Penn Undergraduate Research Mentoring Program
Project Descriptions

Summer 2020

Please read this before proceeding to project listings!

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

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

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

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

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

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Annenberg

COMMUNICATION

Joseph Turow

Exploring Public Discussions of Deepfakes

This research will involve analyzing media discussions of deepfakes (accessed through databases such as Factiva, Lexis Nexis, and EBSCO) to create a critical chronology of the ways newspapers, magazines, websites, and apps have discussed the nature and challenges of the controversial phenomenon. The aim will be to help planners of a Spring 2021 International Annenberg School conference on deepfakes to better understand the ways deepfake issues, and the organizations and individuals involved with the issues, have developed over the past several years.

The Merriam Webster dictionary says deepfake "is typically used to refer to a video that has been edited using an algorithm to replace the person in the original video with someone else (especially a public figure) in a way that makes the video look authentic." Other sources broaden the term's meaning to include still images as well as audio. Although some chroniclers trace deepfake technology back to the 1990s, a Redditt website user coined the actual term in late 2017. I will help the student choose the databases in which to search, understand how to access and use the databases, decide on the search terms, figure out the manner in which to record the findings, and consider ways to analyze the material for the paper the student will write about her/his findings. The student will be welcome to help plan the conference as well as to attend it and see how the findings of this study influenced the meeting's program and the ideas with which attendees grapple.

Arts and Sciences

BIOLOGY

Nancy Bonini

Molecular mechanisms of brain aging and disease

The laboratory uses Drosophila melanogaster as a model for the human brain in aging and neurodegenerative disease. We study molecular and cellular mechanisms by which the brain helps to protect itself from the insults of age, and combats diseases like Alzheimer's disease and other dementias. To discovery the molecular mechanisms, the laboratory uses a range of techniques, including genetic crosses of various genotypes, western immunoblots for proteins, immunohistochemical staining for proteins, brain paraffin sections for brain structure and protein levels, among others. These studies help to reveal the pathways and processes that lead to deterioration of the brain in disease, and can help protect the brain against insults of aging.

Mia Levine

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

Specialized proteins package genomic DNA into chromatin. This DNA packaging regulates gene expression, chromosomal inheritance, genome defense, and many other essential, strictly conserved biological processes. Nevertheless, many essential chromatin proteins evolve very rapidly over time. Even closely related species encode essential genes encoded by wildly different DNA sequence. The biological significance of this paradox—conserved cellular functions supported by unconserved molecular machinery—is poorly understood.

The Levine Lab aims to address this paradox by studying the causes and consequences of evolution at chromatin proteins that package the very ends of chromosomes—the telomeres. Genes that encode telomeric proteins are absolutely essential for ensuring that two chromosomes don't fuse together end-to-end. Such chromosome fusions cause both DNA breaks during cell division and mistakes in chromosome inheritance. These aberrations are hallmarks of cancer cells.

Using the model fruit fly, Drosophila melanogaster, we aim to test the hypothesis that rapid telomeric protein evolution is driven by so-called selfish DNA elements embedded in the ends of chromosomes. We will engineer fruit flies that encode the ancestral versions of the rapidly evolving proteins. To construct these genotypes, we replace the target gene with a version from another species. We will assay this chimeric fly for various phenotypes related to telomere function. This project offers the opportunity for one undergraduate to learn classical Drosophila

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genetics, evolutionary genetics, cell biology (including confocal microscopy), and molecular biology including cloning and quantitative PCR. Students with a keen interest cell biology or evolution are encouraged to apply.

Timothy Linksvayer

Genetic and epigenetic mechanisms regulating social behavior in ants

Like human societies, ant colonies rely on the principle of division of labor. In ants, this consists of the development of phenotypically distinct individuals (castes) from the same genome—workers and queens, which display great difference in morphology, physiology, and behavior. Thus, ants are a powerful model system to study how epigenetic pathways and the social environment regulate genome function at the molecular, organismal and societal levels. One key unanswered question is how environmental and social information—i.e. the state of the colony—is converted into epigenetic signals that select shape the developmental trajectory of each larva, which ultimately determines their adult caste (worker or queen) and social behavior. This project will integrate behavioral, genomic, and epigenetic approaches to make progress in answering this question.

