysis of digital materials and write reports-- either in Philadelphia or remotely, with regular zoom conferences. They will have a chance to turn this work into a larger research project, present it at conferences, and publish it.

If COVID means that the excavations cannot take place, students will work remotely on the vast unpublished material that we have amassed during excavations and surveys from 2006-2019-- which covers a period from ca. 3500 BCE to 1200 CE.

ASTRONOMY

Gary Bernstein

Analysing Astronomical Images from the Dark Energy Survey

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

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. Applications from first-generation/low-income students are particularly encouraged.

Masao Sako

Data Analysis in Astrophysics and Cosmology

**My project can be completed entirely remotely.*

Measuring Cosmological Redshifts of Supernovae Using the Earth's Atmosphere

As light from the sky passes through the Earth's atmosphere, refraction bends the light in a way that depends on the spectral properties of the source. Although these astrometric shifts are typically treated as a nuisance and corrected for in most astronomical image analyses, precise measurements of the source locations and modeling of differential chromatic refraction (DCR) can in turn be used to study the spectral properties of the sources that are otherwise inaccessible. In this project, the student will investigate to what degree DCR can be used to improve redshift measurements of cosmic supernovae. This is a high-risk/high-reward project that might lead to either a null result or potentially a high-impact result with deep implications for future supernova surveys. The student will work closely with the faculty and 2nd-year graduate student Jason Lee in Physics and Astronomy. Applicants should have taken at least a year of introductory physics. Basic coding skills in Python would be beneficial, but not necessary.

Data Mining Transient Astrophysical Phenomena from TESS

The Transiting Exoplanet Survey Satellite (TESS) is a NASA mission that is currently collecting data. Although the primary goal of the mission is to search for planets around other stars, the rich dataset is useful for studying various kinds of transient and variable astrophysical phenomena including supernova, supermassive black holes, variable stars, and other rare catastrophic events.

In this project, the student will develop Python code to analyze the light curves (brightness vs time) of sources observed by TESS. We have supervised machine-learning classifiers that can be adapted to classify some types of light curves. These light curves will then be used to simulate future observations with the upcoming Rubin Observatory Legacy Survey of Space and time. If time allows, the student will also help develop an unsupervised classifier for identifying rare and previously-unseen events. The student will work closely with the faculty and 3rd-year graduate student Helen Qu in Physics and Astronomy. Basic coding skills in Python are required for this project. Some background in basic machine learning would be beneficial, but not necessary.

BIOLOGY

Nick Betley

Neural Circuits Regulating Hunger and Exercise

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

The lab is interested in understanding how the brain processes information from the external world to facilitate appropriate behavioral responses that are necessary for survival. We study robust and essential behaviors such as feeding and drinking that are necessary for survival since the neural circuits that influence these behaviors are likely to be conserved. Dysfunction in these networks leads to improper decisions and has consequences for human health. In our current projects, we are beginning to explore how the brain changes following exercise and trying to understand how that influences our metabolism, food choices and overall health. We are currently seeking students interested in learning how to manipulate neural circuits in awake behaving animals and record neural activity in living mice. The research will focus on how food intake is regulated and how exercise changes that regulation.

Marc Schmidt

Neural Bases of Courtship Display in a Songbird

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

My laboratory is broadly interested in how the brain controls behavior and specifically the complex behaviors that are produced during courtship interactions. To study this question, we investigate singing behavior in brown-headed cowbirds, a highly gregarious songbird where males have a pronounced courtship display that contains both an elaborate song as well as a complex postural component. Interestingly, females also play a role in courtship exchange producing subtle wing displays in response to song.

We study this suite of behaviors from the neural circuit level all the way how it is produced in a natural social context. Summer students will be able to choose at what level they wish to be involved in the project.

At the circuit level, we perform neural recordings in the brainstem, trying to map out connectivity between areas involved in reproductive behavior and those that form party of a specialized neural circuit involved in song production. We are particularly interested in examining parallels between this circuit in males (which sing) and females (which do not sing but respond selectively to song with their wing displays). Part of the mapping process involves fluorescent imaging of brain slices and tracing connectivity between targeted brain areas.

At the more behavioral level, we have a large aviary equipped with 10 computer-vision cameras and 24 microphones where we can monitor moment-to-moment behavior in all birds (8 male and 8 female) during the entire breeding season. We are particularly interested in quantifying the dynamics between males and females during the breeding season and evaluating the types of signals used by males when courting females and the how females respond to these signals. Our long term goals are to eventually record neural activity during these interactions. This project is in collaboration with an engineering lab.

Corlett Wood

Ecological Genetics of Plant-Microbe Interactions

**My project is entirely in-person.*

Plants and animals rely on beneficial partnerships with microbes to survive. However, because hosts often suppress their immune systems when forming these mutualistic relationships, it can make them vulnerable to parasite infection. The Wood Lab studies how hosts navigate this tradeoff between forming mutualisms and fighting infection. Our goal is to understand the genetic basis of species interactions—especially between hosts, mutualists, and parasites—and how it affects ecology and evolution.

We study these questions in alfalfa and its relatives (the plant genus Medicago), a group of plants in the bean family. These plants rely on mutualistic bacteria for nitrogen, an essential nutrient. Our lab infects Medicago plants with a parasitic nematode—a widespread agricultural pest—to test how hosts balance mutualism and fighting parasite infection. The next phase of our research is to determine whether any of the plant genes that are required to recruit mutualistic bacteria are involved in parasite resistance. We will experimentally infect plants with bacteria and nematodes and search for regions of the genome that affect both interactions.

This project offers an opportunity for two undergraduates to learn the fundamentals of ecological genetics, host-symbiont interactions, and disease ecology. Students will collaborate with Dr. Wood, PhD students Mac Calvert and Addison Martin, and lab manager Nuri Yi on all aspects of this project, gaining experience in experimental design, plant and microbiology, data collection, and statistical analysis. No prior research experience is needed! Students with an interest in species interactions, evolutionary and ecological genetics, disease ecology, or plant biology are encouraged to apply.

CHEMISTRY

Tobias Baumgart

The Role of Protein/Protein Liquid Phase Separation in Interactions with Lipid Bilayer Membranes in Health and Disease

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

Our lab is intensely interested in how lipid / protein interactions contribute to the function of biological membranes. To be able to elucidate molecular mechanisms behind important processes involved in membrane function, we work with in-vitro systems and purified (ordered as well as intrinsically disordered) proteins. It has been recently discovered that the phase separation of protein solutions into a dense, protein-enriched, liquid phase coexisting with a more dilute phase, underlies a multitude of phenomena related to the function of biological cells. Some of these phenomena, such as the plasma membrane invagination process called endocytosis, occur on the surface of lipid bilayer membranes.

A recently discovered endocytic pathway called Fast Endophilin Mediated Endocytosis appears to involve liquid phase separation of the protein endophilin, an adaptor protein called lamellipodin, as well as a G-protein coupled receptor - the beta 1 adrenergic receptor. Interactions of the receptor with all other molecular key players: the lipid bilayer, endophilin, and lamellipodin, depend on local molecular properties of certain regions of the receptor, such as its electrostatic charge. This property can be modulated through post-translational modifications (PTMs) such as phosphorylation. This project will examine how such PTMs affect molecular interactions. We will be asking how PTMs affect mixing / demixing phase transitions, and how the resulting protein droplets interact with lipid bilayer membranes.

In this project, the participating undergraduate student will learn a significant spectrum of fundamental biochemistry and biophysical techniques, including molecular cloning, DNA and protein gel electrophoresis, protein and DNA purification and manipulation, as well as a multitude of additional characterization techniques, including both experimental and computational approaches. Mentoring will include the PI, as well as graduate students and postdocs currently affiliated with the lab. We have a significant amount of experience working with undergraduate students where our lab is their first research experience. Numerous of our peer reviewed publications have been co-authored by undergraduate students, with several featuring undergraduate students as first authors.

Ivan Dmochowski

Xenon-Based Contrast Agents for Molecular Imaging

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

The successful student applicant will join my laboratory as part of Team Xenon, which currently involves 1 postdoc, 4 graduate students, and 1 undergraduate, all of whom have experience mentoring undergraduates. Projects can be tuned based on student background and interest. Members of the group are designing proteins and small molecules that have good affinity for xenon and can serve as contrast agents for NMR/MRI. Why xenon? It turns out that Xe-129 has a spin-1/2 nucleus and is an excellent isotope for NMR/MRI studies. Through a process called hyperpolarization, a collection of Xe-129 spins can give a very large NMR signal, which is normally a limitation of this technique. Some group members express and purify proteins and others synthesize organic molecules that have high xenon affinity. Other commonly employed techniques in the laboratory include molecular dynamics (MD) simulations to learn about sites that xenon adopts within these structures, perform spectroscopic measurements including Xe-129 NMR spectroscopy and fluorescence quenching, and sometimes grow crystals for high-resolution analysis by X-ray crystallography. Over the past few years, significant breakthroughs have been made in the identification of proteins such as beta-lactamase, maltose binding protein and ribose binding protein, which yield considerable Xe-129 NMR signal. New small molecules generated in the lab are being tested for detection in live animals.

Karen Goldberg

Design and Synthesis of Organometallic Catalysts for Global Energy Solutions

Second-year applicants only

**My project is entirely in-person.*

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 Microbial Chemistry

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

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

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

[Skills, Experience, and Opportunities Available] Mentored introduction to the items listed under basic responsibilities, and a subset of the available skills to learn with each project (to be determined by student's interest).

[Basic Responsibilities] Strict adherence to laboratory safety protocols and regulations. Maintenance of a laboratory notebook in keeping with lab standards. Regular reporting to supervisor (both to Dr. McCallum and designated graduate student in the lab). Participation in laboratory events, including weekly lab meetings. Assistance with basic laboratory maintenance (cleaning and maintaining laboratory equipment, organizing supplies, preparation of common supplies, etc.). Carrying out approved experiments under the direct mentorship of Dr. McCallum and a current graduate student in the lab.

[Project 1] “Development of a novel biocatalyst.” Working with a current graduate student to discover and characterize a microbial enzyme that is hypothesized to carry out an interesting chemical reaction. Available skills to learn: basic molecular biology (PCR, molecular cloning, gel electrophoresis), protein expression, protein purification, biochemical assays, synthetic organic chemistry, microbiology.

[Project 2] “Comparative metabolomics.” Working with a current graduate student and/or Dr. McCallum to study the metabolites produced by different microorganisms and potentially discover new bioactive compounds. Available skills to learn: microbiology, natural products isolation, liquid chromatography, mass spectrometry.

[Project 3] “Functional metagenomics of a sponge.” Interrogate the biochemical capacity of a

marine sponge using modern biochemical techniques. Available skills to learn: basic bioinformatics, microbiology, molecular cloning, phenotypic screening, isolation of genomic DNA, creation and maintenance of a metagenomic library.

CLASSICAL STUDIES

James Ker

Methodologies for Latin Language Teaching in Philadelphia

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

One or more student-researchers will investigate the past, present, and future of Latin language education and select at least one specific method to explore in detail.

The geographic focus on Philadelphia reflects, first, the persistent influence of the city's schools, universities (including Penn), and publishing houses in the history of US classicism. The Philadelphia-focus is also motivated by the fact that new methods in educational linguistics can only be properly developed and evaluated with reference to a specific local community.

The student-researcher(s) will meet regularly with the advisor throughout the project, and will move through a structured process from exploration to proposal to deeper research to writing or presentation of new resources.

They may develop their own specific focus or choose from a range of possible topics already identified, including: classical themes in Black literary societies in nineteenth-century Philadelphia; the innovative mid-20th century textbook *The Road to Latin* published in Philadelphia and co-authored by an African American teacher, Helen Chestnutt; the widely influential *Using Latin* textbook published by Philadelphia school principal John Gummere; Rudolph Masciantonio's pioneering Latin-language program in Philadelphia elementary schools in the 1980s; the past and present activities of the Philadelphia Classical Society; the recently founded Boys Latin charter school in West Philadelphia; neo-Latin writings about Philadelphia and/or local inscriptions in Latin; opportunities for Latin-language enrichment in the Mediterranean Section of the Penn Museum; game-based, imaginative, or creative learning activities in which Latin language use is responsive to the learner's social context. The choice of topic may be informed by the student-researcher's specific interests or background. If two students are involved, they will have the option of working together on a shared topic or independently.

First-hand prior experience in learning Latin for at least one year is required.

The student-researcher will gain extensive content-expertise in the chosen topic and will also

further their skills in project-design, research practice, written and oral communication, and collaboration. The resulting project could be the basis for future for-credit work (such as a Senior Research Paper in Classical Studies) and/or specific resources used in future school-oriented programs.

EARTH AND ENVIRONMENTAL SCIENCE

Hugo Ulloa

Escaping from Light — A Circadian Migration of Active Matter in the Aquatic System

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

The collective migration of suspended microorganisms in natural aquatic environments is one of Earth's most mysterious and massive planetary-scale diurnal processes. Microorganisms, such as plankton, can move vertically over long distances (up to ~1km), from the near-surface euphotic region to deep dark zones to feed and avoid predators. They perform this extraordinary diurnal journey by swimming or controlling their relative buoyancy to the surrounding fluid. The inherent driver of this diel vertical migration (DVM) is the spatiotemporal light distribution across the water column of aquatic systems, such as oceans and lakes, known as phototaxis, that sets the light-oriented swimming direction.

The DVM process has been extensively investigated on zooplankton, where Daphnia had been the emblematic study subject on a lab scale. Mechanistic models have reproduced general features of the DVM. At the same time, numerically-based ecological models can resolve complex prey-predator dynamics. However, little is known on how fluid flow physics, such as background turbulence, affects microorganisms' strategy or ability to escape from the light.

This project builds on a current deterministic model to investigate the macroscopic behaviour of plankton for performing DVM by expanding the physics affecting vertical transport and mixing in aquatic systems. The project has two work packages; one student will lead each. In the first work package, a student will numerically resolve a one-dimensional, determinist model for DVM, incorporating new parameterizations for the plankton dispersion and the plankton-flow interaction. In the second (parallel) work package, a student will perform laboratory-scale experiments in Prof Arnold Mathijssen Lab facilities. Experiments will be performed on a slender plexiglass aquarium filled with water populated by Daphnia. The aquarium has an external illumination system that allows controlling the light intensity in the waterbody both vertically and temporally. Different flow fields will be induced by mechanic stirring to examine the response of Daphnia to light and fluid motions. We will use a camera system to track the spatiotemporal distribution of Daphnia. Both numerical and experimental methods will allow examining the response of the active organisms to light intensity and externally forced flows.

In summary, the study will explore a new deterministic model for DVM and the response of zooplankton to light and mechanical forcing experimentally. Therefore, we expect students to actively shed light on the scarcely explored biophysical processes linked to DVM and boost collaborations between Prof Mathijssen and Prof Ulloa. Both numerical and laboratory-developed settings will serve teaching purposes.

EAST ASIAN LANGUAGES AND CIVILIZATIONS

Ayako Kano

Adaptations of Japanese Fiction to Film

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

This project examines significant novels and short stories from modern Japan that have been adapted to film. The project will be ideal for students majoring in, or interested in pursuing, Cinema and Media Studies, Comparative Literature, East Asian Languages and Civilizations, Visual Studies, Gender, Sexuality and Women's Studies. The student will learn how to conduct basic research and fact-checking, how to deal with literary and cinematic materials such as document scanning and extracting film clips, and different citation formats for publishing. The project will consist of case studies that engage with some of the most important authors and film directors of modern Japan, such as Kenzaburo Oe, Haruki Murakami, Akira Kurosawa, and Juzo Itami. Knowledge of Japanese language is very helpful but not required.

ENGLISH

Emily Steiner

Animals in Medieval Literature and Culture

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

I am looking for research assistance for a book I'm commissioned to write for Reaktion Press. It will be a profoundly interdisciplinary book, and I welcome students interested in literature, history of art, religious studies, environmental humanities, classics, archaeology, and law. Competence in reading Latin, French, Hebrew, or Arabic is a plus.

Here's a description of the book:

This book surveys animals in medieval literature, art, and thought between c.800-c.1450. Primary sources will range from scientific and philosophical texts, such as Albertus Magnus’s

On Animals, to Arthurian romances, satire, fables, riddles, bestiaries, and saints' lives. Although the book will be focused primarily on the Western Middle Ages, it will make connections between Western and Eastern traditions, as well as comparisons across religious traditions, principally Christianity, Judaism, and Islam. In the broadest view, this book argues not only that the Middle Ages can teach us something about animals, but also that our symbolic, imaginative, and emotional investments in animals have been shaped by the Middle Ages.

Chapter titles:

1. Pecking Orders
2. A Walk in the Ark
3. The Whole Animal
4. Animals, in Part
5. Political Animals
6. Creature Comforts
7. Where the Wild Things Were

LINGUISTICS

Jianjing Kuang

Vowel Modification in Singing Voice

**My project is entirely in-person.*

Singing is a special instance of speech production. Speaking requires the minimum effort of voice production, but singing asks for more careful control of articulation to reach a much wider range of voice production. Moreover, unlike speaking, singing needs to achieve certain artistic goals (e.g., deeper and richer voice), which are essentially shaped by our human auditory and perception system. Because of these reasons, singing serves as an important venue to explore the mechanism and principles of speech production and perception. As a crucial part of the singing techniques, competent singers often modify their vowel space to facilitate their singing voice.

In this project, we will explore how singers' vocal tract gestures map onto the acoustic (audio) output in singing, and how the tongue and the vocal folds work together to achieve a better singing voice. A production experiment will take place over the summer, where singers of different voice types will be recruited to the lab to complete audio and articulatory recordings.

Students will gain substantive experience in data collection and analysis using (1) the ultrasound machine, to track the singer's tongue movement during singing and (2) the electroglottograph, which monitors the contact patterns of the vocal folds during singing. This project has important implications not just to phonetics and cognitive science, but more broadly to various related

fields, such as speech technology, treatment for pathological voice, singing pedagogy, and so on.

Studying singing voice requires very broad interdisciplinary knowledge such as linguistics, engineering, computer science, psychology, physiology, and musicology. Students with relevant backgrounds are encouraged to apply.

The study will take place at the phonetics sound booth in the linguistics department at UPenn. The experiment procedure will comply with the COVID safety protocol of the university.

Gareth Roberts

Experimental Communication Games

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

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.

There is more than one project students could become involved in, including an ongoing NSF-funded project in which participants communicate with each other by sending color signals, and other communicative projects currently under development. 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 if necessary, 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.

PHILOSOPHY

Quayshawn Spencer

A Pluralist Solution to the Race Problem

**My project can be completed entirely remotely.*

"A Pluralist Solution to the Race Problem" is the name of a book I'm working on that attempts to advance and defend a radically new metaphysical view of what race is and whether race is real in the USA. The arguments for the book have all been created. However, there are multiple

premises that still need to be thoroughly defended, and there's several objections to premises that need to be addressed. The remaining work is both empirical and conceptual. It's empirical because it requires finding relevant literature, reading that literature, collecting data from that literature, and analyzing the data. It's conceptual because it requires thinking about how best to collect and analyze the data, as well as how best to defend premises and respond to objections. The research assistant will learn how to write a book in the analytic philosophy tradition from start to finish, and will learn transferrable skills such as logical reasoning, critical thinking, creative thinking, and critical reading. The assistant will also learn a lot about philosophy of race, philosophy of biology, analytic metaphysics, and philosophy of science.

PHYSICS

Marija Drndic

Studies of Atomically-Thin 2D Materials and Devices

**My project is entirely in-person.*

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

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

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

We will consider a successful outcome of the project if the student develops a good grasp on the practical aspects of working with 2D materials as well as a decent understanding on what 2D materials are and how they fit within the larger picture of materials that physicist's study, why

they are interesting for basic physics studies and what is the range of their possible applications, as envisioned by the physics community at this point. The student will have a chance to participate in a world-class research, have a chance to contribute to new scientific results, be an author on new papers and also interact with other labs and collaborators at Penn with whom our lab collaborates. Finally, the student will have a chance to continue contributing to research in the Drndic lab beyond the summer and the PURM project.

Mentors will include: Postdoc Parisa Yasini, Graduate students: Jesse Elliott, Rachael Keneipp and Killian Chou.

I. Joseph Kroll

Automatic Recognition of Beaked-Whale Clicks across Acoustic Receivers in the Ocean

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

Quantifying the numbers and locations of beaked whales in the ocean is important for their conservation because they may be harmed from US Navy sonars during training operations. These whales emit patterns of clicks with varying intervals lasting tens of seconds. Locations of the whales are derived by measuring the time differences of arrival (TDOA) of a single click among a plurality of bottom-mounted receivers. Automatically identifying with a computer the same click at each receiver is the crux of this research opportunity.

You will work with real acoustic data and develop software to correctly associate the clicks, and you will learn about sound in the ocean, the behavior of these whales, techniques in signal processing, such as cross-correlation, and the writing of well-documented software routines. You will write a short final report and present the results to a small group of fellow researchers. It is anticipated the software will later be used with experimental data from the Marianas region of the western Pacific so the whales can be located and counted. Familiarity with the Matlab or Julia programming language would be helpful (not a prerequisite).

This project will be supervised by Dr. John Spiesberger (Dept. Earth and Environmental Science) and Professor Joseph Kroll (Dept. Physics and Astronomy). For more information, please contact Dr. Spiesberger at johnsr@sas.upenn.edu and prospective students may wish to look at www.scientificinnov.com.

Students from any of the Penn undergraduate schools with particular interests in the crossovers between physics/engineering/math/environmental science are encouraged to apply.