Paul Schmidt

Microbiomes as drivers of evolution

Microbes affect a range of traits in their hosts, including fundamental aspects of metabolism, physiology, and immunity. However, how microbes shape the evolution of these traits in populations of their hosts is largely unresolved. Our previous work has shown that in the model organism Drosophila melanogaster, the composition of the microbiome varies predictably with both space (e.g., across latitudinal gradients) and time (i.e., as a function of season). Manipulation of these microbes was also shown to affect genome-wide patterns of evolutionary change in short term field experiments (Rudman et al. 2019. Microbiome composition shapes rapid genomic adaptation of Drosophila melanogaster. PNAS www.pnas.org/cgi/doi/10.1073/pnas.1907787116). The next phase of this research program is to conduct field experiments using wild-derived microbes and natural diets.

The student will be part of a multi-disciplinary research team and will gain experience in microbial ecology and culture, field experimentation, evolutionary biology, genetic and genomic analysis, and statistics/bioinformatics. There are numerous opportunities for independent as well as group projects, with support from a variety of laboratory personnel. The expectation is that the student will also be a co-author on any resulting publications, and actively involved in all phases of the research process.

CHEMISTRY

Karen Goldberg

Design and Synthesis of Organometallic Catalysts for Global Energy Solutions

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.

Marisa Kozlowski

Development of New Synthetic Methods *2nd year applicants only*

Project 1: Development of new catalytic, oxidative fragment coupling processes. There is significant interest in these methods due to their use in the pharmaceutical industry both for the synthesis of medicinal chemistry leads and in process development. In addition to conventional approaches to reaction optimization, high throughput experimentation techniques are utilized to identify leads and optimize processes. Requirements: Chem 241, Chem 242, Chem 245. Responsibilities: Synthesis and testing of new substrates and catalysts in oxidative bond forming processes. Must be able to keep a good lab notebook, follow safety protocols, and respond to feedback. Benefits: Will develop skills to work independently in a laboratory environment that are useful in the broad context of laboratory research, and specifically useful for careers or PhD programs in chemistry and related fields.

Project 2: Development of new computational models for reaction optimization based on statistical modeling. Electronic structure and quantitative structure activity relationship calculations are used. The results establish mechanistic pathways and the determinants for selectivity. This information in turn is used to predict the outcomes of modified systems with the aim of improving yield, selectivity, or scope. Requirements: Chem 241, Chem 242, Statistics Class, ability to use R or python, familiarity with multivariate multiple regression a plus. Responsibilities: Identify new parameters for fitting reaction data (rate, selectivity, etc.) to catalyst structure. Design new catalysts based on model predictions. Understand statistical

models by exploring fundamental reaction steps computationally with Gaussian. Benefits: Will develop skills computation that are useful to broad range of careers, and especially useful for careers or PhD programs in scientific and engineering fields.

Megan Matthews

Gel-based profiling to develop a small molecule inhibitor for SCRN3

SCRN3 is a biochemically uncharacterized enzyme in the brain. The gene is associated with breast cancer survival, pain nociception and rare neurological diseases but the biochemical activity and metabolic function of the enzyme in cells and tissues has remained poorly understood. In this project, one student will learn activity-based protein profiling to test the potency and selectivity of small molecule inhibitors of SCRN3, where a second student will probe the functional role of the enzyme in cell or animal models. The first project involves an interest in chemistry and biochemistry, where the second project involves an interest in either neuroscience and bioinformatics. The project will expose students to chemical biology and cutting-edge discovery methods used for in vivo biochemistry and drug discovery.

CLASSICAL STUDIES

Ralph Rosen

Seriousness in Ancient Satire: Laughter, Culture, Evolution

This project will involve research towards a book that studies current trends in the scientific study of laughter and humor—including evolutionary, cognitive and psychological theorizing and empirical research—and considers how such research may help us understand Classical satirical literature. In particular I am interested in exploring how research in social psychology and even analogues of laughter and play in primates, can help us address a variety of difficult questions often raised by the formalized literature of Greco-Roman satire, showing how our growing scientific understanding of why humans laugh can be useful for addressing several particularly perplexing literary questions, such as the role of genre in affective cueing, or the central problem of 'seriousness' and 'non-seriousness'.