Robyn Sanderson

Dark Matter and Galaxy Formation: The Two-Headed Monster

**My project can be completed entirely remotely.*

Galaxies like our Milky Way form and grow in a complex ecosystem, shaped by influences from dark matter physics to the birth and death of stars. In our group we study this process from multiple angles: applying machine-learning tools to surveys of the Milky Way to uncover the origins and properties of its stars, using supercomputers to simulate the growth of galaxies under different physics assumptions, and using stellar orbits to map our Galaxy's invisible dark matter component. Our group tackles a broad range of questions using these approaches, tailored to the individual interests and background. Two possible projects:

1. Charting the death throes of massive stars: The evolution of massive stars---up to 100 times the mass of our Sun---strongly influences the evolution of galaxies, yet is very poorly understood. Understanding how these stars end their lives before exploding as supernovae has long been limited by the small number we have discovered. Because they are so rare, finding new massive stars requires searching other galaxies besides our own. With the recent successful launch of the James Webb Space Telescope, which is ideal for observing them, we urgently need to find more massive stars. Participating students will work with Dr. Adrien Thob, a postdoc in our group, to identify and characterize massive stars still hidden by the dust clouds in which they formed, by applying a recently completed, state-of-the-art analysis pipeline to observations from Spitzer, the precursor to JWST.

2. Probing dark matter with dynamics: For decades, we had limited information about the orbits of individual stars in the Milky Way. Then the Gaia mission measured positions and motions for more than a billion stars (about 1% of the total!), allowing us to infer the distribution of mass in our Galaxy by applying the laws of gravity. Most of that mass is dark matter, so changing the type of dark matter can affect stellar orbits. Participating students will work with Mr. Arpit Arora, a PhD candidate in our group, to construct models of the mass distribution of a Milky-Way-like galaxy formed with different types of dark matter, and explore the effect on stellar orbits.

Depending on their specific project, students will gain skills in: coding in Python and Jupyter, reading and analyzing simulated and real astronomical data, using the Linux operating system, the bash shell, or a computing cluster, making and interpreting plots and images, and characterizing data using machine learning.

Evelyn Thomson

Experimental Particle Physics at the High Energy Frontier

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

Experimental particle physics seeks to understand the fundamental particles and forces in the Universe. With the ATLAS experiment at CERN, a huge amount of data is available for analysis to search for new particles. Possible projects based at Penn include designing new searches for particles, applying machine learning to improve the sensitivity of searches, and developing outreach materials for local high schools and science festivals. More information about the Penn ATLAS group can be found here https://web.sas.upenn.edu/pennatlas/. See in particular the post on the US ATLAS SUPER symposium for a sense of the wide range of possible projects using ATLAS data.

Skills: Python, C++, Unix, presentations, particle physics.
Mentors: Professor Evelyn Thomson and graduate students James Heinlein, Lauren Osojnak, and Bobby McGovern.

POLITICAL SCIENCE

Marie Gottschalk

Race, Power and Punishment: Crime in the Streets and Crime in the Suites

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

I am writing a new book titled, "Race, Power, and Punishment" and developing a new class based on the book. This project compares and contrasts the politics of "street crime" and the politics of corporate crime. The similarities and differences between how "crime in the streets" and "crime in the suites" are punished is a central theme of the project.

Key questions include: Why are certain people and groups disproportionately subjected to criminal penalties and to state, interpersonal, and political violence? Why did the United States start punishing street crime more harshly while lightening up on the prosecution and punishment of corporate crime? What should be the main goals of criminal justice reform? What are the primary political obstacles to achieving those goals?

Key topics include the causes and consequences of mass incarceration and the rise of the carceral state; racial, economic, ethnic, geographic, and gender disparities in punishment; and state, corporate, political, and interpersonal violence. The three case studies for the analysis of "crime in the suites" are: the Great Recession and financial crisis; the opioid crisis; and the climate

emergency.

While I expect the book will break new scholarly ground, I am aiming to make it widely accessible to undergraduates. For this reason, I would especially welcome assistance from undergraduates in how to frame the arguments and present the data and evidence in ways that are clear and engaging to students.

This is an opportunity for students to develop research skills in several key areas, including: how to compile annotated bibliographies on a given topic; how to use key databases related to this topic; how to present data using graphs, tables, and other graphics; how to summarize books and articles; how to track down citations and put them in proper bibliographic form; how to track down requested information/data; and how to edit, copyedit, and proofread. It also is an opportunity for students to develop their organizational skills; to learn how to prioritize tasks and meet deadlines; to take initiatives in conducting research; and to become better at focused reading, including when to skim and when to read line by line.

This project is also an opportunity to learn more about race and the criminal justice system, as well as the relationship between reform of the criminal justice system and reform of the U.S. political economy.

Julia Gray

International Cooperation in Times of Global Crisis

**My project can be completed entirely remotely.*

How does the world cooperate on dire global problems -- public health, the climate, trade, finance, migration, and security? Can international organizations (IOs) promote peace, prosperity, and international cooperation? In the last 100 years, countries have formed and joined IOs to tackle these problems, but we know surprisingly little about what exactly makes international cooperation effective, and when and why it fails. In this project, students will examine several IOs from a variety of aspects: their day-to-day operations, how they are perceived in the press, and their legal obligations, to name a few. Because IOs operate on so many dimensions, this project should be of interest to students with a passion for international law, international political economy, inequality in the global economy, and domestic politics. Depending on their level of skill and their substantive interests, students will have the opportunity to conduct in-depth research on a particular IO or region of the world, or work with data that quantifies the comparative advances of IOs. As such, language skills (particularly Arabic, French, or Spanish) and/or data science skills (R or Python) are a plus, as are organization and patience. I am particularly interested in mentoring highly aided, first generation, and BIPOC students.

PSYCHOLOGY

Sara Jaffee

Identifying Academic Outcome Data from the Philadelphia School District

**My project can be completed entirely remotely.*

The student will work with a team that is preparing an application to obtain data from the Philadelphia School District related to child and adolescent school outcomes. This will involve reviewing data that are available from the District, meeting with the team to discuss which outcomes are most relevant for study, becoming familiar with the District's requirements for the proposal, and helping to write the proposal. It may also involve designing an interview that can be administered to teachers or administrators to better understand the strengths and limitations of those data. If data become available during the summer, the student will also be involved in helping to clean and process variables for use in analyses. The student may also be asked to help with data cleaning and processing related to a different project about the experiences of students at Penn who are the first in their families to go to college. As part of working with data, the student will be introduced to Stata statistical software. The student will also be introduced to the Web of Science search engine for conducting literature reviews relevant to the Philadelphia School District application.

Martin Seligman

Understanding Stably Happy People and Exploring the Role of Agency in World History

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

Our lab is currently conducting two major lines of inquiry, side-by-side, "Understanding Stably Happy People" and "Exploring the Role of Agency in Human History." One undergraduate researcher would be assigned to each line of inquiry.

Understanding Stably Happy People: Some people are not only happy in their lives, but their happiness barely changes throughout the day, no matter what they are doing or what has happened to them. Our project attempts to understand this kind of happiness and how it differs from other kinds of happiness and from clinical presentations of high positive affect. The undergraduate researcher on this project would be involved in data collection, data extraction, and literature reviews to determine some of these candidate differences to validate the existence of this phenomenon. The researcher may also assist in explanatory and theoretical components of this research: how does this situation arise? The undergraduate researcher working on this project will work closely with Max Genecov, a doctoral student in clinical psychology, with oversight from Martin Seligman.

Exploring the Role of Agency in Human History: The sweep of human history has been viewed

through the disciplines of economics, ecology, religion, “great man” biography, and “social force” history, but rarely through psychology. Our research team is positing that human psychology is the central force in human history, and exploring the role of agency as it pertains to human progress. Research is focused on assessing the frequency of beliefs in the power of human agency (i.e., efficacy, optimism, and imagination) across history, particularly American History over the last 300 years, with a special focus on gender and race, and to examine the relationship between these beliefs and societal progress. European, Islamic, Indian, and Chinese history may also be examined in parallel. The undergraduate researcher on this project would be involved in operationalizing variables (i.e., progress and agency) for different historical groups/periods, data collection, and literature reviews focused on lexical analysis and human progress. The undergraduate researcher working on this project will work closely with Noah Love, Martin Seligman's research coordinator, with oversight from Martin Seligman and Lyle Ungar.

Larry Silver

Art Museum Core Well-Being Survey

**My project is entirely in-person.*

Increasingly, communities and nations are turning to art museums to address well-being needs. But how do art museums support well-being in visitors? It’s difficult to answer this question with confidence since art museum well-being research is just beginning and currently relies on disparate measurement strategies, limiting the ability to reach consensus. This research project involves the testing and validation of a new survey instrument to assess visitor well-being in art museums. Working with three partner museums—the Carnegie Museum of Art, the Andy Warhol Museum, and the Westmoreland Museum of American Art—this project will recruit art museum visitors to take part in a survey of their experiences within the art museum and their well-being.

The newly developed survey instrument will capture why visitors chose to come to the museum, their emotional experiences within the museum, and their personal well-being related to their museum visit. The project will culminate in a peer-reviewed publication, a non-technical report for art museum professionals, and free distribution of the tested survey instrument.

Students will have the opportunity to gain expertise in the science of well-being, take part in participant recruitment and data collection as part of art museum field research based in Pittsburgh, and develop generalizable professional skills, including data literacy (through assisting in statistical analyses) and scientific communication (through assisting in writing about the project’s findings). Student mentorship will be provided by a team of interdisciplinary researchers with expertise in both the arts and humanities and psychology, including Humanities and Human Flourishing Project Director, Dr. James Pawelski, and Postdoctoral Fellow, Dr. Katherine Cotter.

RELIGIOUS STUDIES

Donovan Schaefer

Hard Feelings: Historic Black Perspectives on Confederate Monuments

**My project can be completed entirely remotely.*

Monuments and memorials—obelisks, statues, plaques, street names—commemorating the history and key figures of the Confederate States of America began to appear shortly after the end of the US Civil War in 1865, mostly (though not exclusively) in former CSA territory. But as many historians have noted, significant spurts of commemoration occurred during periods in which white supremacism was being reasserted, especially during the post-Reconstruction, Jim Crow, and Civil Rights eras. These artifacts have been contentious for decades, but the Black Lives Matter movement has amplified calls for their removal, with an increasing number of monuments and memorials taken down over the past five years. Meanwhile, monuments like the now-removed Robert E. Lee statue in Charlottesville, VA and Silent Sam in Chapel Hill, NC have become flashpoints for protest and white supremacist violence.

Defenders of these artifacts often characterize controversy around them as a new development, a symptom of an oversensitive, less historically conscious society. But in fact, there have been challenges to these artifacts for as long as they have been in existence. Writing in 1931, for instance, W.E.B. Du Bois stated that all Confederate monuments should be affixed with a plaque reading "Sacred to the memory of those who fought to Perpetuate Human Slavery." Such statements demonstrate that criticism of Confederate statues has long been linked to a sophisticated analysis of race, politics, and public culture.

This project will draw out early voices—especially Black voices—theorizing the malignant political effects of CSA commemoration. The focus will be the dozens of Black-owned newspapers (like the Pittsburgh Courier, the Richmond Planet, and the New York Amsterdam News) as well as magazines (like Du Bois' Crisis) digitally available through ProQuest, Penn Libraries, and the Library of Congress' "Chronicling America" database. Student researchers will target specific publications and explore their digital archives, building a broad collection of perspectives, commentaries, images, and analysis.

Student researchers will gain hands-on experience investigating digital archives, knowledge of the history of public material culture in the US, and expertise in how Black commentators understood race in the post-Civil War and Jim Crow eras. Students will also help arrange the materials for presentation in a digital format (to be carried out at a subsequent phase of the project), developing their design and curatorial skills.

No specific background or experience is necessary, though previous coursework in the humanities will be beneficial.

SOCIOLOGY

Xi Song

The Long-Term Evolution of Occupations Using Occupational Outlook Handbooks

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

The research team will digitize historical government publications of the Occupational Outlook Handbook (OOH, hereafter) on career guidance featuring hundreds of occupations biennially from 1949 to 2020 and harmonize the OOH occupational codes with Census Standard Occupational Classification (SOC). Drawing on cutting-edge natural language processing and machine learning methods, we will convert unstructured text descriptions of occupations into structured variables. Analyses using these occupation-level characteristics will offer new insights into changing occupations, jobs, and the workforce in the United States, particularly the growth and decline of different occupations and inequality in changing occupational opportunities for different social, economic, and demographic groups. Undergraduate RAs will be given crash courses in Python and R programming languages in general and regular expressions for text processing in both languages in particular.

Michael Lachanski, PhD student in Sociology
Sukie Yang, PhD student in Sociology

Dental Medicine

ORAL MEDICINE

Katherine France

Patient Attitudes Regarding the Role of the Dentist in Vaccination for Coronavirus Disease 2019 (COVID-19) and Human Papillomavirus (HPV)

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

The primary objective of this study is to better understand patients' attitudes toward the role of dental professionals in provision of preventive health care, specifically in the distribution of vaccines for COVID-19 and HPV.

This is an extension of a pilot study completed in 2021. A previously published questionnaire regarding patient acceptance of HPV vaccination by dental providers was adjusted and distributed. Survey questions addressed patients' attitudes and acceptance of HPV and COVID-19 vaccination, their perceptions of dental care providers' role in HPV and COVID-19 vaccination, and their comfort in having a dental provider administer HPV and COVID-19 vaccines both in general and on the day of the survey as well as comments and demographic information. The proposed continuation of this study will include validation of the survey using a focus group of eligible patients and expanded data collection.

Content validation will be completed in partnership with Tamara Cadet, PhD, Associate Professor at Penn Social Policy and Practice. This phase will allow for adjustment of the survey instrument to align questions with a health belief model. We will first distribute the adjusted survey to content experts in the field to determine the appropriateness and applicability of the questions. The survey will then be distributed to a focus group of patients to determine the construct validity, appropriateness of wording, clarity of scoring, and meaning of the questions. These results will then be recorded, transcribed, coded according to the health belief model, and analyzed for themes to determine appropriate changes. Based on this feedback, the study team will revise the survey instrument.

After validation, the adjusted study instrument will be distributed to a convenience sample of 600 young adult (18-45) patients attending appointments at Penn Dental Medicine community sites that serve this population (Dr. Bernett L. Johnson Sayre Health Center, Spectrum Health Services, Philadelphia FIGHT, and others as available). This data collection will take place in person.

The appropriate student partner for this project has an interest in health equity, health beliefs, and access to care, the ability to work with both faculty and patients, and a strong work ethic and warm personality. They will learn how to analyze health beliefs and survey instruments as well as fundamental skills of survey-based research and public health data collection. Depending on

the student and in accordance with University policies, the project may include both phases above or may be limited according to necessity.

ORAL SURGERY AND PHARMACOLOGY

Katherine Theken

Identifying Biomarkers of Analgesic Response to Ibuprofen Following Wisdom Tooth Extraction

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

The current opioid crisis has highlighted the need to optimize pain management with non-addictive analgesics, such as non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs are recommended as first-line analgesics for the majority of patients undergoing third molar (wisdom tooth) extraction. However, there is considerable variability in the degree of pain relief that patients experience, with 20-30% of patients requiring supplemental opioid medication for adequate pain control within 6 hours of the initial NSAID dose. In order to avoid undertreating patients who will not respond adequately to NSAIDs, oral surgeons routinely prescribe opioids to all patients to be taken if needed, resulting in unused opioids for many patients who do not require them which are subject to misuse and diversion. The use of precision medicine approaches to tailor analgesic therapy would enable oral surgeons to prescribe opioids only to those patients who require them and avoid unnecessary opioid prescriptions in those patients who can achieve adequate pain relief with NSAIDs alone. This project focuses on identifying the factors that contribute to inter-individual variability in the analgesic response to ibuprofen and need for opioids after third molar (wisdom tooth) extraction. The ultimate goal of this work is to identify biomarkers that are predictive of analgesic response to NSAIDs and facilitate a precision medicine approach to pain management.

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

Design

ARCHITECTURE

Laia Mogas Soldevila

Biomaterial Pavilion Prototyping

**My project is entirely in-person.*

In this project a team of interdisciplinary undergraduate researchers will fabricate and assemble a prototype structure for an architectural pavilion entirely made of new biomaterial composites.

-- Background:
I am an interdisciplinary Designer and for the last decade I have interfaced with Materials Science and Biomedical Engineering to transform material systems proven by life sciences to be benign to the human body, into at-scale Architecture that is benign to the Earth. Specifically, I develop ultra-sustainable blends and objects from shrimp, fungi, wood, algae or silk materials that outperform some technical composites and ceramics, and ultimately biodegrade without toxicity unlike their man-made counterparts.

-- Completed Research:
In the last 5 years, with colleagues at MIT and Tufts Biomedical, this PI has developed a large-scale additive manufacturing platform to make biodegradable structured surfaces using biomaterial blends. Since September 2021 at Penn I am extending this platform to scale the work into pavilion-size to demonstrate, not only mechanical performance and new aesthetics of biomaterial skins, but also self-supporting structural assemblies towards their adoption into sustainable architecture systems. The project presented here directly contributes to this endeavor.

-- Project Steps:
By Summer 2022 STEP 1 & 2 will be completed:
STEP 1 - BLENDS: We are developing a catalogue of biomaterial blends for the improved additive manufacturing platform mentioned above.
STEP 2 - TESTS: Promising blends will be printed in Spring 2022 forming complex geometries at 1:1 scale.
During Summer 2022 we will focus on STEP 3:
STEP 3 – PAVILION PROTOTYPE: From the tests, a final system will be chosen for completing a prototype for a large-scale pavilion that will be shared at a conference venue or as part of a museum exhibit.
DETAILED SUB-STEPS
3.1- use 3D CAD software to design a structural shape from which select a chunk to prototype
3.2- generate tool paths for material extrusion using our custom computational tools

3.3- extrude biomaterials on tool paths layer by layer in our custom 2.5D printing platform
3.4- fabricate the chunk skeleton using CNC-machining of plywood or 3D-printing of plastics
3.5- assemble the prototype chunk and test its durability, stability and aesthetics concluding recommendations for further development

-- Direct Mentorship:
On top of my direct mentorship in lab, students will learn from:
— Liam Lasting, our projects director and graduate Architecture student developing innovative soil construction methods.
— Vlasta Kubusoba, our synthetic biology lead and visiting PhD student developing scent-encapsulating biomaterial objects.

FINE ARTS

Joshua Mosley

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

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

The goal of the project is to produce a series of animated videos that will inform both the Dutch water sector and the public at large about the impact of accelerated sea level rise on the Netherlands and to contribute to public debate about the best adaptive approach. Although 26% of the Netherlands is below sea level and a further 34% is vulnerable to flooding, the Dutch are convinced that their water defense systems will continue to protect them as they have since the last major flood in 1953. The climate emergency changes all that. A core group of Dutch climate scientists, adaptation specialists, and climate activists have been trying to inform policy makers and the public about the need for radical adaptive action, to little avail. Because half the population resides in vulnerable areas where 70% of GDP is earned, there is a tendency to downplay the seriousness of the threat. Our goal is to develop approaches with animation that deliver the message in a manner that gets past defenses.

We call our effort Project Poldergeist. The project was initiated in the summer of 2021 by Professor Simon Richter, who remains as my co-mentor, and three PURM interns, who have also continued. They produced a first video with the title “How Much of the Netherlands is Below Sea Level?” that had over 4,400 views on YouTube. Analysis of viewership and circulation on social media shows that the video has been seen by many members of the professional water sector and in other countries that turn to the Dutch for water expertise.

As a collaborator in this research project, you will dig into the policy and adaptation dilemmas posed by accelerated sea level rise. You will have the opportunity to engage with experts in the

fields of climate science, water management, adaptation, engineering, city planning, and policy. Following the research phase, you will be involved in the video production process with the goal of bringing unacknowledged aspects of climate adaptation into public view in a manner that has a positive influence on public opinion and policy making. Storyboarding and video production will consist of collaborative and individual components. In contrast to last year's iteration of the Poldergeist Project, there will be a greater focus on the development of effective animation strategies that have the potential to convey knowledge, reframe issues and change behavior.

Education

EDUCATION, CULTURE, & SOCIETY

Krystal Strong

The MOVE Activist Archive

**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 in 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. Under the leadership and in collaboration with Mike Africa Jr. of The MOVE Organization, the MOVE Archive is a site of organizational history and collective memory, a catalyst for transformative justice, and a guide for social movements.

The MOVE Activist Archive works 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. Student archivists will receive training to help describe, create metadata, organize, and catalog a unique collection of MOVE organizational materials. Additionally, students will work directly

with members of the MOVE organization and help collect oral histories about their lived experiences and political work.

TEACHING, LEARNING, & LEADERSHIP

Janine Remillard

Supporting Novice Teacher Development through Online Inquiry Groups

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

This design-based research study seeks to explore ways that learning to teach might be extended beyond the boundaries of teacher education programs through online video-feedback inquiry groups. Our instructional focus for this study is a short, high-leverage, classroom activity, called a number sense routine. Using an approach developed through our previous research and an online video commenting platform (Torsh), novice teachers upload videos of brief number sense routines recorded in their classrooms and then comment on the videos of others in the group, over several cycles. Each inquiry group will participate in two cycles of inquiry in the spring of 2022 and another two in the fall of 2022.

Video and feedback data collected from participants during the inquiry group cycles, along with two focus group interviews, comprise the corpus of data for the study. Data collected in Spring of 2022 will be analyzed during the summer. Findings from this analysis will guide redesign of inquiry group structures and supports for two additional cycles in Fall 2022. Through these cycles of inquiry and revision, we will develop, test, and refine a low-cost and sustainable model for supporting novice teachers as they enter the work force. Findings can also inform approaches used in the teacher education programs to develop novices' skills in implementing number sense routines.