This project represents a new approach to the polarity of 'seriousness' and 'non-seriousness' in ancient satire, combining a study of such concepts as articulated and theorized by ancient authors and literary critics themselves, with insights from modern biological and psychological research into laughter, particularly derisive laughter. Understanding the dynamics of laughter as a phenomenon of human physiology and social behavior will allow us to peel back many layers of confusion surrounding ancient satire and to analyze more clearly the appeal and function of this literature in its original performative settings.

I would be interested in a student assistant specifically to help me gather and synthesize the current scholarship on laughter and humor in the biological, psychological and anthropological disciplines. This work will particularly appeal to students who have interests in anthropology, primatology, evolutionary theory, and psychology, as well as in Classical Studies and the history of comic literature.

EARTH AND ENVIRONMENTAL SCIENCE

Alain Plante

The energetics of decomposition in soil

The decomposition of soil organic matter provides energy to heterotrophs (the microbial population) and nutrients to primary producers (plants). If the energy provided by soil organic matter is a currency in soil biological function, then this energy should be measured by scientists and potentially used as an index for the biological health of soil. Direct measurements of the energy status of soil organic matter have become accessible through new analytical techniques, and two indicators the energetics of decomposition have recently been developed: the energy density of soil organic matter represents the potential fuel for heterotrophic activity, while activation energy represents a barrier to microbial energy use due to soil organic matter stabilization mechanisms. The goal of this project is to estimate thermodynamic quantities (energy density and activation energy) using analytical thermal analysis on a set of soil samples collected from various ecosystems across North America. These estimates will be compared to estimates of Gibbs free energy (ΔGo) determined using the information about the chemical composition of soil organic matter determined using carbon-13 NMR spectroscopy. The objective is to ultimately be able to describe the decomposition process in soils in energetic terms as a potential indicator of biological soil health, which in turn can be used as a measure of ecosystem or agricultural sustainability.

Lauren Sallan

The Role of Predators in Marine Revolutions

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

raised the possibility that these changes were driven by a loss of predators, specific predators, or other factors such as increased plant productivity or nutrients.

Unfortunately, appropriate data for predator guilds, particularly among fishes, is lacking, leaving the 40-year old hypothesis for the MMR as just that. We have already compiled a host of diversity data for vertebrates, including fishes and sharks, over the Mesozoic (200-65 million years ago), but this needs to be finalized through the inclusion of remaining predators, vertebrate and invertebrate, using the scientific literature and museum collections. We will then test for predator and prey associations within ecosystems and through time, and for linked changes in predator and prey traits suggestive of an arms race. The student will learn to use appropriate statistical tests and models to determine whether predators can be linked to massive increases in biodiversity over global scales and long time periods. No previous experience with programming, statistics, biology or paleontology is required.

ECONOMICS

Petra Todd

Study of School Performance in Mexico

This project analyzes classroom administrative and census data on school performance in Mexico. The goals of the research is to better understand what are the important factors that contribute to higher performance, school progression and dropping out. We also aim to understand how anti-poverty programs affect student achievement. The project would be working with the professor and two graduate students from the economics department. It will involve some programming, so any background in programming and statistics is helpful.

GERMAN

Simon Richter

Water as a Universal Connector in West Philadelphia

This project offers students a unique opportunity to work in an historically under resourced community in West Philadelphia to harness and synthesize arts, citizen science, and Science, Technology, Engineering, Mathematics (STEM) education. The student will work in collaboration with the Water Center at Penn with guidance from Prof. Howard Neukrug, Executive Director of the Water Center and former CEO and commissioner of the Philadelphia Water Department. The goal of the project is to generate greater community engagement with the natural world and work towards engaging natural and anthropogenic communities for sustainable development. This effort will also create a constructive dialogue between the

university and its surrounding community regarding environmental and economic justice. Through this project, the Water Center at Penn is working to enhance the overall ecosystem health of our shared neighborhood through a focus on water.