The undergraduate researcher will work with a team of faculty and doctoral students from the Graduate School of Education to analyze qualitative data and synthesize preliminary findings. Through this work, the mentee will learn how to use coding schemes to code video and transcribed data, look for patterns, and generate preliminary assertions, in collaboration with other researchers. This project will be of particular interest to undergraduates interested in education, as working on the project will introduce them to current research on mathematics teaching, urban education, and teacher development.

The project is directed by two GSE researchers, Janine Remillard and Caroline Ebby. They will oversee the research. The team includes several GSE doctoral students, who are experienced teachers and researchers. The undergraduate will be trained and mentored by PhD student Lara Condon and will be supervised by Janine Remillard.

Engineering & Applied Sciences

BIOENGINEERING

Lukasz Bugaj

Quantifying How the Cell Cycle Affects Cell Death during Targeted Cancer Therapy

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

Many cancers can be treated with potent drugs that block specific oncogenic proteins. However, after some time on treatment, cancers often develop resistance to these drugs. Thus there is a critical need to understand how cancer cells respond and adapt to the drugs we use to target them. Our lab studies drug resistance in a class of lung cancer cells, the deadliest form of cancer in the US. Our work indicates that upon drug treatment, cells preferentially die in some phases of the cell cycle over others. By understanding this cell cycle dependence, we hope to identify cellular factors that might promote cancer cell death more efficiently. However, very little information exists about how cancer cell behavior varies as a function of cell cycle stage.

In this project, we will directly observe and quantify the cell cycle progression of cancer cells upon treatment with therapy. We have generated cancer cell lines that express fluorescent reporters that indicate all 4 cell cycle stages. Using these cell lines, we have begun to generate time lapse movies of these cells under drug treatment.

The goal of this summer PURM project will be to develop a method to extract, quantitate, and visualize how cell cycle progression changes during drug treatment. We will use a combination of published and custom MATLAB scripts to automate cell detection, tracking, and fluorescence quantitation. We will also import single-cell time lapse data into R and visualize the cell cycle and cell fate (eg, survival, death) data. Success in this work will generate new knowledge on the relationship of drug treatment to cell cycle progression, and will generate new hypotheses for effective drug treatments that leverage cell-cycle-specific mechanisms to promote cell death.

Through this process, the student will develop many important skills including programming in MATLAB and R, image analysis, cell tracking, data wrangling and analytics, data visualization, and cancer biology.

Christopher Fang-Yen

(1) Deciphering Neural Circuits in a Worm. (2) The Physics of the Violin

**My project is entirely in-person.*

Our lab has positions available in two unrelated projects. Please indicate which is of interest to you.

1. 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 use an infrared laser system to kill specific cells or sever nerve fibers to test models of the function of these structures. 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.

2. How do violins work? Despite more than a century of study, many important unsolved problems remain. In particular, different bows have different tonal qualities, but how these qualities are related to the bow's physical properties is poorly understood. A new project in our laboratory focuses on understanding how the bow interacts with the body of a bowed string instrument to generate sound. During playing, the bow hair is drawn against the string, causing the string to repeatedly stick to and be suddenly released by the hair, in a process known as stick-slip oscillation. These string movements then create vibrations in the body of the instrument, which radiate sound to the air. We are developing a novel device for modulating the bow's properties and measuring its vibrations and the resulting sound generation during bowing. The student will help construct this device and use it to test models of coupling between the bow and instrument. Tasks may include mechanical construction, circuit design, computer programming and modeling, data acquisition, data analysis, and interpretation of results. Prior experience in electronics, computer programming, and/or 3D printing is helpful but not required.

Brian Litt

Continuous Seizure Risk Assessment in Focal Epilepsy Patients

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

Mentored by Brian Litt, M.D., and PhD students Akash Pattnaik, Nina Ghosn

Motivation
The motivations of this project are to monitor epilepsy monitoring unit patients with a continuous measure for seizure risk. Epilepsy patients are monitored for 7-10 days with a minimal understanding of how likely a patient is to have a seizure at various points. Rather, clinicians anticipate seizures using vocal cues from patients and physical cues indicative of incoming seizures. A computational model for seizure risk would inform the dynamics of a person's seizures and how external inputs modulate incoming seizures.

Methods
A recent Kaggle competition challenged participants to forecast seizures from long-duration continuous iEEG and the winning algorithm was published. The first step will be to calculate the set of winning features from this algorithm, which include normalized band power, cross-frequency coherence, and signal mean and variance. We will select 16 channels per patient and calculate features on 20 second segments per the Kaggle competition. The training set will consist of pre-ictal and inter-ictal clips from the first n seizures and the testing set will consist of iEEG from consecutive seizures. Then, we will apply XGBoost to classify between pre-ictal and inter-ictal clips. Since the original model was developed for multi-month recordings, the primary challenge with this project will be to identify a model that works on our multi-day recordings. We can use the probability of classification as a metric for seizure risk, and consequent analysis will include change in risk following medications, at circadian cycles, and changes before seizures.

Skills
Proficient coding ability in either Python (preferable) or Matlab
At least one semester of an undergraduate machine learning course or one semester of an undergraduate signal processing course
One semester of an undergraduate neuroscience course is beneficial but not necessary

Michael Mitchell

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

**My project is entirely in-person.*

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.

Andrew Tsourkas

Generation of Antibody-Drug Conjugates by Proximity-Based Sortase Mediated Ligation

**My project is entirely in-person.*

There has been growing interest in the use of antibody drug conjugates (ADCs) for the treatment of cancer as mounting data suggests an increase in anti-tumor effectiveness and reduced toxicity, compared with the administration of unlabeled antibodies either alone or in combination with chemotherapy. To date, all of the FDA approved ADCs are heterogeneous formulations in terms of both the location of the drug and the number of drugs per antibody, i.e. immunoglobulin G (IgG). Recent evidence has shown that differentially labeled antibodies, i.e. labeled at different locations and with different numbers, can have distinct therapeutic and pharmacokinetic properties and some subpopulations can show little, if any, therapeutic activity yet account for most of the toxicity. Therefore, there has been a movement towards the development of site-specific ADCs, which are precisely labeled with drugs at pre-defined locations.

Leveraging our experience with engineering antibody binding domains and sortase enzyme activity, we have recently developed two new approaches for the preparation of highly uniform ADCs, one site-specific bioconjugation approach, Proximity-Based Sortase-mediated protein Ligation (PBS-PL), whereby sortase is used to ligate drugs to a peptide tag that has been introduced into the antibody backbone, and one region-specific bioconjugation approach, Proximity-based Sortase Isopeptide Ligation (PBS-IL), which allows for the labeling of native antibodies with reduced variability compared with current lysine/cysteine residue labeling approaches. Both methods produce ADCs in high yields, are compatible with glycosylated IgG, and offer vastly more flexibility in antibody-drug linker chemistry. Therefore, we believe that these technologies will provide new, favorable approaches for the production of ADCs that will be of interest to the pharmaceutical industry.

Students working on this project will prepare various ADCs using PBS-PL and PBS-IL and characterize the physical chemical properties and efficacy of these agents against pancreatic cancer cell lines. Students will learn protein engineering skills, including the genetic modification of proteins, protein expression, and protein purification. Students will also analyze ADCs via electrophoresis, chromatography, and mass spectrometry. Finally, students will perform cell cytolysis assays to measure efficacy. Students will be trained on requisite techniques by graduate students and research associates in the lab.

CHEMICAL AND BIOMOLECULAR ENGINEERING

Bomyi Lim

Generation of Live Cell Imaging System to Investigate X-linked mRNA Expression Dynamics during Immune Responses

**My project is entirely in-person.*

X-chromosome Inactivation (XCI) is the dosage compensation mechanism utilized by female mammals to equalize the expression of X-linked genes between the sexes, by silencing one of the X alleles. We are collaborating with Dr. Montserrat Anguera's lab at Penn Vet, who discovered that lymphocytes have a unique "dynamic" mechanism to maintain XCI, where naïve T and B cells' cytological enrichment of Xist RNA at the inactive X allele return to the chromosome during discrete phases of development. We hypothesize that the repressive chromatin along the inactive X chromosome is more relaxed in immune cells, allowing some genes on the inactive X chromosome to be activated in response to immune stimulation from pathogens. We will test this hypothesis using CRISPR genome editing to generate mouse models capable of allele-specific live imaging of X-linked gene expression during lymphocyte development and also for mature cells responding to pathogen infection. We believe that such transcriptional escape from the inactive X can account for the more robust immune response observed in females vs. males and pathologically contribute to female bias observed in several autoimmune diseases.

Undergraduate researchers will work closely with a PhD student to ensure successful training and mentoring while learning important protocols involved with conducting research projects. They will learn to perform CRISPR/Cas9-mediated genome editing, mammalian cell culture, confocal microscopy, and image analysis using custom-built Matlab scripts for quantitative analysis. The PI will meet regularly with the students to provide guidance and feedback as well. Since the project involves both traditional biological experiments and quantitative analysis, students will obtain insights from multiple disciplines.

Lu Lu

Physics-Informed Neural Networks for Solving Differential Equations

**My project can be completed entirely remotely.*

Deep learning has achieved remarkable success in diverse applications; however, its use in scientific computing under the name of scientific machine learning (SciML) or AI for Science has emerged only recently. In this project, we will focus on the use of deep learning in solving partial differential equations (PDEs). Physics-informed neural networks (PINNs) solve a PDE via embedding the PDE into the loss of the neural network using automatic differentiation. The PINN algorithm is simple, and it can be applied to different types of PDEs, including integro-differential equations, fractional PDEs, and stochastic PDEs. Moreover, from the implementation point of view, PINNs solve inverse problems as easily as forward problems.

Despite promising early results, there are still some issues in PINNs to be addressed. One open problem is how to effectively sample the residual points for the training of the PDE. The residual points are usually randomly distributed in the domain or grid points on a lattice. However, this may be not efficient in certain cases. Very recently, there are some works along this line. In this project, we will develop different methods to generate residual points and improve the training efficiency of PINNs, including employing different quasi-Monte Carlo methods and proposing new active-learning methods.

In order to incorporate undergraduate students into my project, the students will be mentored as follows.
(1) Accessible beginning: As a start, undergraduate students will learn fundamentals of deep learning and programming using Python and TensorFlow/PyTorch. The student may also read the materials of my course "Data Science and Machine Learning in Chemical Engineering" in Spring 2022. I have developed a Python library, DeepXDE (https://github.com/lululxvi/deepxde), for PINNs. the student will learn how to use DeepXDE to solve PDEs.
(2) Data collection and analysis of computational tasks: This project focuses on a comprehensive comparison of different numerical algorithms, and thus it heavily relies on computers. The students will perform computational tasks by running existing algorithms, collect and analyze the output data, and compare the effects of different parameters and the performance of different algorithms.
(3) Improving current algorithms (optional): After the students have a good understanding of the current algorithms, the students are encouraged to modify the algorithms to improve the performance, but this is optional.
(4) The students will interact with our PhD students and have regular weekly meetings with the PI.

COMPUTER AND INFORMATION SCIENCE

Jianbo Shi

High Fidelity Human Behavior Modeling and Prediction

**My project can be completed entirely remotely.*

We envision an AI agent as the missing cognitive link between humans and machines. The AI "brain" will use its multimodal sensing capabilities to understand the human: to model, explain, and predict human behaviors. Such understanding should not be limited to physical appearance or 3D body dynamics, but at the mental model level: recognizing intention, personality, the moment of confusion, etc.

While our past research has focused on universal models for human behavior, our current effort is focused on constructing a "personalized" prediction model tailored to individuals with different experiences and personalities.

We are studying this problem by constructing an escape-room experiment. The subjects' goal is to follow clues placed around the room to find multiple related objects and either conceptually relate or physically assemble the objects. We record from two egocentric cameras: a head-mounted GoPro and Gaze-tracking Tobii glasses. We also record from up to four third-person cameras: a pair of synchronized Azure Kinects and insta360s. We have created a detailed 3D map of the room using a Matterport Scanner. With this dataset, we construct an AI model for modeling semantics of high-level/long-term subject decision-making and action-taking by correlating 1) gaze pattern, 2) attention, with 3) hand-object interaction and body movement.

Trainees in the project will learn computer vision and deep learning tools, and hands-on experience with data collection.

Duncan Watts

Web-Based Experiments to Improve Deliberation and Reduce Polarization

Second-year applicants only

**My project can be completed entirely remotely.*

Polarization is a growing concern in online communities, and many proposals have been made for mitigating hostility in partisan deliberation. However, the efficacy of these proposals is uncertain, and before they are implemented at scale, they should be tested in controlled conditions. In this PURM project, students will join in the development and implementation of a human-subjects experiment designed to test techniques for reducing polarization in small-group deliberation. Experiments will take place online in a zoom-like interface, and experimental interventions will take the form of online training or real-time feedback during the process of deliberation.

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

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

ELECTRICAL & SYSTEMS ENGINEERING

Pratik Chaudhari

Extreme-Scale Few-Shot Learning for Natural Taxonomies

**My project can be completed entirely remotely.*

Few-shot learning refers to the problem where one is interested in training a deep network from very few labeled samples. If our desired dataset has very few samples, one approach is to train a model on data from a related dataset and adapt this model to our desired dataset, e.g, if our eventual goal is to classify cancer pathologies, then it might help to first pretrain on textured images of fruits to learn low-level features and then fine-tune this model to the actual dataset. Continual learning is a related problem where we would like to iteratively update learned models as they see more diverse data. As machine learning systems tackle an increasingly diverse set of problems, these techniques are increasingly becoming important because it is difficult to curate large amounts of training data for each problem.

Natural data (e.g., images of all species of birds, animals, and plants) can be organized into hierarchies (e.g., animals → mammals → carnivores → dogs). There are large scale efforts such as iNaturalist (https://www.inaturalist.org/) where citizen scientists have built such taxonomies for 1000s of categories. The goal of this project is to exploit such structure on the semantics of natural images to build new methods for few-shot learning and continual learning.

Skills you will learn: (a) basics of deep learning, (b) image classification, (c) algorithms for few-

shot learning, and (d) using cloud computing for large-scale experimentation.

Skills you should have: Proficiency in programming in Python at the level of CS 121.

This project could appeal to students in CIS and ESE with interests in deep learning. Scope of the project can be modified depending upon the student's interests, e.g., these ideas also apply to deep learning using multiomics data in clinical neuroscience.

Deep Jariwala

High Temperature and Low-Power Memory Devices

Second-year applicants only

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

Memory devices present key bottleneck in most modern computations. The development of low-power, fast and highly scalable memory is therefore critical. This project comprises of developing memory devices in the extreme performance range (low power, low voltage etc) or operation in extreme conditions e.g. high temperatures.

The lab has expertise in novel nanomaterials as well as fabrication and characterization of such memory devices. An undergraduate student will be expected to do some simulations followed by assistance in fabrication or characterization of the memory devices.

The undergraduate will be mentored/paired with a graduate student or postdoctoral scholar in the lab.

MATERIALS SCIENCE AND ENGINEERING

Russell Composto

Technical, Societal and Behavioral Strategies for Reducing the Effects of Extreme Heat Events in Urban Environments

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

The goal of this project is to organize and synthesize current research on the science and technical applications of the science around reducing the consequences of extreme heat events in cities. Heatwaves create non-trivial health and mortality risks for residents, especially for the most vulnerable populations, as well as produce negative effects on infrastructure and on the greater economy.* Extreme heat days are being recorded, and potential changes are being predicted under climate change models, as part of strategies to understand and improve climate change resilience (e.g., https://mappingresilience.onebillionresilient.org/). In particular, Philadelphia's most vulnerable citizens are experiencing heat-related health issues at an alarming

rate.

This project would have multiple stages: a) collecting and understanding the current knowledge on heat events and their impacts; b) summarizing current research on heat-mitigation established technologies, as well as newer and emerging technologies and their readiness for application; and c) summarizing current research on societal/political/behavioral strategies of implementation of heat-mitigation strategies. Technologies to explore include immediate approaches such as "cool" roofs (https://coolroofs.org/) as well as advanced strategies such as phase change materials to improve thermal performance of buildings Phase Change Materials. This project may also involve interviewing professionals who work in these areas (e.g., municipal leaders, experts at research or other organizations). Deliverables would include written reports and presentations, and potentially communications targeted for a general audience (e.g., web page content, video).

The project could be distributed between two students – one with a STEM background, who has had basic coursework in thermodynamics (required) and heat transfer, and one with a social or political science background. Students would gain experience with literature review and technical and general written and oral communication and presentation skills while investigating a grand challenge for today's (and the future's) global population. This project would help build the resource base for a larger 3-year project, which, if funded, would provide potential future opportunities for students to travel abroad to work on heat-event mitigation projects.

Additional Mentors: REACT Project co-PIs (Daeyeon Lee – CBE, Zahra Fakhraai – Chemistry, Kristin Field – Education/Prof Dev for REACT & the Singh Center for Nanotechnology, Penn Institute of Urban Research faculty/staff)

*C40, Nov. 2021 (accessed 1/21/22: https://www.c40knowledgehub.org/s/article/How-to-adapt-your-city-to-extreme-heat?language=en_US)

MECHANICAL ENGINEERING AND APPLIED MECHANICS

Cynthia Sung

Origami-Inspired Design and Fabrication

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

We are interested in how origami structures can be used to create transformable and deployable mechanisms. Origami-inspired engineering produces cheap, lightweight, and highly customizable robotic designs. By manipulating a fold pattern, we can change the geometry and mechanical response of the pattern for a variety of applications, including ground locomotion, swimming, and medical.

In this project, the student will work with a graduate student in the lab to learn about origami-inspired engineering, design, and fabrication, as applied to a cm-scale robot. We will explore topics such as how curved creases can be used to reduce actuation requirements and simplify control. The work will involve computer aided design (Solidworks, DraftSight), rapid prototyping via laser cutting and 3D printing, electronics design, and Arduino programming. In addition, the student will learn how to design an experiment for measuring relevant metrics (e.g., reliability of folding, speed of locomotion, etc.) on the fabricated robot.

Further details about on-going projects in the lab can be found at: https://sung.seas.upenn.edu/

Ottman Tertuliano

Mechanical Properties of Tissues under Dynamic Loading Conditions

**My project is entirely in-person.*

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

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

Kevin Turner

Variable Stiffness Contact Pads to Enhance Robotic Grasping

Second-year applicants only

**My project is entirely in-person.*

The stiffness of the surface of a robotic gripper has a significant effect on the ability to handle and grip different objects. For example, a compliant gripping surface leads to large contact areas and lower contact pressures and thus can facilitate the gripping of delicate or complex-shaped objects. In contrast, a stiff gripping surface leads to smaller contact areas that can enable grasps with high precision and dexterity. Traditionally, the stiffness of a gripping surface is set by the

material used in the gripper and cannot be changed on demand. The objective of this project is to develop and characterize contact pads with a stiffness that can be tuned through the application of an electrical signal. These pads will allow the stiffness of robot end-effectors to be dynamically changed, thus increasing the versatility and capability of grippers.

In this project, the student will develop a fabrication process for making variable stiffness contact pads, manufacture and characterize the stiffness tunability of the contact pads, and, if time permits integrate and test the contact pads in a simple robotic system. Through this project, the student will gain experience with polymers that have an elastic modulus that can be actively tuned, techniques for manufacturing printed electronics, mechanical characterization approaches and data analysis, and robotic gripping processes/hardware. This project is well-suited for students majoring in mechanical, electrical, bio-, or materials engineering and related disciplines.

Law

LAW

William Ewald

Writings of James Wilson

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

James Wilson (1742-1798) is not well known. He was the first Professor of Law at the University of Pennsylvania. Before that, he signed both the Declaration of Independence and the US Constitution. He was appointed one of the first Justices of the Supreme Court--and then, when his land speculations collapsed, died in debtors' prison. (He is the only Supreme Court Justice to have been sent to prison.) That last fact caused his papers to be scattered and his name largely erased from the history books.

New archival discoveries make clear that his role in the drafting of the Constitution was far greater than has been commonly supposed. I am at work on a full-scale intellectual biography of Wilson. As part of that project, I am preparing a scholarly edition of his papers.

For that work, I need assistance in transcribing 18th-century manuscripts. Scans of the original documents exist, but they need to be converted into text, which requires an ability to read Wilson's handwriting. (Fortunately, it is mostly very good.) The job needs to be done with precision, and is best done with two people working together: one reading out the text, the other transcribing then reading back what has been transcribed.

That part of the task can be done (if necessary) entirely remotely. It could also be done in person. (The Law School would no doubt provide space.)

There are also various letters and other documents scattered in local archives. Tracking them down and photographing them could involve a treasure hunt for unknown documents, but whether that will be possible during the pandemic is not clear.

I would expect this project to teach undergraduates something about the drafting of the Constitution, the life of James Wilson, and the practical aspects of archival research and the editing of historical materials.

Some familiarity with US revolutionary-era history would be helpful, but is not required. The main prerequisite is a capacity for meticulous work and for looking after the details. Perhaps the principal thing to be learned is that, in work of this kind, precision matters greatly.

Jacques Delisle

Law's Changing Roles in China; Two Faces of Sovereignty in China

**My project can be completed entirely remotely.*

Students can choose to work on either of two overlapping projects:

1. Law's Changing Roles in China
The Chinese Communist Party's approach to law has ranged from hostility to effusive declarations of support and substantial commitment. Three features have persisted while their content has shifted. The party's view of law has been instrumental, as means to party-defined ends. But those ends have changed repeatedly. The Party has retained control over the content of law and functioning of legal institutions. Yet, the length of the leash on which the Party leads the law has varied. The Party has relied on law as a means to govern the economy, society, and the party-state, and to preserve its own power. But law's "market share" in playing these roles has fluctuated.

This project focuses primarily on the Xi Jinping years (roughly the last decade), but also assesses the background of the post-1978 Reform Era, and the Mao Era (1949-1976).

2. The Two Faces of Sovereignty in China
In many contexts, China's approach to sovereignty is Janus-faced. Sovereignty at international law and in international relations is conceived in "naturalist" terms. On this view, legal commitments cannot encroach upon China's sovereignty (with the view of "unequal treaties" from the 19th century being a principal illustration) or constrain the party-states exercise of sovereignty within Chinese territory. Sovereignty domestically is, complementarily, defined in highly "positivist" terms. On this view, the regime has unfettered discretion about how to govern its people and territory, constrained only by procedural requirements (and not substantive principles).

This pattern is evident in China's approach to several contested issues, including: the governance of Hong Kong, the Taiwan question, Xinjiang, and disputes in the South and East China Seas, as well as China's engagement with the World Trade Organization and the international human rights regime. In some of these areas, China's positions conflict with near mirror-image views of sovereignty held by its interlocutors and adversaries.

Students engaged in either part of this overlapping project will help collect and assess materials relevant to "testing" the theses sketched in the first paragraphs of each section above. Materials to be gathered and evaluated include primary legal sources, statements by regime leaders and organs, media reports, and scholarship and policy commentary by Chinese and non-Chinese sources. Chinese language skills preferred, but not required. Students will be encouraged to offer their own views and analyses, and will learn to work with legal materials.

Paul Robinson

Getting Away with Murder and Rape: Examining the Criminal Justice System's Balance of Interests

**My project can be completed entirely remotely.*

Failures of justice for serious offenses are common in the US. A majority of killers elude justice. For more than 18,000 homicides annually, at least 10,000 killers walk away without a homicide conviction. Perhaps more troubling, homicide has the best victimization-conviction ratio of any offense. Of more than 1,200,000 aggravated assaults annually, only 8.3% are convicted for their crime. Of 64,000 annual rapes, 99.3% end in no felony conviction.

Most criminal justice scholarship focuses on identifying and avoiding serious injustice, as perhaps it should. Commonly ignored by academics are the causes and societal costs of regular failures of justice, even for serious offenses like murder and rape.

This project investigates the causes of serious justice failures and reforms that might avoid them. In doing this, the project will examine, for example, formal legal rules that provide non-exculpatory defenses (such as statutes of limitation), common investigative errors by police, inadequate investigative financing, legal limitations on police investigative authority (including restraints on the use of technology), criminal procedures such as pretrial release, plea bargaining, early release on parole, and executive clemency, as well as the reasons for citizen noncooperation with investigators, recent police tendencies toward non-intervention (due perhaps to defunding, low morale, or concerns about liability), and the recent increase in anti-justice ideological movements such as those pushing for abolition of punishment, decarceration, decriminalization, sanctuary cities, and progressive prosecutors. Part of the project will involve finding and examining real-world cases affected by justice failures stemming from these causes.

What may be most interesting about the project is that the rules and practices that regularly produce serious failures of justice are rarely irrational or accidental. In nearly every instance, the rule or practice exists because it promotes or protects some legitimate and even important societal interest. Thus, the real goal of the project is to examine the balance of conflicting interests in each of these areas. Some current balancing may seem appropriate while others may seem in need of adjustment.

The small group of people currently working on this project include two previous PURM students (including one who is now at Penn Law). The group typically has a daily zoom meeting in which tasks are assigned and yesterday's work discussed. The resulting materials will provide the basis for Professor Robinson's upcoming Seminar in Criminal Law Theory at the law school this fall and ultimately for publication of a scholarly book.

Beth Ann Simmons

International Borders, Human Trafficking, and Human Rights

**My project can be completed entirely remotely.*

How do hardening borders and enhanced border control affect international human rights of persons in, near, and transiting border zones? The first part of this project asks whether and how border security reduces credible reports of human trafficking between countries. Students will learn what human trafficking is, how to format data that can be analyzed systematically from qualitative US Trafficking in Persons Reports, and how to extract information on bilateral aid for border security and human trafficking from a large database.

The second part of this project will investigate whether and how border hardening and enforcement has affected human rights in unanticipated ways. We will use qualitative Amnesty International reports to code allegations of human rights violations in border regions by border control and immigration officials. In all cases, students will be working from established protocols and criteria for coding the information from the original sources. The research is global, but students may be asked to perform online research of specific cases for more detailed information. Toward the end of the project students can expect to come up with ideas for data visualization and interpretation.

Skills include strong attention to detail; excellent reading comprehension; and competent use of excel spreadsheets. Participants will work with a small core of researchers to achieve data consistency and develop informative and intuitive ways to visualize the data. Students may expect to learn some simple analytics and spatial mapping software to visualize where trafficking patterns have developed, persisted and diminished over time on a global basis, and to visualize patterns in border-enforcement related human rights violations in time and space. PURM researchers will present their findings to members of the Borders and Boundaries research group. Students interested in any major are welcome to apply.

Students will learn about human rights (and rights violations) in border zones around the world, and gain a grounded appreciation for the goals, dilemmas, successes and unanticipated consequences of strong attempts to "secure" international borders.

Student researchers will be supervised by Professor Beth Simmons, Penn Integrates Knowledge (PIK) Professor, Penn Law/Political Science/Wharton) assisted by her co-author, Dr. Lauren Pinson, University of Texas, Dallas. Student researchers will also have access to postdocs and graduate students of the Borders and Boundaries Team for advice on an ad hoc basis. Most of our work can be conducted virtually, but we aim to meet in person on campus periodically, as health and safety conditions permit.

Medicine

ANESTHESIA

Krzysztof Laudanski

Peristence of Inflammation after Elective Heart Surgery Leads to Unfavorable Outcomes

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

Coronary artery bypass surgery (CABG) is frequently performed (800,000 annually) in the USA. However, it has no clear advantage over diet, exercise, or per-cutaneous coronary intervention (PCI) interventions. This project examines if post-surgical changes of the immune system significantly accelerate atherosclerosis, thus reducing the benefit of surgery.

In the project, a student will study the expression of several genes involved in atherosclerosis and their potential to progress the disease in patients after heart surgery. Furthermore, we will link these findings to the emergence of neurodegeneration markers and other unfavorable surgery outcomes. We plan to use RT-PCR but other techniques (flow cytometry, western blot) may also be used as well.

We are looking for enthusiastic, engaging students who want to make a difference in the world. PI of this project is heavily involved in students' long-term to augment their future careers.

For this position, skills in basic lab technique is desired, with special emphasis on PCR techniques. We will provide cell cultures, flow cytometry, and protein analysis training. If necessary DNA/RNA techniques will be tough as well. In addition, students will be involved in data analysis. If they do not have experience, training will be provided. During the project, they will interact with staff from Dr Sullivan’s lab (CHOP) as well as other students in the lab. My lab interacts with the cardiac surgery team (Dr Szeto), and students may be involved in these interactions in order to collect the clinical data. The project's ultimate goal is for a student to produce an abstract that will be a base for a published article as the durable statement of their participation.

Alexander Proekt

Dynamics of Learning

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

During learning, performance tends to increase in a stepwise fashion, with plateaus of consistent performance punctuated by sudden changes when a more effective strategy is adopted. Little is known about the specific neural correlates of these changes. We would specifically like to learn whether and how neural dynamics change in anticipation of a behavioral change.

In our lab, we have already developed tools to analyze the neural dynamics of a learned task. Given the firing rates of a population of neurons during several trials, we can determine when during a trial there are robust differences in joint firing patterns between different conditions. We can then compare this information about differences over time to what various task strategies would predict.

This project aims to characterize changes in neural dynamics and strategy during bouts of learning by applying this analysis to neural firing recorded during trials over the course of the learning period. Specifically, we will train each mouse over several weeks on a decision task. As it performs the task on a treadmill, we will record the activity of parietal cortex neurons using a two-photon microscope. Task performance and neural dynamics data will then be analyzed together.

The students will be mentored by both Dr. Proekt and PhD candidate Ethan Blackwood. There are opportunities to help with both the animal training and modeling/data analysis sides of the project. Students will also attend group lab meetings and develop general scientific skills, such as experimental design, interpretation of results, and troubleshooting.

Huafeng Wei

Mechanisms of Dantrolene Neuroprotection in Alzheimer's Disease

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

My lab is interested in studying the mechanisms of dantrolene neuroprotection in Alzheimer's disease. Dantrolene is the only drug to treat malignant hyperthermia (MH) in anesthesia practice. Our lab is the first to demonstrate that dantrolene significantly inhibited memory/learning impairment in various animal models. We also demonstrated that dantrolene is neuroprotective in AD by restoring intracellular calcium homeostasis. Under the supervision of Dr. Ge Liang or Mr. Robert Vera, the PURM students will join our team to study the effects of dantrolene on

calcium changes in cytosol and mitochondria and its relationship with amyloid/tau pathology, mitochondria function, oxidative stresses, inflammation and eventually the neurodegeneration and neurogenesis. The student will also assist the animal research work studying the effects and side effects of intranasal dantrolene administration in various AD animal models. We will also train students on initiation of research idea, designing of research work, data collection and abstract presentation and manuscript publication. Please see following web site for lab information and previous publication.

https://www.med.upenn.edu/weilab/

https://www.pennmedicine.org/news/news-releases/2020/march/giving-commonly-muscle-relaxant-through-nose-potential-treat-neurodegenerative-diseases

https://www.biospace.com/article/releases/eagle-pharmaceuticals-to-develop-dantrolene-sodium-for-potential-treatment-of-alzheimer-s-disease-in-collaboration-with-university-of-pennsylvania/

Ian Yuan

Analysis of Anesthetic Depth with Processed EEG (Electroencephalography)

**My project can be completed entirely remotely.*

Through this project the student will gain experience in signal processing and machine learning of clinical time-series data. The dataset consists of EEG (electroencephalography) and Near-infrared spectroscopy (NIRS) collected from infants and children under anesthesia and sedation. The goal is to apply traditional signal processing techniques (fourier transform, power spectrum, etc...) and modern techniques (machine learning) to analyze these data to correlate with clinical endpoints.

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 and machine learning experiences are preferred but not required.

All of the student's work can be done online/remotely. The student will be listed for authorship on publications that include the student's work.

BIOCHEMISTRY & MOLECULAR BIOPHYSICS

Kenji Murakami

Structural Dissection of Histone Deposition Coupled with Transcription

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

Throughout transcriptionally-active genes, the passage of transcribing RNA polymerase II (pol II) is rapidly followed by deposition of histone variant H3.3. This variant is of particular interest in the context of aging, because it accumulates with age and impacts gene expression. In metazoans, histones H3.3 and H4 are deposited throughout transcribed genes by the HUC complex. The molecular mechanisms that recruit these complexes to regions of active transcription are currently unknown.

In a critical advance, we have recently succeeded in reconstituting the transcription-coupled histone deposition complex in abundant homogeneous form. This advance sets the stage for structural characterization that integrates two cutting-edge approaches. We will resolve the structure of the complex to the highest possible resolution by cryo-EM single particle analysis (project 1). We will also perform an extensive cross-linking and mass spectrometry (XL-MS) which is complementary to cryo-EM analysis (project 2). We expect this study to provide the first molecular evidence of the interplay between histone deposition and transcription, as well as a first-of-its-kind view of its structural basis.

The students involved in this project would be mentored by Hee-jong Kim, a BMB graduate student and Chun Yang, a postdoc in the Murakami lab. The work involves protein expression and isolation from yeast including a thermophilic fungus, and structural analysis. Data analysis can be done in person or remotely. Our lab has strong expertise in cutting-edge techniques of cryo-EM analysis and XL-MS and has developed hands-on manuals for both techniques, such that undergraduates can acquire a unique combination of these skill sets, while understanding principles behind them. Students will also attend lab meetings, individual meetings with the PI, and are welcome to pursue the project after the summer towards authorship on one or more scientific papers.

CANCER BIOLOGY

Eric Brown

Identification of DNA Repair Factors That Predict Responses to Novel Targeted Cancer Therapies

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

The Brown laboratory has developed and implemented a novel strategy to identify factors that predict responses to a new class of cancer therapies that target DNA replication checkpoint proteins, such as ATR and WEE1. Inhibition of these proteins causes toxic levels of DNA replication fork-associated DNA damage in cancer cells more so than in normal tissues and thus is a promising cancer treatment. However, biochemical retrievals of DNA replication forks indicate that drug treatment causes the recruitment of DNA repair factors. These repair factors suppress both DNA damage and the therapeutic effects of these new cancer drugs. The Brown laboratory is identifying these repair actors by performing large-scale proteomics on DNA replication fork retrievals and comparing the proteins identified to cancer genome databases. This approach permits identification of cancers that may be more susceptible to DNA replication checkpoint inhibitors because they lack the ability to repair the damage caused by these drugs.

The Brown laboratory is now in the process of bioinformatically identifying recruited DNA repair factors and determining how their mutation impacts responses to DNA replication checkpoint inhibition. Activities of the 10-week summer project will vary depending on the skill sets of the undergraduate researcher and their educational interests. Procedures that will be used and taught include cell culture, transfection, siRNA-mediated knockdown, western blot, flow cytometry, Excel spreadsheet quantification, in silco data mining, and computer programing (R). All of these skills are in no way required for the available summer projects, but each of these represent an entry level for different goals. This research endeavor is being led in the Brown laboratory by Dr. Jasmine Peake, a PennPort scholar who is especially interested in undergraduate education. Dr. Brown will meet with Dr. Peake and the undergraduate researcher(s) no less than twice a week to oversee experimental design, data interpretation and project direction. This highly collaborative and exciting project is designed to make significant inroads in both our understanding of genome maintenance and improving cancer treatment.

CARDIOVASCULAR MEDICINE

Victoria Vetter

Enhancement of Electrocardiographic Screening of Hypertrophic Cardiomyopathy in Children using Novel ECG Measurements to Improve Identification and Prevent Sudden Cardiac Death

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

Large scale electrocardiographic (ECG) screening has demonstrated that the ECG can help to identify children and young individuals with undiagnosed conditions that predispose them to sudden cardiac arrest (SCA), such as hypertrophic cardiomyopathy (HCM), the most common cause of SCA in children. While it has been stated that 95% of ECGs in individuals with HCM are abnormal, the current literature has limited information on ECGs in children diagnosed with HCM. The ECG can be abnormal when echocardiographic (ECHO) manifestations have not yet developed. The primary finding in the ECG is left ventricular hypertrophy (LVH) as determined by standard ECG measurements of R and S wave amplitudes, Q waves, and ST and T wave changes. The specific initial ECG findings in children with HCM is not well understood, nor is the progression of abnormalities on the ECG and their correlation with ECHO measurements, particularly using new or novel computerized measurements related to left ventricular hypertrophy. The test characteristics of the ECG (sensitivity, specificity, positive and negative predictive values) are not well defined regarding HCM. New novel composite ECG standards could improve these test characteristics.

This study will evaluate a large cohort of HCM subjects at the Children's Hospital of Philadelphia to compare a variety of ECG measurements indicating LVH, including standard measurements as well as novel computerized measurements (sums of voltage, voltage duration, and integrated QRS areas) with echocardiographic measurements of LVH or LV mass. We will identify the ECG abnormalities in children with HCM/LVH at the time of presentation, further catalogue changes that occur over time, and associate all these findings with ECHO measurements. Using a case control study design, we aim to identify specific novel ECG findings that correlate with the diagnosis of HCM and to determine the best measurements that predict the presence of HCM. These more sensitive and specific predictive ECG findings could aid in the early identification of those at risk of having HCM. This will improve the ability to identify individuals affected by HCM and provide a simple and inexpensive screening test, enhancing the diagnosis and treatment of children with HCM.

The student will learn research design, data acquisition and input, data analysis and interpretation, and will participate in manuscript development. In addition, the student will have the opportunity to shadow pediatric cardiologists in their clinics at CHOP, learn how to read electrocardiograms, and learn about cardiac conditions that cause sudden cardiac arrest.

CARDIOVASCULAR SURGERY

Pavan Atluri

Understanding Myocardial Metabolic Changes in Acute Non-Ischemic Cardiomyopathy

**My project is entirely in-person.*

Cardiac contractile function depends on adequate energy supply from a constant flux of metabolic substrates. Myocardial ATP is derived mainly from fatty acid oxidation; however, substrate utilization is dynamic and may be altered in settings of ischemia, stress, and cardiomyopathy. These changes over time have been implicated in both contractile dysfunction and cellular death. In chronic cardiomyopathies, these biochemical alterations have become attractive areas of novel pharmacologic intervention with encouraging results. However, the role of metabolic substrate utilization and its implications on function remain unexplored in settings of acute non-ischemic cardiomyopathy. This project will be undertaken to examine the metabolic pathways of energy production in models of acute cardiomyopathy and correlate them with underlying structural changes in the myocyte.

Our lab in the Division of Cardiovascular Surgery has a long track record of mentoring undergraduate and medical students as well as post-doctoral fellows. Our projects involve modern cell culture and protein analytic techniques as well as rat surgical models of disease. In addition to the above project, our lab has several other projects related to surgical cardiovascular disease that students may participate in. During their summer project, we intend our undergraduate students to learn and independently perform aspects of cell culture techniques, protein isolations, and various additional in vitro assays. Furthermore, interested students will also participate in the various surgeries we perform as a part of our rodent models, and we expect students to gain basic surgical skills and exposure. We also expect all our students to gain working knowledge in cardiovascular anatomy and physiology. Our students will work and be mentored by lab technicians, medical students, and post-doctoral research fellows (all surgeons) in addition to myself. Mentoring will occur via weekly lab meetings and didactics, as well as day-to-day supervision from our postdoctoral fellows. We expect many of our students to continue doing research with our group throughout their collegiate experience and have future opportunities for independent study for interested students. We have a very successful track record of mentoring our students toward their goals of graduate school or medical school.

Additional day-to-day supervisors for students:
Amit Iyengar, MD (Post-doctoral Research Fellow, Cardiothoracic Surgery Resident)
Noah Weingarten, MD (Post-doctoral Research Fellow, General Surgery Resident)
D. Alan Herbst, MD (Post-doctoral Research Fellow, General Surgery Resident)

DERMATOLOGY

Elizabeth Grice

Skin Microbiome-Derived Antibiotics to Prevent and Treat MRSA

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

A position is available to conduct research as part of an ongoing study to identify and characterize novel antimicrobial molecules ("natural products") produced by the skin microbiome. The skin microbiome consists of a diverse assemblage of bacteria, fungi, and viruses. Microorganisms are a rich source of bioactive secondary metabolites and other molecules with unique chemical structure and potent cytotoxic, antitumor, antimicrobial, and anti-inflammatory activity. Over half of approved small molecule drugs in the past 30 years are derived from natural products. We conducted a systematic screen to identify novel skin microbes that inhibit the major skin pathogen, methicillin-resistant S. aureus (MRSA). We identified a panel of 3 microbes that when applied to the skin in combination, prevent MRSA colonization in animal models. Integrating techniques including microbial culture, genomic analysis, fractionation/filtration, in vitro skin cell culture assays, and gene expression analysis, the student will characterize candidate small molecules and assess their functional potential for modulating inflammation of the skin and suppressing colonization and infection by MRSA. The ideal candidate will have some molecular biology laboratory experience and a strong background in biology, chemistry, and/or microbiology. If the candidate has computational skills, they will also have the opportunity to take part in microbial genome assembly and annotation. Mentoring and training will be provided by the lab manager, Dr. Simon Knight, and an MD/PhD student, Monica Wei. This is an ideal position for a student that wishes to gain experience conducting research on the mechanisms and function of the human microbiome.

ENDOCRINOLOGY, DIABETES & METABOLISM

Lorraine Levitt Katz

Pediatric Diabetes Risk Assessment and Treatment

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

The student will assist with research studies, ranging from early risk screening for pediatric diabetes to characterizing youth diagnosed with new onset diabetes to screening for medication studies for type 1 and 2 diabetes. Responsibilities include recruiting and participating in patient visits, often serving as the first point of contact with families. There is the opportunity for patient and family interaction and the projects provide excellent opportunities for nursing students as well as pre-health students. You will learn about all aspects of the clinical research/regulatory

process as well as the care of patients in endocrinology/diabetes.

One prospective clinical research project is currently enrolling individuals from the Penn Medicine Biobank and Center for Applied Genomics Biobank (CHOP) who have high or low polygenic risk scores for type 2 diabetes. We are interested in determining if individuals without diabetes but high or low genetic risk for diabetes may have differences in insulin and glucose response, body composition, and other biomarkers. We hypothesize that those with high genetic risk scores will have worse insulin and glucose responses compared to matched subjects with low genetic risk scores. The student would primarily help with recruitment (phone calls, emails, follow up etc), and has the opportunity to learn about the study days at the clinical research center and interact with subjects. Mentors include Dr. Lorraine Katz (CHOP, Endocrinology), Dr. Jessica Wilson, and team. Another potential project examines trends in newly diagnosed youth with type 1 and type 2 diabetes in the city of Philadelphia

Looking for individuals with excellent interpersonal, organizational skills and attention to detail. We encourage candidates who wish to extend their participation in the studies into the schoolyear. Must be familiar with Microsoft Word/Excel. Must be courteous and work well with people. Professional attire in accordance with hospital policy is required.