The primary goal of the West Philadelphia project is to develop a water-centric framework to restore natural systems in the distressed Cobbs Creek community of Philadelphia and guide the ecological function and the historic community benefit. A secondary goal of the project is to connect Cobbs Creek to other regional and accessible natural assets. This framework is intended to serve as a model for water-centric, nature-based revitalization in underserved areas of other large cities.

A specific objective of this bigger project focuses on STEM education at the Cobbs Creek Community Environmental Center (CCCEC) focusing on various topics ranging from source water, water quality and public health implications, aquatic ecosystems, environmental monitoring, microbiology, biotechnology, and environmental job/career opportunities. Through this research, students will be assisting in understanding the following research topics as applied to Cobbs Creek- water quality, aquatic ecosystem and food webs, microbial ecology, public water utilities, social and environmental justice and public health.

As part of this community-based research project, two undergraduate students will be involved in:

- Evaluation of existing state of knowledge for Cobbs Creek regarding history, water quality, aquatic health and socio-cultural aspects surrounding the creek
- Field trips to Cobbs Creek Community Environmental Center
- Data collection on water quality, aquatic and public health aspects,
- Interaction with residents to gather information on local ideas of environmental justice and equity
- Analysis and interpretation of collected data
- Writing reports and articles targeted to a general audience

The project will expose the student/s towards fundamental principles of research methodology such as literature review, data collection and analysis. Through field trips and local interactions with schools and local stakeholders, the student/s will be exposed to the real-world aspects of research and obtain an understanding of stakeholder needs. This experience will expose the student to how to undertake applied research in academic environments based on real world stakeholder needs.

Pre-requisites: Strong passion for water, environment, equity and social justice.

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HISTORY

Kathy Peiss

Lesbian Feminism in Philadelphia: William Way LGBT Community Center Exhibit

Students will develop an exhibit on the history of lesbian feminism in 1970s-1980s Philadelphia at the William Way LGBT Community Center. They will be involved in all stages of the exhibit: doing archival research, planning the exhibit's themes, picking out items for display, writing wall texts, and installing the exhibit. Most of their time will be spent using the John J Wilcox, Jr. Archives at William Way, which contains extensive collections of newspapers, periodicals, ephemera, activists' papers, poetry chapbooks, buttons and pins, and recordings related to lesbian feminist politics, social spaces, community, and culture. Students may also be able to conduct oral histories. Applicants should have a strong commitment to and interest in LGBTQ issues and history, and be self-motivated, well-organized, and able to work collaboratively. They will learn how to do archival and qualitative research, prepare exhibitions, and write effectively for the public. Applicants should note if they would be available in September to work on the installation.

Mentors for this project are Kathy Peiss, Nichols Professor of American History at Penn, who will provide overall supervision and work with students on research methods and historical literature; and John Anderies, Director of the Wilcox Archives, who will advise students on using the archives, curation of materials, and writing for an effective historical exhibit.

Melissa Teixeira

Economic Life in 20th Century Brazil

This project explores the social, economic, and political experience of inflation and hyperinflation in Brazil under Military Dictatorship (1964-1984) and subsequent transition to democracy. The research assistant will be asked to pull, consult, and organize primary sources and economic data using library resources. Their first task will focus on materials on IMF and World Bank interventions in Brazil. They would also consult the institutional websites of these organizations to pull materials from the 1960s to the 1990s. Students will be asked to digitize and prepare brief summaries of materials, and to organize them into a digital research catalogue. The input of economic data into Excel will be another assignment, as well as making graphs/tables. Given the focus on IMF/World Bank, all sources will be in English. No prerequisites or prior experience necessary, but knowledge of Portuguese or Spanish would be a bonus to allow me to expand the types of sources the student accesses. Students will acquire: 1) experience using research catalogues/databases and digital resources; and 2) skills working with quantitative data and an introduction to Excel (including how to make graphs). The student will also engage with the practices and politics of economic policymaking and acquire familiarity with the institutions that still govern the global economy.