Mitchell Lazar

Determining the Role of Vagal Innervation in Metabolic Dysfunctions Associated with Circadian Disruption

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

Circadian rhythms are arranged in a hierarchical order with the hypothalamic suprachiasmatic nucleus (SCN) acting as the master circadian clock, but peripheral tissues possess cell-autonomous clocks that regulate circadian gene expression in a tissue-specific manner. However, published data from the Lazar lab using a mouse model with a hepatocyte double knock-out of the circadian repressors Rev-erb alpha and beta (HepDKO) suggests that there are genes in the liver that retain rhythmicity without Rev-erbs. We hypothesize they are maintained by non-cell-autonomous rhythmic signals from the SCN. A potential conduit for these signals is parasympathetic innervation from the brain to the liver via the vagus nerve. Thus, the focus of the project is to delineate the role of vagal acetylcholinergic inputs to the liver in the maintenance and regulation of rhythmic gene expression and metabolic homeostasis across the 24-hour day. Presently, we have determined that surgical disruption of vagal inputs to the liver by common hepatic branch vagotomy (HVx) altered the rhythmic signature of a significant portion of previously retained genes. However, under the conditions of a 12:12 light/dark cycle, a normal chow diet and wildtype Rev-erb beta expression in the liver and SCN, there are no gross, observable metabolic impacts of these transcriptional alterations. Recent pilot data from HVx animals either maintained on a high fat diet, maintained under dark/dark light conditions or with Rev-erb alpha/beta deleted in the liver, exposed HVx as potentially protective against the metabolic disruptions (increased weight gain, insulin resistance, etc.) associated with circadian

desynchrony.

We are seeking a highly motivated undergraduate interested in metabolism and circadian biology to help with experiments determining how the vagus nerve acts as an important conduit for SCN "control" over hepatic rhythms and the resulting metabolic diseases associated with circadian disruptions such as jetlag and shiftwork. During the 10 week project a mentee can expect to learn skills associated with mouse husbandry, mouse metabolic phenotyping (glucose tolerance tests, insulin tolerance tests, etc), tissue collection from murine subjects, nucleic acid isolation from frozen tissue samples, reverse transcriptase-quantitative polymerase chain reaction (RT-qPCR), Western blot protein analysis, enzyme-linked immunosorbant assay (ELISA) protocols and data analysis utilizing programs such as Excel, R and GraphPad Prism.

The undergraduate would be mentored by myself along with a postdoc, Lauren Woodie, and a technician, Brianna Krusen.

EPIDEMIOLOGY

Aimin Chen

Environmental Chemical Exposure and Child Development

Second-year applicants only

**My project can be completed entirely remotely.*

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

The undergraduate student will work on a project to examine the association between an exposure and an outcome. The student will gain experiences in PubMed literature search and review of the study topics. The student will participate in data management and statistical analysis by modifying sample codes in SAS or R and summarize study findings using tables and figures. The student will draft a report for the research project. The student will have an opportunity to collaborate with a large group of researchers in epidemiology, biostatistics, obstetrics, pediatrics, environmental health sciences, and public health. The research is conducted virtually using computer and software. The applicants are expected to have experience in biology, environmental sciences, public health, or data science.

Anne Marie Mccarthy

Understanding Personalized Breast Cancer Risk Using Genetics and Imaging

**My project can be completed entirely remotely.*

Breast cancer is one of the leading causes of death among women. Mortality from breast cancer can be reduced by regular mammography screening, which can detect breast cancers early. However, mammography is an imperfect tool which may miss more aggressive breast cancer subtypes. There is a critical need to more accurately identify women at higher risk of aggressive breast cancers in order to guide preventative measures.

The student research assistant will work with Dr. Anne Marie McCarthy on projects related to breast cancer epidemiology, genetics, and breast imaging. Dr. McCarthy's expertise is in breast cancer screening, with studies that address the prediction of aggressive breast cancer subtypes. Currently, our team works on studies that evaluate the joint impact of genetics and breast imaging on predicting breast cancer risk. Regular tasks will include performing literature reviews, assisting with data cleaning and analysis, and creating tables/charts for publication.

This research will contribute to our understanding of the genetic factors that influence breast cancer risk, as well as breast imaging methods that can identify women at high risk of cancer. The student assistant will gain significant experience in epidemiological research, including an understanding of breast cancer and its risk factors, familiarity with STATA statistical software, and experience with manuscript preparation and publication. Students will also gain general professional experience working as part of a research team. This work can be done remotely.

GENETICS

Ziyue Gao

Evolution of Guardians of the Genome

**My project can be completed entirely remotely.*

Different species are surprisingly similar in their genetic composition: for instance, humans and our closest evolutionary relatives, chimpanzees, are nearly 99% identical in genome sequence. On the other hand, any two persons, even identical twins, differ slightly in their genomes. Given these observations, we cannot help but ask what determines the rate of genetic differences? How are these genetic differences distributed in the genome, and why? What are the phenotypic and evolutionary consequences of these genetic differences? Our group aims to answer these questions by building a better understanding of the causes and consequences of genetic variation between species, populations, and individuals.

This project investigates the evolution of DNA repair and replication genes and aims to quantify

the short- and long-term selective pressures on these genes. We take a computational approach by combining mathematical modeling, statistical analysis, and high-throughput computation of data from comparative genomics, human genetics, and cancer studies. From working on this project, student researchers will learn core concepts in genetics and summary statistics of genetic variation data for detecting and characterizing selection. They will gain first-hand research experience in genomics and computational biology, and develop useful skills in programming, statistics, and scientific communication that are transferable to other fields. This project is completely computational and can be performed remotely, but in-person sessions are encouraged for effective mentoring and timely feedback.

Klaus Kaestner

Investigating the Etiology of Type 1 and Type 2 Diabetes

**My project is entirely in-person.*

The Kaestner lab carries out metabolism and diabetes research to work towards understanding the etiology of type 1 and type 2 diabetes. We use state-of-the-art technologies to analyze all aspects of pancreas biology by profiling the endocrine and immune systems with deep cellular and molecular phenotyping. Our team's comprehensive profiling of the natural history of type 1 and type 2 diabetes will pave the way for future discoveries and new treatment modalities for diabetes.

This position will allow students to learn multiple aspects of molecular biology and genetics, from core molecular biology principles to cutting edge next generation sequencing. We also utilize advanced imaging and microscopy approaches to study the pancreas in both the normal and the diseased state.

Because we study human tissues, our studies have direct translational relevance to disease progression and treatment. The lab has a mix of graduate students, postdoctoral fellows, and research specialists to facilitate a supportive and fun mentorship environment.

Erin Duffy, Research Specialist
Suzanne Shapira, Research Specialist

Iain Mathieson

Genetics and Health of Ancient Humans

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

Modern medical genetics has been extraordinarily successful at identifying genetic variation associated with human disease. These discoveries have led to improved treatments for many devastating diseases and a deeper understanding of the biological basis of human phenotypic variation. This project aims to combine this rich source of information with data about the

genetic makeup and health status of ancient humans to try to understand how human health metrics and disease risk have evolved over time. Did the transition to agriculture increase risk of diabetes? Did historical changes in climate lead to changes in human stature? Do ancient epidemics protect us against infectious disease? By combining archaeological and genetic data from ancient humans we will address some of these questions.

The project brings together aspects of evolutionary biology, statistics, and medical genetics to address a fundamental question about evolution with relevance to human health. Student researchers will develop practical skills in bioinformatics, programming and statistics, as well as learning about cutting-edge discoveries in human evolution and medical genetics. The project is fully computational so could potentially be completed remotely, although by preference will be in-person if university policy allows.

John Murray

High Throughput Identification of Developmental Regulators

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

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

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

For this summer project, the student will screen genes identified in the C. elegans embryonic expression atlases for developmental phenotypes. They will systematically test for embryonic lethality after the loss of each gene, followed by the use of state-of-the-art single-cell phenotyping tools (including time-lapse imaging, automated cell tracking, and expression analysis) to define the role of each gene in development.

Sarah Tishkoff

Identification and Characterization of Regulatory Variants Influencing Adaptive Traits in Ethnically Diverse Africans

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

Regulatory variation plays an important role in shaping phenotypic variation, including disease susceptibility and adaptation to diverse environments. However, astonishingly little is known

about regulatory variation in Africa, a region with the highest levels of genetic diversity on a global scale. Our lab is integrating genomic and transcriptomic data to identify regulatory variants that influence gene expression and play a role in human evolution and adaptation to diverse diets and environments in Africa.

The student working on this project will assist with functional genomic studies of candidate regulatory variants that play a role in adaptive traits. The project will involve targeted DNA sequencing, cloning and in vitro luciferase expression assays and/or CHIP-seq/ATAC-seq analyses to characterize epigenetic variation in appropriate cell types. Candidate variants will be modified by CRISPR editing to determine the impact of variants on gene expression and phenotypes. Examples of traits we are studying include skin pigmentation, stature, lactose tolerance and heart development. A qualified candidate will have a background in genetics or molecular biology and will have some laboratory skills. If the applicant has computational skills, there will also be an opportunity for doing computational analyses of regulatory variants. This is an excellent opportunity to obtain experience in human genomics research.

Zhaolan (Joe) Zhou

Modeling Neurodevelopmental Disorders in Mice

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

We have two independent 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.

IMMUNOLOGY

Nilam Mangalmurti

Understanding Red Cell Immune Function

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

At nearly 30 trillion cells, red blood cells (RBCs) are the most common circulating cell in the human body. They can modulate inflammatory responses due to their large surface area and constant contact with circulating pathogens and host-derived inflammatory mediators. Indeed, RBCs function as immune modulators through regulation of local and systemic chemokines, complement activation, and immobilization of pathogens. However, astonishingly little is known about the potential role of RBCs in initiating immune responses. We have recently discovered that RBCs express the nucleic acid-sensing toll-like receptor TLR9 on their cell surface.6 The discovery of TLR9 on RBCs represents a fundamental breakthrough in our understanding of red cell biology and the non-gas exchanging functions of RBCs. This discovery provides insight into the role of non-classical immune cells in the innate immune response.

I am a physician-scientist with a clinical practice in critical care and a cutting-edge research program focused on syndromes affecting the critically ill. These syndromes include sepsis, the dysregulated host response to infection. Despite decades of research and over one hundred clinical trials, definitive therapy for sepsis remains out of reach, and innovative approaches to this problem are essential. One fundamental and critical knowledge gap in sepsis research is how circulating red blood cells (RBCs) contribute to the abnormal immune response.

My lab has several projects focused on RBC- nucleic acid sensing in acute inflammatory syndromes. These include- investigating the role of RBC-nucleic acid sensing in the development of sepsis and exploring the role of RBC-nucleic acid-sensing as a universal mechanism for anemia. Additionally, we are working on RBC-based diagnostics for known and emerging pathogens. My lab uses cell culture, in vitro model systems, animal models, and human samples to answer fundamental questions surrounding RBC immune function.

Undergraduates joining the lab will be placed in a tiered mentoring schema (reporting to the lab post-doc/junior faculty daily and meeting weekly with the PI). Undergraduates will spend the first 2-to 4 weeks learning basic lab skills (cell enumeration, PCR, western blotting, and ELISA). Interested undergraduates will learn animal necropsy as well. During the second half of the summer program, undergraduates will aim to use the skills acquired to address a specific question related to one of the ongoing projects. Undergraduates will attend weekly lab meetings.

My goal for the undergraduate researcher is to teach basic laboratory skills and foster a deeper appreciation and understanding of disease-based, wet-bench translational research.

MEDICINE

Kristoffel Dumon

Clinical Simulation Training in Virtual Reality

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

The model of clinical training in the United States has not changed much in the past 100 years. With the increasing availability and affordability of immersive virtual reality, we may be at the moment where surgical training can be completely revolutionized and overhauled in striking ways.

Although other researchers and for-profit entities are working on developing immersive virtual training models, the Dumon research group's aim is to produce an open source clinical training development platform. Using this software, clinical educators could design and run their own training scenarios or educational content instead of having to purchase them from third parties. Being open source, the software would naturally grow and develop over time through the creation of a network of developers intent on improving clinical training.

The group is currently working on designing basic clinical scenario pilots as well as developing the architecture for the open source software described above. The scenarios are being developed in the Unity game engine platform and for use on the Oculus 2 headset.

We seek an industrious undergraduate with a desire to exercise both the creative and analytical mind to forward our research efforts. This student should be comfortable with computer technologies and have an interest in the field of medicine. The student will have the opportunity to learn about not only about clinical topics, but also learn a bit about working with game engines, 3D graphics design software, and principles of adult learning. The group aims to create innovative simulations for publication and implementation in the Penn Surgery training program and hopefully an international audience long term.

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. Dr. Kristoffel Dumon and Dr. Noel Williams are leading the project. Daniel Weber is a software engineer and will be involved day-to-day in mentoring the students on software design.

Jeffrey Thompson

Personalizing Care for Patients with Lesion Suspicious for Lung Cancer through Methylation Analysis and Droplet Digital PCR of Cell-Free DNA

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

The Liquid Biopsy Lab, led by Director Dr. Erica Carpenter, MBA, PhD, focuses on the analysis of cell-free DNA (cfDNA) and body fluid analytes from cancer patients. Blood and other non-invasively captured patient samples are used to detect biomarkers which allow: 1) early detection of disease as well as post-therapy monitoring of minimal residual disease, 2) an efficient means of determining clinical and biological response to therapy and, thus, clinical decision making, and, 3) cancer genetic phenotyping to drive personalized medicine. The focus of the lab is driven by the needs of investigators and clinicians, such as Dr. Jeffrey Thompson, MD, MTR, who will serve as co-mentor for this project.

The student will focus on the development of highly sensitive approaches for the isolation and analysis of cfDNA isolated from the blood and bronchoalveolar lavage fluid (BAL) of patients enrolled at bronchoscopy in the clinic of Dr. Thompson and his clinical colleagues. The student will conduct assay development, perform sample preparation, summarize/analyze results, and will be exposed to the clinical aspects of lung cancer patient diagnosis and treatment. There may be clinical shadowing opportunities with Dr. Thompson and opportunities to participate in studies involving other cancer types studied in our lab. This is an ideal project for those interested in medical science, but may be undecided between medical and graduate school, and would like to gain experience in both translational and clinical research.

MICROBIOLOGY

Erle Robertson

Oncogenic Viruses and Human Cancers

**My project is entirely in-person.*

The Robertson Laboratory continues to support undergraduate trainees who are interested in biomedical research during their tenure at Penn. Over the last 18 years we have supported many undergraduates who have gone on to careers in Medicine and Biomedical research by pursuing MD, PhD degrees. Our group investigates the mechanisms of oncogenesis by viral agents and the human microbiome. We focus on how these infectious agents drive the oncogenic process through initiation and progression of these cancers via targeted dysregulation of a number of cellular processes. We investigate these questions using a wide range of molecular biology tools which includes biochemistry, genetics, epigenetics, molecular biology and cell biology to determine the fundamental mechanisms by which these agents disrupt cellular processes. The

majority of undergraduates who are focused, determined and have a curious mind as well as the will and drive to succeed have flourished in our lab, as seen by co-authorships on many publications by themselves or working with graduate students and post-doctoral trainees.

Mentorship will be provided by:
Dipayan Bose - postdoctoral fellow
Francesco Pennino - postdoctoral fellow
Shahana Parveen - postdoctoral fellow
Mohammad Asad - postdoctoral fellow
Nian Ma - postdoctoral fellow

NEUROLOGY

Kathryn Davis

Epilepsy Quantitative Imaging and Electrophysiology Lab

**My project can be completed entirely remotely.*

Project: Developing a convolutional graph neural network (last generation of neural networks, very little published in epilepsy so far outside of EEG) that takes in both structural and functional imaging (i.e. DTI and fMRI) and predicts surgical outcome as well as seizure lateralization and localization. This project will leverage publicly available datasets, some more well curated epilepsy data (potentially enigma), as well as our own data. Working with fourth-year MD, PhD student, Alfredo Lucas, and Dr. Davis.

Skills Required:
Python (must)
Pytorch familiarity recommended, but not necessary
Basic understanding of ML/DL, no experience needed per se

Project: Developing a ML based model that is capable of identifying disease factors in epilepsy, similar to (Lee, H. M. et al. Decomposing MRI phenotypic heterogeneity in epilepsy: a step towards personalized classification. Brain (2021) doi:10.1093/brain/awab425.) but that uses the functional connectome instead of the structural connectome, or that utilizes a combination of both. Working with fourth-year MD, PhD student, Alfredo Lucas, and Dr. Davis.

Skills Required:
Python (must)
Sklearn familiarity recommended, but not necessary
Basic understanding of ML/DL, no experience needed per se

Project: Characterizing epilepsy phenotypes using thalamic morphometry
Epilepsy is a disorder of abnormal brain networks, but we currently lack methods to identify which brain networks are affected in individual patients. The thalamus is a critical node in many seizure networks, plays an important role in seizure dynamics, and is sensitive to degeneration in many of the epilepsies. Utilizing structural MRI data for patients with epilepsy, the student will analyze local shape changes in the thalamus and correlate these with clinical data to develop imaging-based epilepsy phenotypes. The student will develop skills in the use of FSL and statistical analysis (the GLM, in particular). Some programming experience is desirable, but not necessary. Working with post-doctoral fellows, Drs. James Gugger and Nishant Sinha, and Dr. Davis.

Ethan Goldberg

Mechanisms of Neurodevelopmental Disorders

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

This Project is to be undertaken in the laboratory of Ethan M. Goldberg, MD, PhD, Assistant Professor of Neurology & Neuroscience in the Division of Neurology at The Children's Hospital of Philadelphia and Departments of Neurology & Neuroscience at The University of Pennsylvania. Dr. Goldberg is a pediatric neurologist and Director of the Epilepsy Neurogenetics Initiative at CHOP and runs a basic biomedical research laboratory studying neurological disorders in experimental model systems with the goal of identifying disease pathomechanisms and developing novel treatments.

The lab uses human and mouse genetics, electrophysiology, pharmacology, opto- and chemogenetics, induced pluripotent stem (iPS) cell biology, and function imaging (two-photon calcium imaging) in iPS cell-derived neurons, brain slices from mice in vitro, and in awake behaving mice in vivo.

The lab is organized into Teams structured around specific disease entities. The student will join and be an active member of a Team, working under the direction of a senior graduate student or postdoctoral fellow, and will meet regularly one-on-one and as a Team with the PI. The student will learn basic neuroscience approaches and fundamental techniques, such as cell culture, animal surgery, neuroanatomy, neurogenetics, cellular neurophysiology, and/or microscopy.

Representative recent publications from the laboratory include:
-- Favero, M., Sotuyo, N.P., Lopez, E., Kearney, J.A., Goldberg, E.M. (2018). A Transient Developmental Window of Fast-Spiking Interneuron Dysfunction in a Mouse Model of Dravet Syndrome. J Neurosci. 38(36):7912-7927. PMC6125809.
-- Goff, K., and Goldberg, E.M. (2019). Vasoactive intestinal peptide-expressing interneurons are impaired in a mouse model of Dravet syndrome. Elife. Jul 8;8. pii: e46846. PMC6629374.
-- Zaman, T., Helbig, K., Clatot, J., […] Goldberg, E.M. (2020). SCN3A-related neurodevelopmental disorder: A spectrum of epilepsy and brain malformation. Ann Neurol,

88(2):348-362. PMID: 32515017.
-- Tran, C., Vaiana, M., Nakuci, J., Somarowthu, A., Goff, K.M., Goldstein, N., Murthy, P., Muldoon, S.F., Goldberg, E.M. (2020). Interneuron desynchronization precedes seizures in a mouse model of Dravet syndrome. J Neurosci. 40(13):2764-2775. PMC7096149.
-- Mattis, J.H., Somarowthu, A., Goff, K.M., […] Goldberg, E.M. Corticohippocampal circuit dysfunction in a mouse model of Dravet syndrome. bioRxiv 2021.05.01.442271; doi: https://doi.org/10.1101/2021.05.01.442271.

Roy Hamilton

Transcranial Alternating Stimulation of the Brain To Improve Working Memory Performance

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

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. Evidence 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 mild cognitive impairment (MCI) or early Alzheimer's Disease (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 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. 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, and WM performance compared to sham.

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 this project will be trained to deliver tACS, perform assessments of WM, and collect and code behavioral data. In the event that research cannot be conducted on campus due to the COVID-19 pandemic, the student's work will focus on coding, analysis, and reporting of previously collected behavioral data. 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.

Shavonne Massey

EEG Monitoring and Outcomes of Critically Ill Neonates and Children

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

The critical care epilepsy/electroencephalography program at CHOP is dedicated to investigating optimal neuromonitoring strategies and treatment practices in critically ill neonates and children. In addition, we study acute and chronic outcomes of affected patients, with the goal of developing neuroprotective strategies that can improve these outcomes. Our proposed summer project will focus on two specific populations of critically ill patients - (1) neonates with congenital heart disease who undergo corrective heart surgery and (2) children and neonates who require support with extracorporeal membrane oxygenation (ECMO). Both of these patient groups are at high risk for brain injury, and as a result, they are monitored with continuous electroencephalography (EEG) to diagnose and manage seizures (which are the most common sign of brain injury). We have a large database capturing the clinical, EEG, treatment, and outcomes data on these patients since 2012. We know that 10% of neonates with congenital heart disease will experience seizures acutely in the hospital, but less is known about which neonates will develop epilepsy later in life.

Our first project will be to define the incidence of epilepsy and other neurologic sequelae (motor impairment, speech delay, neurobehavioral syndromes) in survivors of congenital heart disease, and to develop prediction models for these outcomes based on neonatal characteristics. A student would be responsible for assessing these outcomes from electronic medical records data and entering it into the database.