MUSIC

Carol Muller

#1 Faith of our Fathers, South Africa   #2 South African Jazz Podcasts

1 involves processing, summarizing, transcribing, and organizing all the archival and interview materials collected in South Africa in the last 2 years. It focuses on the Christian underground preparing South Africans for the transition away from apartheid through faith based communities.

#2, travel to South Africa in May or June 2020 to record interviews with South African jazz musicians in Johannesburg that will be edited into a biweekly podcast series to air 2020-21. So 26 interviews for 52 weeks. Dependent on securing Penn funding for the project. Student will transcribe and edit the interviews into podcasts on return to Penn.

NEAR EASTERN LANGUAGES AND CIVILIZATIONS

Heather Sharkey

Middle Eastern History in 15 Foods

I am doing preliminary research for a book that will tell the history of the Near and Middle East, from ancient times to the present, through fifteen foods. I seek a PURM student who loves history; who would enjoy thinking critically about the social meanings of food; and who is eager to develop skills in historical research. Knowledge of the region in any period – including the Hellenistic and Islamic eras – is a plus.

Which fifteen foods best encapsulate the history of key "cultural moments" within the Near and Middle East? The PURM student will help me to answer this question by surveying relevant literatures, consulting with experts in different periods, and even deciding what to cover under the rubric of "food". Can or should I include, for example, a distillate like rosewater, which generations of sultans in the Ottoman court valued for the fragrance it imparted to dishes and for its medicinal properties?

Responsibilities will entail assembling a bibliography and securing copies of articles or excerpts from books. It will also entail identifying potential visual and material sources for this study, such as illustrated manuscripts and rare books within the Penn Libraries' collections, and objects in the Penn Museum.

Finally, the PURM student will help me as I start writing a pilot chapter on one of the chosen foods. I am considering, for example, featuring barley, one of the first cultivated crops of the

Fertile Crescent, whose history can help to illuminate the origins of agriculture and its social consequences.

PHILOSOPHY, POLITICS, & ECONOMICS

Cristina Bicchieri

Norms, coordination and public policy: experiments on coordination and cooperation

Coordination problems arise in many economic, political, and social situations. A person's decision to join a social movement, invest in a risky asset, or follow a social convention are examples of cases in which a person may only want to do so if other people do as well. Many times, people are able to coordinate on an efficient outcome, but in other occasions, they fail to do so. In this project, we are interested in finding sources of successful coordination in simple games. In particular, we will investigate whether people are willing to follow a computer's recommended action in different experimental conditions. In some conditions, we will match players with simple tasks such as the minimal group paradigm. This design will allow us to gain insight into whether certain conditions cause people to believe that other players will choose a particular action. Working closely with postdoctoral fellow, Dr. Abraham Aldama, through this project, the student will gain experience in the design, implementation, and analysis of the results of a laboratory experiment.

Desired Skills: Some knowledge of game theory and Stata programming skills.

PHYSICS AND ASTRONOMY

James Aguirre

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

The Terahertz Intensity Mapper (TIM; http://obscos.astro.illinois.edu/tim/) is a newly funded experiment to study the star formation history of the universe over a period of 4.5 billion years, when the rate of forming stars in galaxies was at its peak. It will make 3-D maps of the far-infrared emission of the gas in galaxies which is actively forming stars, informing models of how galaxies form, grow, and evolve. It will fly on a high-altitude balloon to get above the majority of the earth's atmosphere, which would otherwise block far-infrared wavelengths. This flying telescope must be able to record data and point autonomously with high accuracy, functioning much like a robotic spacecraft. Construction of the telescope platform is now beginning at Penn.

The student will work in the laboratory with faculty, graduate students and other undergraduates in a collaborative environment to build key pieces of the flight electronics for TIM. These

include the star cameras, sun sensors, and attitude sensors (inclinometers, gyroscopes) necessary to determine the telescope's motion, as well as installing the flight computers and developing flight software to record the data and control the telescope.