Our second project will focus on neonates and children on ECMO, for whom we are currently developing prediction models for the occurrence of seizures, neuroimaging abnormalities, and mortality in children hospitalized at CHOP between 2012-2018. We will validate this model in a cohort of children at CHOP from 2019-2021. A student would be responsible for identifying appropriate patients and entering their basic data into the database. Students will also work with neurology and ICU physicians to enter clinical data for patients.

During these projects, students will learn skills that are vital to clinical research, including evaluation of electronic medical records and use of RedCAP database software. Students would also help with statistical analysis and model development for both projects. We would envision having one student primarily work on each project. Students will also have the opportunity to shadow on inpatient rounds (epilepsy monitoring unit, critical care EEG monitoring service) and outpatient clinic (pediatric epilepsy, epilepsy neurogenetics).

Nicholas Abend, MD (Associate Professor, CHOP Neurology) will also mentor the students.

NEUROSCIENCE

Shinjae Chung

Neural Circuit Mechanisms Underlying Sleep and Emotional Regulation
**My project is entirely in-person.*

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 our lab 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.

Amelia Eisch

Hippocampal Circuitry in Brain Health, Injury, and Disease *First-year only*
**My project can be modified to accommodate remote activities if made necessary by University policy.*

We study the rodent dentate gyrus, a brain region closely connected with the hippocampus and which is involved in many brain functions including learning and memory, mood regulation, and reward processing. We use a range of techniques to map, measure, and eventually manipulate aspects of rodent dentate gyrus neural circuitry. We also study the impact that these manipulations have on dentate gyrus function by studying rodent behavior.

Six Eisch Lab "mini-projects" are available to PURM students during Summer 2022, 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, Assist Prof and Dr. Eisch's "lab partner"); 2) socially-dominate other mice? (Fred Kiffer, PhD, NASA Postdoc Fellow); 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, NINDS PostdocFellow); and 5) new neurons regulate cognition (Yun)? Additionally, 6) what is the role of the hippocampus in addiction? (Yun, Eisch, and Lorianna Colón, PhD, CHOP-supported postdoctoral fellow). Finally, 7) how do the brain and bladder communicate to regulate bladder voiding after normal development vs. in a mouse model for early life urinary tract infection (Yun, Eisch, collaborator Steven Zderic, MD)?

Projects are in-person but will pivot to remote/virtual if necessary; indeed, in Summer 2020 we hosted 8 students for successful virtual experiences, and in Summer 2021 several trainees worked remotely part-time as well. Even if remote, Summer 2022 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 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.

Joshua Gold

Understanding Relationships between Arousal and Cognition

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

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

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

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

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

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

Ben Scholl

Analysis of In Vivo Dendritic Spine Activity

Second-year applicants only

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

Synaptic pathology is a prominent feature of autism spectrum disorders (ASD). Synaptic dysfunction is presumed to be an underlying cause of ASD, as genomic studies have identified risk genes regulating synaptic structure and physiology. It is currently unknown how synaptic integration, organization, and function are impacted within individual neurons. One overarching goal of this lab is to understand how specific proteins shape the structural and functional properties of dendritic spines and the neurons they reside on.

To study the link between genes associated with ASD and dendritic spine activity, we use a combination of genetically-encoded calcium indicators (GCaMP) and state-of-the-art two-photon microscopy. Currently, there are a wide variety of GCaMP reporters available, but most have not been validated for or used to investigate synaptic function in vivo. Therefore, this project will compare and contrast in vivo image datasets from different GCaMP reporters.

Students will be expected to either be familiar with or desire to learn either Matlab or Python for data analysis. They will be expected to learn how to code in one of these programs, as well as become familiar with imaging software used to process image datasets. They will be expected to handle imaging datasets, be taught to process them, and learn to perform subsequent analyses under the direction of the Principle Investigator. Either interest in or a background in computer science, bioengineering, or physics would be helpful.

Students will also be expected to work alongside other students (undergraduate and graduate), attend lab meetings, and be encouraged to engage in other scientific events on campus (in person if possible).

Students will also have the opportunity to observe other aspects of the research in the lab

including surgical implantation, animal handling, data collection on two-photon microscopy, image data processing, and analysis of processed image data.

NEUROSURGERY

Zarina Ali

Enhanced Recovery after Neurosurgery

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

Despite surgical, technological, medical, and anesthetic improvements, spinal surgery still often results in significant post-operative morbidity, including chronic opioid dependency and poor functional outcomes. Excluding complications related to anesthesia or surgery, the surgical stress response with its increased metabolic demands on the body serves as a critical pathogenic factor in postoperative morbidity. Enhanced Recovery After Surgery (ERAS) is a multimodal, multidisciplinary approach to patient care that focuses on the reduction of this surgical stress response. ERAS pathways have been widely adopted and implemented in many surgical disciplines. However, broad application of ERAS principles to the general spine surgery population has not yet been studied thoroughly. The Penn Neurosurgery ERAS protocol incorporates evidence-based principles designed to promote the expeditious surgical recovery of the spine surgery patient. We propose to study a prospective cohort of patients undergoing spinal surgery to assess the feasibility and efficacy of our ERAS protocol in the neurosurgical population in order to improve clinical/functional status and decrease postoperative opioid use.

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 & 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.

ORTHOPAEDIC SURGERY

Fanxin Long

Genetic Studies of Skeletal Development and Homeostasis

**My project is entirely in-person.*

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

Robert Mauck

Mechanobiology in Knee Joint Development

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

Mechanical forces are incredibly important to the proper development and maintenance of tissues in our body. Nonetheless, we do not have a solid understanding of the mechanisms by which mechanical forces affect cells during tissue development and whether these forces are more important at certain stages of development than others. Therefore, we have devised techniques to alter muscle loading in limbs of juvenile mice to investigate how the altered loading environment affects the maturation of tissues within the knee joint.

This project will involve analyzing the gait of these mice to determine the extent to which forces are altered in the knee and then measuring the changes to the tissues through biomechanical and biological assays. Other individuals that will mentor the student(s) include Josh Baxter, Research Assistant Professor, and Talayah Johnson, Bioengineering PhD Student.

Neil Sheth

Building an Orthopaedic Center of Excellence in Sub-Saharan Africa

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

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

We present a novel, sustainable, collaborative solution to this problem. We propose to build an Orthopaedic Center of Excellence in Moshi, Tanzania, in conjunction with Kilimanjaro Christian Medical Center, to be populated by foreign thought leaders year-round. With the University of Pennsylvania at the center, the collaboration is formulated to include the following:

• 26 major academic institutions, donating 2 weeks/year, to provide care and train local providers
• Each institution will sign out a service every 2 weeks to the next visiting institution
• Each team will utilize pre-determined clinical care protocols for the delivery of musculoskeletal care
• Each team's clinical focus will be on Pediatric Orthopaedics, Orthopaedic Trauma, Adult Reconstruction (hip and knee), and Plastic Surgery (soft-tissue rearrangement and vascular surgery)

• Five to six years of support before a transition to domestic ownership of the center, led by local surgeons trained in the latest techniques and on the latest equipment, combined with foreign support as needed

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

Sireesh Ramesh was a PURM student from 2019/2020 and focused on the economic and social impact of the project on the local community in Sub-Saharan Africa. He was able to work with a PhD in Economics to calculate an Impact Money Multiplier which has been a major contribution to our project. He spent 10 days in Africa during the Summer of 2019. He continues to be an integral member of our team and will serve to be a mentor for the next PURM student.

OTORHINOLARYNGOLOGY

Ian Jacobs

Cartilage Tissue Engineering for Laryngotracheal (Windpipe) Reconstruction

**My project is entirely in-person.*

At the Bioengineering and Biomaterials Lab at Children's Hospital of Philadelphia we have adopted a rapid translational approach for tissue-engineering new biomaterials to help patients. Our priority target is engineering cartilage for laryngotracheal reconstruction to enable infants and children with subglottic stenosis to breathe 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 biofabrication, cell culture, and biomaterials. Students will not be directly involved in animal work, but they will have the opportunity to study engineered tissues grown in the lab before they are implanted in animals, and to work with graduate students and postdocs to study how the engineered tissues perform after they are implanted.

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

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

We offer:
• A collaborative and open environment that fosters learning and scientific growth
• An exciting environment where 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

PATHOLOGY

Craig Bassing

Elucidating Mechanisms That Regulate Lymphocyte Antigen Receptor Gene Assembly

**My project is entirely in-person.*

The viability of all jawed vertebrates depends on their intrinsic adaptive immune systems that mount highly-specific responses to different pathogens. RAG1/RAG2 (RAG) endonuclease mediated assembly of diverse antigen receptor genes through recombination of these genetic loci in developing lymphocytes is the molecular basis for adaptive immunity. Despite the vital role of the RAG endonuclease, its expression must be regulated to generate only one type of antigen receptor on each lymphocyte, which provides specificity and prevents autoimmunity, and also to prevent the formation of antigen receptor locus translocations that cause fatal lymphoid cancers. We recently discovered that DNA cleavage by the RAG endonuclease activates intracellular signals that transiently repress transcription of the Rag1 and Rag2 genes.

The summer research project will be to employ small molecule inhibitors of specific signaling proteins and transcription factors to: 1) elucidate molecular mechanisms that govern RAG DNA cleavage-mediated feedback inhibition of RAG activity, and 2) determine the role of these mechanisms in regulating antigen receptor gene assembly. The fundamental skills that the mentee will learn include: evaluating primary literature, designing and interpreting experiments, presenting and discussing data, and documenting experimental records. The technical skills will include: tissue culture; isolation of DNA, RNA, and protein; quantitative Taqman PCR quantification of DNA cleavage and gene expression; and western blot analysis of protein expression.

Una O'Doherty

Probing the Nature of the Naive HIV Reservoir

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

Highly active anti-retroviral therapy can clear the blood of HIV-1 virions. Despite long-term suppression of virus, when the medications are stopped viral rebound occurs. Thus, reservoirs of latent, treatment-resistant HIV-1 exist in infected individuals and are a major barrier to cure. Eradicating the remaining reservoir poses a significant challenge as it is very small - less than 1 in a million CD4+ T cells are true HIV reservoir cells.

Until recently the HIV reservoir was thought to persist within memory CD4 + T cells. The memory reservoir was thought to be a transcriptionally silent piece of inert integrated DNA. On the contrary, the HIV reservoir is highly dynamic. Contraction and expansion forces are exerted simultaneously, thus mimicking stability. Moreover, our group was the first to show decisively that HIV reservoirs actually persist within a related less differentiated CD4+ T cell – a naïve T cell. These T cells are defined by their lack of exposure to cognate antigens. Their unique attributes make them a powerful resilient reservoir that evades immune detection. In fact, our work shows that naïve infection is critical to the size, stability, and diversity of the HIV reservoir.

Project: To study the forces exerted on the HIV reservoirs using an in vitro model that we developed and characterized. This model mimics many important aspects of HIV in vivo. The student will use it to probe the important differences between the latent and productive states of HIV infection as well as the qualities of the reservoir in different cellular subsets.

Undergraduates who choose our lab will be part of a tight knit team. Our signature strengths are agility and open mindedness. Join us for a unique exposure to cutting edge science that probes the HIV reservoir. Our studies will provide insights into the forces that maintain the HIV reservoir and will reveal underlying basic mechanisms that determine why a T cell dies or divides.

Those involved in mentoring the student:

Una O'Doherty, MD PhD- PI
Ashley Ginda, PharmD- Research Specialist
Lotte Kearns, BS- Research Specialist
Alfonso Oceguera, PhD- Postdoc

Nancy Spinner

Mechanisms of NOTCH2 Mutation in Alagille Syndrome

**My project is entirely in-person.*

Alagille syndrome (ALGS) is an autosomal dominant multi-system disorder caused by mutations in 2 Notch signaling pathway genes, Jagged1 (JAG1) and NOTCH2. This disorder affects the liver, heart, kidneys, and vasculature, with minor eye and skeletal findings, and characteristic facial features. JAG1 is a cell surface ligand, and NOTCH2 is one of 4 human Notch receptors. Our laboratory identified both genes as ALGS disease genes, and the proposed experiments form part of our current work to better understand uncertainty in Alagille syndrome diagnostics, both in interpretation of genomic variants, and uncertainty underlying variable expressivity. While we know a lot about the mechanisms of Jagged1 mutations (seen in ~95% of ALGS patients), which are caused by having one dysfunctional allele (haploinsufficiency), we know little about how mutations in Notch2 cause disease. Consequently, diagnostic labs classify a very high percentage of Notch2 variants as having uncertain significance, which we hope to change. Notch2 mutations are much less frequent than JAG1 and are found in 2.5% of patients. The NOTCH2 mutations identified in Alagille syndrome patients are varied and include missense, frameshift, nonsense, and splice site mutations. For this project, we will examine Notch2 mutation carrying RNA transcripts from patients with Alagille syndrome to determine if the mutant alleles are expressed, and if yes, at what level compared to the wild type alleles.

The student will learn how to work with patient cell lines, extract RNA, make cDNA and sequence the NOTCH2 transcripts to determine if the mutant allele is detectable, or if it appears to have been degraded by nonsense mediated decay, a cellular process that prevents the translation of mutant proteins. We will use quantitative techniques like droplet digital PCR (ddPCR). These experiments will be done in the presence and absence of cycloheximide, a chemical that blocks protein translation and nonsense mediated decay. To complement these experiments, we will also design a luciferase reporter assay for NOTCH signaling, to determine if the mutant alleles are functional. These experiments will involve stable expression of a NOTCH2 cDNA (either wildtype or mutant) into NIH 3T3 or CHO cells and monitoring of Notch signaling after stimulation of the receptor with a Notch ligand.

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

Kai Wang

Understanding the Genetics of Human Diseases through "Transformer" Models

**My project can be completed entirely remotely.*

Background
Prior knowledge on phenotype-gene relationships and phenotypic information can facilitate the identification of disease-causing mutations. In 2017, we developed NLP methods for automated abstraction of phenotype concepts in the form of Human Phenotype Ontology (HPO). Between 2018 and 2020, we further developed computational tools for NLP analysis on clinical notes, with multiple manuscripts involving three Penn undergraduate students. From 2020, we began to explore light-weight "transformer" models (a type of deep neural network), and demonstrated that we can match the performance of BERT originally developed by Google but with a minor fraction of the computational costs and with the ability to handle biomedical contexts (for example, special c. and p. and chr:start-end notations in genetic variants, and specialized clinical descriptions on neurodevelopmental/psychological manifestations). In 2021, in a blind competition where the true answer is not known in advance, we won the Biocreative Track 5 LitCovid challenge organized by NIH/NCBI. Our transformers was just selected to replace BERT in the PhenoTagger server at NIH, due to its superior performance and speed.

Questions
The student will address two questions: (1) how transformer algorithms can be applied to automate phenotype extraction and gene-finding, based on clinical descriptions from genetic literature and clinical notes (2) what are the optimal parameters in the current sets of transformers for ranking causal genes/variants higher within the list of all genes, based on the several benchmarking data sets in which the truth is known.

Methodology
In the current project, we will evaluate several widely used NLP algorithms, such as Word2Vec, GloVe, ELMo, BERT, BioBERT and XLNet, as well as our newly developed tools (EHR2Vec, MedE2Vec and BioFormer), on real-world clinical data and biomedical literature for disease diagnosis, such as Autism Spectrum Disorders and other pediatric genetic diseases. To address the two scientific questions mentioned above, the student will use the pre-packaged tools to perform analysis on the several benchmarking data sets that we have generated, and evaluate how different parameter settings can change performance. Dr. James Havrilla, a Bioinformatics Scientist in the lab and a TA for the CAMB550 class, would be more than happy to advise the student together with me. The results will inform us whether transformer based approaches can facilitate automated extraction of data and patterns of the data to improve healthcare delivery.

PEDIATRICS

Kristina Cole

Center for Pediatric Tumor Cell Atlas

**My project is entirely in-person.*

Background: Cancers are made up of a mixture of cells that are malignant, normal, immunologic and supportive. By understanding the unique features of the individual cells within a tumor (spatially) and as a cancer evolves (temporally), we expect to learn more about what causes pediatric cancer to become resistant to treatment. As the Center for Pediatric Tumor Cell Atlas (PI: Tan), we have performed single cell analyses on well characterized pediatric leukemia, neuroblastoma and high grade glioma patient tumors at diagnosis and at relapse. The PURM student(s) would assist with preparing public release of these results. There are 2 components of the project:

1) Biospecimen and clinical data review – for each of the patients whose tumors are profiled, there is corresponding clinical and biospecimen data that is captured and linked to the experimental data. The student will assist Dr. Cole and the biospecimen team to ensure that the data is complete and accurate in our database. They will have the opportunity to examine surgical, radiology and pathology reports in addition to looking at pathology slides and MRI imaging.

2) Single cell experiments – in collaboration with Dr. Kai Tan's laboratory personnel, the student will assist with experiments related to single cell analyses of tumors, including validation of research findings in tumor tissue. If a student has experience in genomic data analysis, there may be an opportunity to work with computational biologists examining the single cell data.

Benefits: Participation in the project would allow students 1) to learn about pediatric cancer diagnosis, treatment and care; 2) to learn about single cell techniques and assist with performing experiments and/or analyses with laboratory personnel; 3) to learn about the Human Tumor Atlas Network (HTAN) through meetings and teleconferences; 4) to interact with other summer students, speakers and pediatric cancer patients/survivors through participation in the CHOP Oncology Center for Childhood Cancer Research Summer Student Series.

Alexander Fiks

Clinical Effort Against Secondhand Smoke (eCEASE)

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

We are looking for a research assistant who would assist on the electronic Clinical Effort Against Secondhand Smoke (eCEASE) national study funded through the National Institutes of Health (NIH). This study seeks to improve the quality of tobacco control service delivery in pediatric practices and help parents quit smoking. The study is based at 12 CHOP primary care sites. The intervention consists of the innovative Electronic Health Record (iEHR) platform used to screen families for tobacco use and refer smoking parents to smoking cessation resources and treatment.

The main study aim is to compare parents' combusted tobacco quit rates, and adoption of tobacco free behaviors between the two arms.

The study Principal Investigator (PI) and co-investigator are Dr. Fiks and Dr. Jenssen. This research is housed within the Children's Hospital of Philadelphia's Center for Pediatric Clinical Effectiveness. Broadly, Dr. Fiks and Dr. Jenssen conduct research in primary care settings locally and nationally to improve pediatric decision making and child health outcomes and use clinical decision support systems and population health management techniques to protect children from secondhand smoke exposure and tobacco use.

Over the course of the program, the RA will learn the fundamentals of human subjects' research, EPIC chart review, survey administration, collection of CO and cotinine samples, working in pediatric primary care settings. They will also acquire content knowledge of smoking cessation treatments and will participate in weekly research team meetings.

The RA will assist with planning for and initiating the follow up part of the study. The RA will go through the study onboarding and upon successful training completion, will work in CHOP primary care clinics to approach already enrolled parents in the study for a follow up survey and assist in collecting parents' saliva and breath samples for cotinine and CO testing. The RA may also follow up with parents remotely.

Prior experience in data collection and conducting surveys is preferred, but not required. The RA should be comfortable with approaching and conducting surveys with families. Customer service experience is a plus. The candidate must be detail-oriented with strong communication and organizational skills and comfortable with working independently.

We are looking for about 8-10 RAs to join the study across 12 sites, as we will have 800 enrolled parents to follow-up with.

Brian Jenssen

Clinical Effort Against Secondhand Smoke (eCEASE)

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The main study aim is to compare parents' combusted tobacco quit rates, and adoption of tobacco free behaviors between the two arms.

The study Principal Investigator (PI) and co-investigator are Dr. Fiks and Dr. Jenssen. This research is housed within the Children's Hospital of Philadelphia's Center for Pediatric Clinical

Effectiveness. Broadly, Dr. Fiks and Dr. Jenssen conduct research in primary care settings locally and nationally to improve pediatric decision making and child health outcomes and use clinical decision support systems and population health management techniques to protect children from secondhand smoke exposure and tobacco use.

Over the course of the program, the RA will learn the fundamentals of human subjects' research, EPIC chart review, survey administration, collection of CO and cotinine samples, working in pediatric primary care settings. They will also acquire content knowledge of smoking cessation treatments and will participate in weekly research team meetings.

The RA will assist with planning for and initiating the follow up part of the study. The RA will go through the study onboarding and upon successful training completion, will work in CHOP primary care clinics to approach already enrolled parents in the study for a follow up survey and assist in collecting parents' saliva and breath samples for cotinine and CO testing. The RA may also follow up with parents remotely.

Prior experience in data collection and conducting surveys is preferred, but not required. The RA should be comfortable with approaching and conducting surveys with families. Customer service experience is a plus. The candidate must be detail-oriented with strong communication and organizational skills and comfortable with working independently.

We are looking for about 8-10 RAs to join the study across 12 sites, as we will have 800 enrolled parents to follow-up with.

Peter Kurre

Nanovesicle Regulation of Stem Cell Activity

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

A small pool of hematopoietic stem and progenitor cells (HSPC) in the bone marrow (BM) provide lifelong production of blood and immune cells. Operationally defined units comprised of HSPC and their surrounding BM niche cells maintain steady state function and adapt to stress and injury. The prevailing model views HSPC as passive recipients of signals from the niche. This project aims to challenge that paradigm in two ways. First, we will focus on the active secretion of nanometer-size vesicles from HSPC as a constitutive, evolutionarily conserved cellular function. Second, unlike conventional ligand-receptor signaling, extracellular vesicles (EVs) traffic non-coding (including micro-) RNA to bystander cells. The mechanism by which EV-contained miRNA regulate tissues is not well understood, and we will determine the role of a particular panel of miRNA carried by HSPC-derived EVs in regulating bystander niche cells. The significance of the project lies in gaining fundamental insight into how hematopoiesis is regulated and in the translational application of that knowledge in improving the outcome of hematopoietic stem cell transplantation.