The student will learn the use of laboratory electronics and the basics of electronic design, layout, and fabrication. The student will learn mechanical design (SolidWorks) and machining skills. The student will also learn skills in programming (Python and C; microcontrollers using Arduino). The student will also learn some of the relevant astrophysics behind the experiment to relate the design requirements of the telescope to scientific goals.

Previous experience with computer programming, robotics, electronics, or mechanical design software is highly desirable (and please include this in your application) but not required.

Douglas Durian

Topics in Soft-Matter Mechanics

Soft-Matter Physics is a new and growing field concerning fundamental understanding of liquids and solids that are non-crystalline and far-from equilibrium -- and that hence are not amenable to our usual physics tools. Penn has arguably the strongest Soft Matter effort in the world, and I am current chair of the American Physical Society's Division of Soft Matter. The following two soft matter projects are cutting-edge and will lead to peer-reviewed publications, but are readily accessible to undergraduates adept with computer programming and introductory classical mechanics.

Project-1 involves forms of soft matter composed of hard particulates, where unusual mechanics emerge from collective effects not obvious based on the properties of individual particles. Most prior work is for spherical particles, and only now is the role of particle shape beginning to be to explored -- usually by systematically perturbing from a sphere (or disk in 2d). As a new direction I propose to explore the packing properties of special set of four polygonal particles defined by the so-called haberdasher dissection, which can be assembled as either a square or a triangle and hence can fill space two entirely different ways. A many-body collection of such particles will be "glassy" and frustrated from crystallizing in an entirely new way. Packing fraction versus temperature and pressure will be determined using the HOOMD-Blue general purpose hard particle Monte Carlo particle simulation toolkit. A small collection of haberdasher particles will also be 3d printed for visualizing the packing behavior more informally.

Project-2 aims to elucidate the mechanics of twisted fibers, which are important in far-ranging macro-scale applications as well as for polymeric materials and biomolecules. We wish to elucidate (a) the nature of torque versus fiber tension and (b) the nature of dissipation versus the rate at which a taut fiber twists or untwists. This will be done by high-speed digital video experiments for the damped oscillatory motion of a disk suspended between twisted strings and a hanging mass. The resulting new insights will directly inform the design and performance limits of a low-cost high-speed hand-powered centrifuge recently proposed for medical diagnostics in the third world, where actual centrifuges are not available or cannot be powered.

Jonathan Heckman

Popularize a topic in particle physics *2nd year applicants only*

Popularize a topic in particle physics. This could include the physics of the Higgs boson, the hierarchy problem, the cosmological constant problem, etc. Possibilities include production of videos, a website, etc.

Bhuvnesh Jain

Planetary systems around Milky Way stars

My group works on lensing and cosmology with the Dark Energy Survey and other datasets. I also have interests in the interface with theory, the dark matter distribution in galaxy clusters, and other topics, such as planetary science, where undergraduate students have done summer projects. I'm usually open to exploring the choice of projects with every student, a great project for summer 2020 relates to debris disks and cometary clouds around Milky Way stars. Physics major Jake Nibauer had led an interesting study last summer in which he measured the properties of debris disks (disks around stars that have recently formed planets) using a cosmological survey. This innovative study has recently been submitted for publication, and it has opened up new directions. For next summer, a new student would work with Jake and me to apply these tools to a new dataset and look for signals from both disks and "exo-Oort clouds", the distant clouds of icy bodies from which comets originate. Some familiarity with python is needed for this work, and a working knowledge of calculus and mechanics is helpful.

A. T. Charlie Johnson

Sensor Concepts Based on Single-Atomic-Layer Nanomaterials

Project 1: We have developed technologies that duplicate and extend our ability to see, hear, and touch, but for odor detection and analysis, biological systems (e.g., dogs) remain the "gold standard." The goal of this project is to develop an electronic nano sensor system capable of similar feats such as the detection of disease by the odor of human blood samples or monitoring of air pollution in real time. Our sensor concept is based on a carbon nanotube technology invented in our lab. Course work or experience in Physics or Chemistry is desirable but not essential. The work will involve collaboration with colleagues from the Ovarian Cancer Center and the Penn Vet Working Dog Center, among others.