This is a long-term project involving the student in planning, execution and analysis of experiments. With an eye on skill and career development, students will fully participate in journal clubs, lab meetings and presentations. The experimental design builds on established and validated models in the lab, and the student will become familiar with molecular biology, real-time PCR, tissue culture and flow cytometry tools, as well as data analysis and presentation. A post-doctoral scientist and senior research technician will provide day-to-day oversight and guidance.

Clement Ren

Cystic Fibrosis Clinical Research

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

The overall goal of my research is to improve our assessment and understanding of CF lung disease. Our approaches to achieving this goal utilize respiratory physiology testing, lung imaging, retrospective chart review, and patient registry analyses. Further information regarding my research and representative recent publications can be found at https://www.research.chop.edu/people/clement-l-ren.

Joseph Rossano

Clinical Research in Pediatric Cardiology

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

We have multiple research projects in our Cardiac Center including basic-translational research, health services research, outcomes research, and clinical trials.

There are many mentors for these research projects and Michael O'Byrne, MD is the director of Cardiac Center Research Core.

Lisa Schwartz

Pediatric Behavioral Oncology

**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 (AYA) impacted by cancer (those with cancer predisposition, on active treatment, or survivors). Current studies include: 1) a multisite study tracking self-management of AYA survivors, 2) evaluation of implementation of survivorship care plans, 3) longitudinal tracking and outcomes of families with youth tested for cancer predisposition, 4) a study developing interventions for families undergoing genetic testing for cancer predisposition, 5) studies

tracking physical activity of AYA with cancer. It is also possible to get experience working on a study with AYA with sickle cell disease. Dr. Schwartz also conducts digital health research (apps, text messages) and has some related grants pending funding.

Examples of possible projects/tasks include: 1) Detailed electronic health record reviews to assess accuracy of patient knowledge, and document health history and recommendations. 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. 5) Provide feedback on intervention materials and measures. 6) Assist with recruitment. 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. Dr. Sara King-Dowling is a Research Associate in the lab that helps with overseeing student trainees. 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.

Christopher Thom

Interrogating Tropomyosin 1 Function in Blood Biology

**My project is entirely in-person.*

We each make 200 billion red cells and 400 billion platelets every day. When the mechanisms directing processes go awry, hematologic diseases and/or cancer can result. The Thom lab previously identified Tropomyosin 1 (Tpm1) in a computational screen for blood-regulatory genes. Genetic perturbations in Tpm1 alter red blood cell and platelet biology in humans and in cultured cells.

We also recently created a Tpm1 conditional knockout mouse, and we are looking for summer research assistance on a project to better define how Tpm1 regulates blood cell formation and function in vivo. This project will involve isolation and analysis of blood cells (red blood cells and platelets) and analysis using molecular biology techniques (RNA and protein isolation, real time PCR, western blotting, flow cytometry), along with advanced microscopy techniques. Students can optionally participate in mouse husbandry and tissue dissection. Students will benefit from weekly meetings with Dr. Thom to plan experiments, to analyze and interpret data, to review genetic manipulation strategies, and to review related scientific literature. Through weekly joint lab meetings with our collaborators, students will also benefit from hearing about related ongoing projects in human stem cell biology and statistical genetics.

Daniel West

A Coaching Program to Support Development of Clinical and Professional Skills to Advance CHOP's Clinical and Education Missions

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

The long-term goal of this work is to develop and implement a coaching program to support all CHOP trainees and faculty physicians in developing or increasing knowledge, skills and performance that advance CHOP's clinical and education missions. Self-identified coachees will be assigned a coach who will work with them to develop a learning plan with specific, actionable, and measurable learning goals. Coaches will then do clinical observations and meet periodically with their coach to review assessment data and adjust their learning plan and goals accordingly. As part of this program, coaching dyads will participate in post-coaching semistructured interviews to understand their experience and as part of program evaluation. The interested undergraduate student would conduct these interviews and help analyze data using in-depth content analysis. Students would gain fundamental skills in qualitative research, and will be mentored primarily by Dr. Jay Mehta, Associate Professor of Clinical Pediatrics, and Dr. Dorene Balmer, the Director of Research in Pediatric Education.

PHYSIOLOGY

Joseph Baur

Nicotinamide Adenine Dinucleotide (NAD) Supplementation in Heart Failure

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

Nicotinamide adenine dinucleotide (NAD) is a critical cofactor for hundreds of enzymes. NAD levels decline during normal aging and in multiple disease states. Recently, NAD depletion has been shown in failing hearts and novel NAD precursors such as nicotinamide riboside (NR) have been found to protect against heart failure in rodents. We have generated a novel mouse model to test whether NAD deficiency per se is sufficient to cause the metabolic or functional changes

associated with heart failure. Based on our data suggesting that the heart benefits more from intravenous precursors that from oral dosing, we are collaborating with Dan Kelly's group here at Penn to test the utility of intravenous NR in two human-relevant models: heart failure secondary to ischemic injury or treatment with a chemotherapeutic drug. Endpoints include in vivo heart function by echocardiography and ex vivo mitochondrial function. Finally, we are testing NAD precursors in a model of mitochondrial disease that leads to heart failure: Friedreich's Ataxia. Together, these studies will reveal fundamental details of how NAD metabolism influences cardiac physiology, and will help guide efforts to develop novel therapeutic approaches for the treatment or prevention of heart failure. The project will provide opportunities to learn biochemical assays, metabolomics, mitochondrial isolation and functional testing, echocardiography, and rodent handling.

Paul Titchenell

Glucagon Blockade for the Treatment of Stress-Induced Hyperglycemia

**My project is entirely in-person.*

Stress-induced hyperglycemia is associated with poor outcomes in nearly all critical illnesses. This acute elevation in glucose after injury or illness is associated with increased morbidity and mortality, including multiple organ failure. Stress-induced hyperglycemia is often attributed to insulin resistance as controlling glucose levels via exogenous insulin improves outcomes, but the preliminary data presented herein argues against this being the sole driver. Glucagon is another glucoregulatory hormone that increases in trauma and other critical illness. We found that blocking the glucagon signaling cascade via either a mutant in protein kinase A or the glucagon receptor itself was sufficient to prevent stress-induced hyperglycemia in our mouse model of critical illness. This project will now test if using a clinically-validated glucagon receptor antagonist is sufficient to treat stress-induced hyperglycemia and prevent associated complications in the liver, kidney, and heart and improve survival. We hypothesize maintaining euglycemia via treatment with a glucagon receptor antagonist will mitigate excursions in glucose, decrease organ failure and improve survival. in our mouse model of critical illness. This important pre-clinical work will lay the foundation for potential future clinical trials investigation if glucagon blockade could be an effective tool to treat stress-induced hyperglycemia and associated morbidity and mortality.

Undergraduate researcher will assist (Dr. Anna Garcia Whitlock) with basic laboratory tasks related to biochemistry, molecular biology, and animal physiology. Mentorship is a top priority in the Titchenell lab. The undergraduate researcher will be trained to perform tasks related to characterizing and phenotypic novel mouse models of hyperglycemia and insulin resistance. These include reagent preparation, genotyping mice, assay execution and presenting and sharing data in a formal lab meeting setting.

PSYCHIATRY

Kelly Allison

Impact of the Timing of Eating on Weight and Metabolism

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

This NIH-funded study examines the impact of the timing of eating on weight and several metabolic health markers, such as resting energy expenditure, body composition, mRNA from adipose tissue, and glucose metabolism. Participants are adults with obesity who are asked to eat on an early schedule (8am -7 pm) for 8 weeks and on a later schedule (12 pm - 11 pm) for 8 weeks, with a 2 week washout period in between. Each participant has four inpatient assessment visits before and after each of these eating conditions. We provide all of the food to the participants to control their calorie and nutrient intake, and monitor their sleep and activity with daily surveys and actigraphy. Your experience would include helping to recruit participants for the study, help manage food distribution to the participants, help with study logistics and supplies, including labeling tubes and setting up the inpatient hospital rooms for assessment visits, and data entry. You would also be able to observe and learn how to process blood samples. Finally, you would attend weekly study meetings with our study team. You would work closely with ***our current clinical research coordinators, one of whom was a previous PURM student, and with Dr. Allison and her co-PI, Dr. Goel. You would get to see all aspects of a clinical research project in motion.***

Emily Becker-Haimes

Improving Youth Mental Health Services with Implementation Science

**My project can be completed entirely remotely.*

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

The first project comprises a systematic review of freely available resources that can be used to support clinicians to work effectively with individuals at-risk for suicide. Students will learn about leading evidence-based strategies for suicide prevention and will code clinician resources for quality, as well as gain familiarity with systematic review methodology.

The second project, Project RESPECT, aims to develop a toolkit of culturally responsive treatment strategies for diverse youth with anxiety or obsessive compulsive disorder. As a part of this study, we are conducting ~30 qualitative interviews with clinicians, youth, and their caregivers to learn how we can optimally support culturally responsive care. PURM students will receive training in and support to complete qualitative coding and analysis of interview data to contribute to the design and refinement of the toolkit. In addition, students will contribute to a companion quantitative survey of expert clinicians that is seeking clinician feedback on how to optimize the toolkit.

Finally, the third project, Project ACTIVE, is a large, NIMH-funded study that is testing how to optimally support clinicians to deliver cognitive behavioral therapy, a leading psychosocial evidence-based practice, in community settings. In this project, students will gain experience with consenting and enrolling participants in to a research study. In addition, students will have an opportunity support qualitative analysis of data gathered from community clinicians as well as to observe clinician therapy practices in the community.

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.*

Standard treatments for Major Depressive Disorder (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, and how to process blood samples for future analysis. Students will be responsible for administering and explaining the use of sleep diaries and actigraphs to all participants, and or 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.

Melanie Pellecchia

Randomized Trial of Project ImPACT, an Evidence-Based Intervention for Infants and Toddlers with Autism Spectrum Disorder

**My project can be completed entirely remotely.*

Project ImPACT is a parent-mediated intervention for young children with autism spectrum disorder (ASD) that blends developmental and naturalistic behavioral intervention techniques to teach core social communication skills. We will gather preliminary evidence on the effectiveness of two doses of Project ImPACT, compared with treatment as usual, in improving social communication and cognition for infants and toddlers, and parent self-efficacy. We will conduct a three-arm randomized field trial in a diverse sample of children with autism less than 3 years of age, using community providers to coach parents. We also will estimate Project ImPACT's cost effectiveness at different doses. This study is being conducted in partnership with the Philadelphia Infant and Toddler Early Intervention system.

Undergraduate research assistants will participate in behavioral coding of intervention sessions and assessment observations. Familiarity with behavioral coding from video recordings is preferred but not required. Undergraduate research assistants will gain experience with identifying autism symptomology in young children from recorded play observations, assessing the use of responsive parenting techniques from recorded play observations, and scoring fidelity of evidence-based intervention practices delivered by community-based providers from recorded session observations. Applicants from under-represented minority groups are strongly encouraged to apply.

PULMONARY, ALLERGY, AND CRITICAL CARE MEDICINE

Michael Shashaty

Clinical and Molecular Epidemiology of Acute Kidney Injury after Lung Transplantation

**My project is entirely in-person.*

This project is a great opportunity for students interested in a clinical or research career. Students will gain experience in clinical and translational research with laboratory and clinical data components, and with potential opportunities to work with human subjects and in hospital settings such as the intensive care unit.

The project focuses on studies of acute complications in patients undergoing lung transplantation. The immediate post-lung transplant period is characterized by the need for intensive care, and recipients are at risk for organ dysfunction syndromes that profoundly impact transplant success and patient survival. We run an ongoing multicenter cohort study, the Lung Transplant Outcomes Group (LTOG), that is designed to determine clinical and molecular/genetic risk factors for the development of primary graft dysfunction (PGD) and acute kidney injury (AKI). The LTOG has contributed multiple prior publications to the transplant and critical care literature in defining PGD as a clinical syndrome, describing the basic epidemiology of post-transplant AKI, and identifying key risk factors and disease mechanisms that may inform treatment strategies. We are currently conducting the largest study to date of AKI clinical and molecular risk factors after lung transplantation, with specific interest in recipient obesity, adipokines, coagulation factors, and circulating molecular mediators of cellular injury such as mitochondrial DNA.

Students will have the opportunity to: assist with obtaining informed consent from prospective lung transplant recipients, process time-sensitive blood and urine specimens from the ICU, collect patient information from the electronic medical record into a computerized database, learn laboratory best practices and sample management procedures, conduct and interpret laboratory analyses such as ELISA to test plasma and urine AKI biomarker concentrations, and participate in weekly meetings with the primary investigators to learn about the conduct of clinical research studies. Students will have direct interaction the LTOG-AKI principal investigator, Dr. Michael Shashaty, and will play an integral role in the research team comprised of research coordinators and lab personnel. Opportunities to shadow physicians working in the ICU setting, which have been possible in prior years, will depend on COVID-related hospital policies at the time of the PURM experience. The opportunity to work on this project may be extendable into the school year.

Prerequisites: Students should be enthusiastic about biomedical research, ready to adhere to patient privacy standards, willing to work with human samples in the laboratory, and be interested in working collaboratively with our research team. Non-lab work can potentially be done remotely.

RADIATION ONCOLOGY

Yi Fan

Reprogram Tumor Stroma to Improve Brain Tumor Immunotherapy

**My project is entirely in-person.*

T cell-based immunotherapy for solid tumors, such as immune checkpoint blockade, is currently limited by efficacy challenges, particularly in immunologically cold tumors including brain tumor glioblastoma (GBM), largely due to limited T cell infiltration and activation. Tumor vasculature is structurally and topologically abnormal, which impedes the delivery of T cells into the tumor. Genome-wide functional analysis of aberrant vascularity may provide global insight into mechanisms underlying T cell exclusion and tumor immunotherapy resistance. Here, our single-cell and bulk transcriptome analyses of tumor-associated endothelial cells (ECs) by genetic lineage tracing reveals robust endothelial plasticity to acquire genetic reprogramming with mesenchymal gene signature, which leads to vessel abnormalities in mouse and human GBM. Whole-genome CRISPR/Cas9 library screening of mesenchymal-like transcriptional activation identifies Foxc2 as a key regulator that drives EC genetic reprogramming and functional dysfunction.

In this project, we will test experimental combination therapy using immune checkpoint inhibitors and adeno-associated viruses (AAV) that target Foxc2 in tumor ECs. GBM will be genetically engineered by RCAS-mediated gene transfer in mice, followed by administration of anti-PD-1 antibody and EC-specific AAV2 that express Foxc2 shRNA. Tumor growth and animal survival will be monitored. Tumors will be excised and subjected to flow cytometry-based immunological analysis of T cell infiltration and activation. Successful completion of this project will contribute to development of AAV-based gene therapy approach to improve brain tumor immunotherapy.

The participating student(s) will learn the experimental skills related to gene therapy, animal modeling, and immunological assays.
Yi Fan, Associate Professor, working as mentor
Mengguo Huang, Research Associate, working as a co-mentor

RADIOLOGY

Elizabeth McDonald

Breast Cancer Biomarker Development

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

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

Hersh Sagreiya

Automated Tools for Clinical Diagnosis Using Medical Imaging and Machine Learning

**My project can be completed entirely remotely.*

We have been developing a pipeline that uses deep learning on 3D medical images to aid in more quantitative clinical diagnoses. For instance, we developed an algorithm that automatically calculates the volume of the liver and spleen on CT, using that information to determine the presence of liver fat or hepatic steatosis. We developed another algorithm that can perform automatic quantification of abdominal fat on CT, while another algorithm can determine the volume of individual muscles on abdominal MRI. This offers the ability to relate these quantitative phenotypes to exciting clinical and basic science questions. As we have previously done, it is possible to link imaging features to genetic data in Penn Medicine Biobank and other clinical data in the Electronic Medical Record. Using this information, it is possible to conduct genome and phenome-wide association studies (GWAS/PheWAS), which can offer insights into both the genetic loci and the clinical factors that can lead to the development of disease. For additional details regarding how such a project can work, please see our work in the Journal of the American Medical Informatics Association: https://academic.oup.com/jamia/article-abstract/28/6/1178/6133906. We are currently trying to bring some of these algorithms to clinical practice and have developed a research PACS (picture archiving and communication system) towards that goal. Opportunities are available to further develop the aforementioned techniques, focusing on clinical and basic science insights that they may elucidate via GWAS/PheWAS studies. Other options include developing new algorithms for tasks such as liver or pancreatic cancer detection, hepatic fat determination on MRI, and pancreas/kidney segmentation, once again with an eye towards using this information for clinical/scientific insights.

As part of this project, you will develop skills in machine learning and deep learning. These are incredibly powerful skills that will be valuable for graduate work in a variety of fields, as well as future job opportunities. You will also have an opportunity to learn more about medicine, particularly medical imaging. Computer science skills are a plus, particularly at the level of introductory computer science/AP Computer Science, although students of all backgrounds are encouraged to apply. You will also be working with Dr. Walter Witschey, who is an expert in

medical imaging research and who has been spearheading several initiatives related to automated diagnosis using machine learning.

Joel Stein

Brain Imaging with the World's First Portable MRI Scanner

**My project can be completed entirely remotely.*

Magnetic resonance imaging (MRI) has become fundamental to diagnosing and managing many neurological diseases, but the cost, size and complexity of typical scanners limits access to these devices and how they can be used. A newly developed, low cost, low field strength, FDA-cleared, portable MRI scanner could decrease barriers to brain imaging, including in intensive care units, emergency departments, doctor's office, rural clinics, or underserved areas worldwide. However, the portable unit generates lower resolution images than typical scanners and its utility for different applications remains uncertain.

Several related projects available for undergraduates focus on our studies using this portable MRI scanner in the radiology department. One condition we are looking at is multiple sclerosis (MS), an inflammatory disease that causes demyelinating lesions and brain atrophy. MS is both a good model to understand the limits of what this new scanner can do and a disease that may benefit from easier access to imaging.

Project 1 - We have scanned over 40 patients with MS on the portable scanner and standard scanners. We need your help labeling lesions on these images and performing a study to understand how well radiologists can detect lesions on the portable scanner.

Project 2 - We are testing a means to measure brain volumes from the portable images. We need your help processing the data from MS patients and healthy controls to see how well the measurements of different brain regions correlate between scanners and with disease burden

Project 3 - We have collected over 1000 cases with new MS lesions detected and measured on conventional MRI. We need your help to parse this data to help us understand the typical size of new lesions detected during MS follow-up imaging.

Your work will be supervised by a neuroradiologist (Dr. Stein) and a graduate student in bioengineering (T. Campbell Arnold). Basic programming skills are desirable, particularly in Python.

Nursing

BIOBEHAVIORAL HEALTH SCIENCES

Charlene Compher

MEDIMEALS Randomized Controlled Trial in Patients with Heart Failure and Malnutrition

**My project can be completed entirely remotely.*

Patients with heart failure often also experience malnutrition that is identified during hospital stays. Symptoms of heart failure may make it difficult to prepare healthy meals with the potential to worsen the malnutrition or heart failure (if they eat salty processed foods). In a random order crossover study design, 100 patients with malnutrition and heart failure will receive either 7 or 21 meals/week comprised of heart-healthy items provided free of charge by the Metropolitan Area Neighborhood Nutrition Alliance (MANNA). Our primary outcome is improvement in malnutrition risk, and secondarily unplanned medical or hospital visits. All the data for the study will be captured in the patient's home by telephone call or by accessing the electronic medical record of the Hospital of the University of Pennsylvania.

Students working on this project will gain study coordinator skills. They will contact patients by telephone at baseline, 30 and 60 days to evaluate malnutrition risk, food intake, body weight, calf circumference, doctor or hospital visits, and satisfaction with meals. They will be trained to use the hospital's electronic medical record to retrieve information about malnutrition and heart failure. They will enter data from the medical record and from phone calls into a REDcap database and prepare monthly enrollment updates for the investigator team. We anticipate needing 18 months to enroll all 100 patients in the trial. Students who continue working with this project over the entire window may be coauthors on the published findings.

Hyejeong Hong

Sputum-Based Single-Cell RNA Sequencing Approaches to Elucidate Molecular Determinants and Predictors of Post-TB Treatment Lung Disease

**My project is entirely in-person.*

The purpose of this pilot study is to exploit single-cell RNA sequencing (scRNA-seq) technology using sputum samples in pulmonary tuberculosis (TB) patients to generate a single-cell atlas of local lung immune response at the time of treatment completion, comparing those with post-TB treatment lung disease (PTLD) to those without PTLD. This cross-sectional study will collect spontaneously expectorated sputum specimens as well as relevant exposure and outcome variables (e.g., lung function and radiographic changes) during their last clinic visit at the end of

the 6-month's TB treatment. Thus, sputum samples are considered non-infectious as culture and microscopy tested negative already at the time of collection. Clinical data and sample collection will occur at the Philadelphia TB Control Clinic, located at 1930 S. Broad Street, Philadelphia. Through this activity, the Research Assistant (RA), who will be an undergraduate with an interest in biomedical translational research, will gain skills in recruitment, data collection, data entry, data quality assurance/control, and handling of biological specimens in a TB clinical setting.

Specifically, The RA will be trained in medical record data abstraction and data entry into REDCap (a secure, web-based research data management application). The RA will also be trained in handling biospecimen samples from participants and in transporting these samples to the Penn Center for AIDS Research (CFAR) Immunology Core laboratory at the Perelman School of Medicine. We will provide unique opportunities to learn scRNA-seq technologies, including sputum sample processing, cell sorting, RNA isolation, library preparation for sequencing and relevant bioinformatics pipelines. Prior to study launch, the RA will complete the University of Pennsylvania Institutional Review Boards (IRB) training and other protection of human subject research training.

The RA will meet with Dr. Hyejeong Hong (Assistant Professor of Nursing, Principal Investigator [PI]) in person weekly and Dr. Gregory Bisson (Associate Professor of Medicine, co-PI) bi-weekly to review recruitment progress and IRB compliance, discuss any issues related to data collection and management, and ensure that all concerns related to participants' responses are handled appropriately. We also expect to provide opportunities to produce abstracts and publishable manuscripts from this project. Taken together, this will provide undergraduate(s) with an outstanding opportunity in hands-on clinical and translational health research.

Sarah Kagan

Partners in CaRe

**My project can be completed entirely remotely.*

In the United States, more than 1 in 5 people have provided health or social care for an adult in their life in the last twelve months. This community of people caring for someone they know is expected to grow as people with chronic or co-occurring health conditions live longer and require additional care. Care partners –the persons providing care, commonly referred to as "caregivers" –support people who have a variety of health conditions and disabilities. Care partners experience many physical, psychological, financial, and social burdens by supporting others as well as gaining benefits including a sense of mastery and purpose. Care partners of people with cancer shoulder an especially high care load, performing a greater number of activities of daily living for a longer amount of time each day when compared to care partners of people with other conditions. While adequate support for cancer care partners is consequential for the outcomes of individuals with cancer, cancer care partners have individual needs as well. Support for care partners must extend beyond the support they require to fulfill their caring roles

for people living with or after cancer. Limited evidence is available to guide understandings of and support for cancer care partners' experiences, especially as those needs intersect with racial, ethnic, gender, sexual, generational, or relational identities.

The specific aims of the Partners in Cancer Care Research (CaRe) are to characterize self-identified care partner networks of people with cancer; elicit, analyze, and illuminate textured personal experiences of cancer care partners; and uncover and characterize ethical or moral considerations of care partners' experience. We will use Database of Individual Patient Experience Methodology (DIPEx) to elucidate and qualitatively analyze care partners' experiences and then create and disseminate a short "catalyst film" of comprised of videotaped interview clips selected for their actionable insights and personal testimony. This study is being conducted by an established interdisciplinary clinical-academic partnership between the University of Pennsylvania School of Nursing and the Abramson Cancer Center.

We welcome undergraduate students to join us. No prior experience is necessary. Students will learn about the topic under study, work with our clinical-academic team, and gain research skills including qualitative interview techniques, qualitative data management, qualitative data analysis, DIPEx, and quality improvement methods.

Lea Ann Matura

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

**My project can be completed entirely remotely.*

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. 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. 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.

Students will learn data entry/management along with actigraph programming and analysis.

FAMILY & COMMUNITY HEALTH

Dalmacio Flores

The SHIFTs Study: Sexual Health Inclusivity during Family Talks

**My project can be completed entirely remotely.*

Forty years of parent-child sex communication research with heterosexual samples has led to the development of interventions that enhance youth efficacy with condom use, encourage resistance when pressured to have sex, and increase an adolescents tendency to access and use reproductive and sexual health services. The same protective effects from sex communication involving parents and their lesbian, bisexual and queer (LBQ) adolescents have not been established. Despite adequate literature detailing the increased sexual health risks LBQ adolescents face, the vast majority of research on LGBTQ+ people focuses on men who have sex with men.

This multi-method qualitative study will begin to examine the process of sex communication at home from the perspective of parents and LBQ cisgender daughters. The main study aims include (1) to describe the perceptions of LBQ adolescents and parents regarding parent-child sex communication, including unique health and sex-related topics they feel they need to discuss and not discuss with one another, (2) to elicit suggestions from LBQ adolescents and parents on the barriers and facilitators to initiating and sustaining LBQ-focused parent-child sex communication, and (3) to solicit from parent-child dyads their ideas for an emergent, LBQ-focused parent-child sex communication intervention.

Undergraduate researchers assisting with the SHIFTs Study will receive training in data cleanup and qualitative data analysis using the software NVIVO. Students will work closely with the research team develop the following skills:

- to generate categories and study thematic patterns in participants' responses
- to prepare conference presentations and publish with the research team
- to assist/facilitate in focus groups involving parents and LBQ youth

Student applicants must be detail-oriented, highly organized, and proficient in MS WORD. Applicants with a commitment to health equity are encouraged to apply.

Adriana Perez

Tiempo Juntos por Nuestra Salud: Physical Activity Intervention for Older Latinos with Mild Cognitive Impairment

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

"Tiempo Juntos por Nuestra Salud" (Time Together for Our Health) tests a physical activity intervention among Spanish-speaking, Latinx elders with mild cognitive impairment (MCI), living in Philadelphia and the surrounding communities. Eligible participants are randomized to one of two conditions: a walking group that meets twice weekly for 12 weeks, followed by bi-weekly mobile health (mHealth) booster sessions; an Attention Control (AC) group attends Spanish health education group sessions adapted from the National Institute on Aging online resources. Both groups may be conducted in person or virtually. The primary outcome (moderate-intensity physical activity) and secondary health outcomes, including cardiovascular health (blood pressure), cognitive health (executive function, episodic memory, working memory) and sleep are assessed at baseline and post-intervention. To inform a future larger cost-effectiveness trial, we are conducting a cost-analysis by calculating intervention costs and comparing to healthcare utilization costs.

The focus of this study is significant because MCI is considered the pre-dementia stage of Alzheimer's disease and the number of Latinx elders living with Alzheimer's Disease is expected to increase by 800% in the next 20 years. The Latinx population continues to grow and are considered one of the most sedentary elder groups in the U.S., however, remain underrepresented in AD clinical trials. The Biden Administration and U.S. Department of Health and Human Services have made Alzheimer's risk reduction a national priority by increasing funding to support Alzheimer's research and by diversifying the scientific workforce. This study seeks to mentor students considered underrepresented by the National Institutes of Health, including those from Latinx background who are bilingual (English/Spanish).

For 10-week summer project, students will learn the following research skills using both in-person and virtual modalities: ethical conduct of research, particularly with historically marginalized communities, linguistic and cultural adaptation of intervention research and recruitment science, data collection/data entry/data analysis procedures, interdisciplinary research collaboration, participant follow-up and engagement (specifically with Spanish speaking older adults with mild cognitive impairment), and opportunity to publish/present findings.

Students will have opportunities to receive mentorship from interdisciplinary team, including, Dr. Perez (Penn School of Nursing (SoN): Nalaka Gooneratne, MD, MSc, Associate Professor at

Penn School of Medicine (SoM) Division of Geriatric Medicine/Center for Sleep/Respiratory Neurobiology, Subhash Aryal, PhD, Research Associate Professor of Biostatistics at Penn SoN, Norma B. Coe, PhD, Associate Professor of Medical Ethics/Health Policy at Penn SoM, David X. Marquez, PhD, Associate Professor, Department of Kinesiology/Nutrition at University of Illinois at Chicago.

Social Policy & Practice

SOCIAL WORK

Millan Abinader

PAIR Studies

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

Position**:**
The PURM student will join a multi-state, multi-university project investigating intimate partner homicide risk. The student's primary responsibilities will revolve around research activities: data collection, project management, translating research for public audiences. The student should be detail-oriented, comfortable working independently while still working well on a team, have good communication skills, and preferably have some background working in the gender-based violence field. This project is a combination of remote and in-person work.

Project Description:
Intimate partner homicide (IPH) accounts for one-fifth of US homicides. Dr. Millan AbiNader, in collaboration with faculty from other universities across the country, is examining risk factors for IPH—what behaviors or characteristics make partner violence more likely to escalate to lethal violence—across six states: Arizona, New Jersey, Maryland, Texas, Missouri, and Oregon. We are collecting data from multiple sources: law enforcement reports, medical examiner data, and survivor interviews. These data will inform the development of risk assessments and interventions for IPH. In Arizona and New Jersey, we are also specifically examining the effect of COVID-19 stay-at-home policies on IPH risk and rates.

We are seeking one student to join our research team. As a team member, you will code law enforcement and medical examiner data, perform literature reviews, assist in project management, and translate research for public audiences. Team members work during normal business hours (9-5, M-F), although some flexibility may be possible. While a large portion of this work can be conducted remotely, students will be expected to attend in-person meetings with Dr. AbiNader and to do in-person data collection when needed.
This is a perfect entry-level position for students interested in the fields of administrative data, gender-based violence, and criminal justice. All training will be provided.

Student Responsibilities:
• Complete data collection and CITI trainings within the first week of hire,
• Enter criminal justice data,
• Accurately enter data and seek assistance when needed,
• Attend biweekly Zoom team meetings,
• Respond within 24-hours to emails,

• Use Slack,
• Regularly check in with supervisor,
• Keep up-to-date and clear notes tracking data entry progress,
• Go in person to collect data in New Jersey and Maryland (potentially),
• Translate research to community audiences, and
• Assist Dr. AbiNader in project management tasks

Team Members will:
• Learn about intimate partner violence,
• Gain skills in data entry and management,
• Contribute to translating research for community audiences,
• Deepen communication skills, and
• Gain experience working on large research teams

Veterinary Medicine

CLINICAL STUDIES NEW BOLTON

Kyla Ortved

The Effect of Phenylbutazone and Firocoxib on Concentrations of Cytokines and Growth Factors in Platelet Rich Plasma and Autologous Protein Solution Preparations in Horses

**My project is entirely in-person.*

Non-steroidal anti-inflammatories are used in horses to ameliorate both inflammation and pain due to musculoskeletal disease. Those same horses are likely to be managed for musculoskeletal disease with other methods, with a trend towards the use of autologous therapies for musculoskeletal disease in the equine athlete. Platelet rich plasma (PRP) and autologous protein solution (APS) are two of such autologous therapies that improve quality of healing in musculoskeletal disease (osteoarthritis, tendonitis and desmitis) in horses, dogs and humans. These substances are thought to exert their effects by concentrating cytokine releasing leukocytes and platelets that release growth factors after activation. NSAIDs have been shown in both horses and humans to effect the concentrations of some cytokines and growth factors in blood-derived autologous substances such as PRP. Based on this, it is possible that the administration of NSAIDs, a relatively common practice in equine medicine, prior to obtaining blood samples for processing of PRP or APS may result in an inferior or less effective product. The objective of this study is 1) to determine the effects of commonly used NSAIDs (phenylbutazone and firocoxib) on the concentrations of growth factors and cytokines in PRP and APS during and after NSAID use, and 2) to investigate concentrations of firocoxib and phenylbutazone in PRP and Pro-stride products and blood after administration of these products.

Undergraduate students are encouraged to participate in this summer research project being conducted at New Bolton Center. Students will need to provide their own transportation to New Bolton Center, Kennett Square PA. Students with an interest in veterinary medicine are particularly encouraged to apply. Students will be involved in blood collection and preparation of PRP and APS. They will also be involved in cytokine quantification in the products processed from horses.

Dipti Pitta

Methane Formation and Mitigation in Diverse Anaerobic Ecosystems

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

Bench work; willingness to work with rumen fluid or feces or manure

Other Mentors:
Meagan Hennessy
Kapil Narayan
Nagaraju Indugu

CLINICAL STUDIES PHILADELPHIA

Margret Casal

Familial Lymphoma in the Irish Wolfhound

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

Lymphoma is a debilitating condition that affects humans, dogs and cats. The goal of our laboratory is to investigate the genetic basis of lymphoma in the Irish Wolfhound, one of the leading causes of death in this breed. This is a continuation/subset of a project that was previously PURM funded, which had led to sample collection, DNA preparation, lineage discovery, and a poster outlining the prevalence and relatedness of Irish Wolfhounds with lymphoma. We now have a sufficient number of samples to perform an initial Genome Wide Association Study (GWAS). The results will not only benefit Irish Wolfhounds but potentially other dog breeds and humans with the same disorder. We anticipate funding from the AKC Canine Health Foundation for the GWAS itself ($9,880). This position is of particular interest to the student who desires insight into the genetics of dogs, the work-up of genetic diseases, and the research aspects of veterinary medicine. The faculty and staff both teach genetics and have 30 years of experience in molecular biology and teaching. Both the faculty and staff have been working up genetic diseases from the clinical picture to the disease-causing mutation since 1991 and have vast knowledge of feline and canine genetics. We are situated in the Ryan Veterinary Hospital of the University of Pennsylvania, where veterinary patients are seen.

Description:
The candidate will work closely with two veterinary geneticists (Drs. Margret Casal and Petra Werner) and the former recipient of the PURM grant (Erika Lutz) to prepare the samples for the GWAS, collate the data, and then analyze the data together with the PI and Dr. Werner. The candidate will learn how to use tools to analyze complex genetic data.

Requirements:
Research techniques will be provided to the candidate. Requirements are interest, motivation, strong organizational skills, and the ability to work independently in a collaborative environment. We are a lively and enthusiastic group. Ideally, the candidate will have an opportunity to author a poster abstract and coauthor a research manuscript..

Cynthia Otto

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

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

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

Fundamental skills to be learned:

Understanding working dog behavior, olfaction and careers
Recognizing and coding canine behavior
Developing organizational skills necessary to collect and analyze data

Other mentors:
Dr. Amritha Mallikarjun - postdoctoral researcher

Charles Vite

Enzymatic Diagnosis of Lysosomal Storage Diseases in Dogs and Cats Using Dried Blood Spots

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

Lysosomal storage diseases (LSD) are genetic disorders caused by insufficient activity of specific lysosomal proteins. The resulting accumulation of unmetabolized substrates in lysosomes leads to activation of pathogenic cascades resulting in disease. Many LSDs have been identified in animals that serve as naturally occurring models of human disease. As early intervention is critical for successful prevention of pathology, early diagnosis is important. Therefore, routine newborn screening has been established using dried blood spots (DBS) due to the ease of collection. Our laboratory's goal is to identify LSDs in animals using fluorescence-based assays.

However, currently serum samples are required from the patient and from a healthy control animal to account for potential shipping impact on enzyme activity. To keep the samples from potential degradation during shipping, samples must be sent overnight on ice packs, and samples are required to be kept chilled or frozen until analysis. A simpler and cheaper alternative for the sample submission would be the use of DBS for these assays identical to human newborn screening. The use of DBS has already been tested with dog and cat samples in other laboratories. A successful transition from serum to DBS samples for the established fluorescence-based enzyme tests in our laboratory would be a great advantage for us. First, it would make the storage of the samples submitted to us much simpler and, secondly, the shipping of the samples to us would be much cheaper which might increase the number of samples sent us.

This position is of particular interest to the student who desires insight into genetic disease in small animals, particularly metabolic genetic diseases, and the research aspects of veterinary medicine. The faculty and staff both teach genetics, have 30 years of experience in molecular biology, working up genetic diseases, and teaching.

Description:
The candidate will work closely with two veterinary geneticists to gather and evaluate specific protocols regarding the treatment of DBS and its effect on enzyme activities for our established enzyme assays in dogs and cats. The candidate will learn various laboratory techniques including the use of fluorescence-based assays and analyses.

Requirements:
Research techniques will be provided to the candidate. Requirements are interest, motivation, strong organizational skills, and the ability to work independently in a collaborative environment. We are a lively and enthusiastic group. Ideally, the candidate will have an opportunity to author a poster abstract and coauthor a research manuscript

EPIDEMIOLOGY

Laurel Redding

The Effect of Dietary Zinc on C. Difficile Colonization and Pathogenesis in Neonatal Piglets

**My project is entirely in-person.*

The early neonatal phase is a critical period of pigs' lives. Not only is there a high probability of morbidity and mortality from infectious disease, but also this period is important for shaping the animal's microbial profile and future intestinal health. The bacteria Clostridoides difficile is a significant pathogen in many species of animals, including pigs, in which it can cause severe

diarrhea and even death. Research in mice has shown that dietary zinc increases susceptibility to C. difficile infection and intensifies the severity of C. difficile-associated disease by modulating the structure and diversity of the gut microbiome. Zinc is included in the diet of pigs at all stages of life as an essential trace element. However, it is unknown whether this type of supplementation affects the rates of C. difficile carriage in sows and their piglets or whether it enhances C. difficile virulence.

The objectives of this study are to determine the effect of dietary zinc on 1) the prevalence of C. difficile in sows and piglets, 2) genetic variation in C. difficile in sows and piglets; and 3) characteristics of C. difficile isolated from these animals. Pregnant sows will be enrolled in a feeding trial where they will be given either a low- or high-dose of dietary zinc, and they and their newborn piglets will be sampled.

We are looking for motivated students to help conduct the feeding trial. The trial will be performed at the swine center of the New Bolton Center campus of the vet school. Students will assist with assigning pigs to the different arms of the trial, observing sows and their piglets, and collecting fecal samples from them.

Students can expect to acquire skills in animal handling, epidemiological research, project management, and data analysis.

No prior experience in handling pigs is required - all training will be provided on site. The campus is about a 45-minute drive from Philadelphia, but low-cost rental options in the area are available for students who would like to live close to the site.

PATHOBIOLOGY

Candice Chu

Novel Biomarker and Therapeutic Target for Chronic Kidney Disease in Cats

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

I am a veterinarian, a boarded clinical pathologist, and an assistant professor at Penn Vet. This summer, I have an in-person project studying chronic kidney disease (CKD) in cats and a potentially remote project studying canine lymphoma cytology.

CKD is defined as irreversible loss of kidney structure or function for more than 3 months. It is a disease that commonly affects cats, with an estimated prevalence reported as high as 50%. While early diagnosis and therapeutic intervention could slow down the disease progression, the conventional kidney biomarker, such as serum creatine (i.e., renal value), is insensitive and will not increase until 75% of renal function is lost. Therefore, I plan to investigate urinary

microRNA (miRNA), a small non-coding RNA, or exosomes, an extracellular vesicle, as novel, non-invasive biomarkers in the early diagnosis and monitoring of disease progression in feline CKD.

Lymphoma is the most common cancer in dogs. The most common clinical signs are swollen lymph nodes. The diagnosis of lymphoma often relies on cytology, where a needle is penetrated into the swollen lymph node to collect lymphocytes for microscopic examination. Image recognition through artificial intelligence and machine learning is a trending technology that can assist the diagnosis of canine lymphoma. Therefore, I plan to test whether AI can correctly diagnose canine lymphoma based on cytology images.

Prior research experience is preferred but not required. In the in-person project, you will learn to use pipettes, practice RNA/exosome isolation in archived feline urine samples, and assist in data analysis. For the remote project, students will learn basic concepts of veterinary cytology, digital pathology, and cell annotation. In addition, you will also learn how to prepare a scientific poster and enhance your presentation skills through one-on-one instruction. Co-authorship is possible if you made direct contributions to the research projects. Please note that the availability and the contents of the projects are subject to change.

To learn more about me, please visit my website at http://candicechudvm.com/.

Wharton

LEGAL STUDIES AND BUSINESS ETHICS

Peter Conti-Brown

History of Banking and Central Banking

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

I am completing two books, both on the history of finance, banking, and central banking. The first is a political history of the Federal Reserve. The second is a history of bank supervision in the United States. Student researchers will assist me in gathering and analyzing documents, proofreading manuscript chapters, and otherwise helping me prepare these books for publication. Students should be interested in the intersections of law, history, finance, and public policy.

MANAGEMENT

Mary Mcdonnell

Shifts in Board Diversity

**My project can be completed entirely remotely.*

This project will explore the factors that have led US companies to enhance the diversity of their corporate boards. Students will be trained to use corporate SEC filings to research and code the demographic traits of corporate board members, as well as the changing manner in which board diversity is discussed and disclosed by US boards. We will then empirically consider the role of various factors in augmenting board diversity, including corporate ideology, social movements, and diversity regulation. This project will provide particularly valuable experience for students interested in pursuing business school or law school in later years.

Natalya Vinokurova

Engines of Innovation in Large Firms

**My project can be completed entirely remotely.*

The R&D productivity of the U.S. firms' declined more than 65 percent between 1975 and 2010. The goal of this project is to understand whether this ***decline was due to a decrease in the large firms' use of centralized research laboratories to organize their research and development. To do this, our plan is to collect a combination of archival and interview data to document the role of central research laboratories in firms' R&D effort over time. The research assistant's***

tasks would include library research (searching online databases, e.g. Hoovers, Proquest, Ebscohost) and email/telephone (contacting the firms of interest to understand their R&D practices) components, as well as organizing the archival documents collected for each firm. The students are expected to keep a running log of their findings.

My goal for this project is to help the students develop research skills (including expertise about available online databases, facility with Excel, and expressing their ideas in writing) that would serve them well in their future endeavors, be they academic or professional. The students who have worked with me over the years have gone on to work in management consulting, equity research, investment banking, and to pursue graduate work in a variety of subjects.

Tiantian Yang

Gender, Tech Bubbles, and the IT Earnings Gap

**My project can be completed entirely remotely.*

This project investigates the gender earnings gap in the tech industry. We will focus on how male and female technical workers search for jobs. For example, do female technical workers have preferences for shorter commutes and less travel, and are they less likely to be employed during searching? Are female technical workers less likely to have access to training for cutting-edge technologies such that they possess less desirable skills? And finally, how do these job-seeking preferences and access to training affect their future job mobility and pay?

For the research assistants, the skills involved will be two:
1. Literature review
2. Writing skills

MARKETING

Jonah Berger

Why Do Things Become Popular? Natural Language Processing and Behavioral Insight

**My project can be completed entirely remotely.*

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.

OPERATIONS AND INFORMATION MANAGEMENT

Katherine Milkman

Behavior Change for Good

**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 with an interdisciplinary team of 140 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, members, 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 BCFG 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.