Project 2: The goal of this project is to create a multiplexed array of protein-graphene biosensors capable of simultaneous detection of multiple protein biomarkers of Lyme disease using human bodily fluids (blood, urine, etc.). The student will be involved in all aspects of the project including graphene synthesis, sensor fabrication, and sensor array testing. Course work or

experience in Physics, Chemistry, Biology, or Computer Programming is desirable but not essential. This work will be done in collaboration with Prof Dustin Brisson (Biology).

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

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

Liang Wu

A new generation of more-efficient solar cells and faster memory devices based on topological materials

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

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

In the first project, you will first fabricate devices made out of topological materials in the Singh center and add electrical contacts. Then you will shine visible light and measure the photo-current to test the conversion efficiency. In the second project, in order to switch the device from on to off state 1000 times than gigahertz, you will shine femto-second (0.000000000000001 second) invisible laser pulse to switch between on and off state. Students could either work on one subject depending on the interests or two projects if time permits.

If you want to know more about our research, this article in Penn Today is good resource.

https://penntoday.upenn.edu/news/bringing-ideas-life-through-experimental-physics?utm_source=Primary&utm_campaign=f21bde7544-

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POLITICAL SCIENCE

Julia Gray

How Does International Cooperation Survive?

How can countries design international organizations (IOs) -- like the United Nations, the Association of Southeast Asian Nations, the EU, NATO, and NAFTA -- that withstand global pressures and help solve international problems? Surprisingly little research looks systematically at the crises and challenges that IOs face over the course of their lifespan, let alone the circumstances under which countries exit or dissolve those agreements. Students working on this project will use a variety of research tools and methodologies to examine the lifespan and survival of over 100 international organizations. Using news articles and other sources, students will assist in creating a database of international agreements over time. Students at all levels of proficiency with quantitative and qualitative research are welcome. I am also enthusiastic about working with highly aided or first-generation college students.

Daniel Hopkins

Examining the Racialization of Contemporary American Politics

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

Michael Horowitz

Data science approaches to military power, economic power, and the future of war

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

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

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

Julia Lynch

Built to Last: Examining the Persistence of Minority Exclusion in Building Trade Unions
2nd year applicants only

Philadelphia's building trades craft unions have maintained their strength despite a national decline in trade union density. This strength, however, has been accompanied by persistent racial inequalities that have characterized these unions since their early days. Repeated legislative attempts made at the national, state, and municipal level to diversify these unions have largely failed. This research project will critically examine the reasons for these failures and identify structural barriers that have allowed racial inequality to persist. The project research this summer will focus specifically on the structure of union apprenticeship programs that function as an entry point to attain union membership. The undergraduate mentee(s) will learn how the Philadelphia's education system, union organizational structure, and city government legislation have worked together to reinforce racial inequality within the city's building trades craft unions. Students will gain experience in research design, gathering primary and secondary sources, and conducting interviews, as well as how to situate a research question within the broader field of political science.

PSYCHOLOGY

Delphine Dahan

Interpreting questions in conversations

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

This project examines these questions by collecting and analyzing conversations in a laboratory setting. Participants are invited to take part in a communication task that resembles a matching game: Two people sit on either side of a table separated by a barrier that blocks access to each other's face and workspace. The game involves two players, a 'director' and a 'helper'. Each player has a set of cards placed in front of them. The goal is for the director to determine which cards they have in common with the helper by asking questions. The verbal exchanges between participants are recorded and later coded and analyzed.

Students working on this research project will be involved in all stages of the research. They will recruit and schedule participants and be responsible for recording the conversations. They will work on the conversations themselves, applying coding protocol and validating inter-coder reliability. Along the way, they will learn to write simple scripts to automatize the coding and analysis. Students will work closely with the Principal Investigator and will meet with the research team regularly to discuss progress, results from analyzes of collected conversations, as well as possible follow-up studies.

Angela Duckworth

Behavior Change for Good

The Behavior Change for Good Initiative (BCFG) at the University of Pennsylvania, led by Professors Katherine Milkman and Angela Duckworth is conducting large-scale field experiments designed to promote sustained behavior change. Our world-class team of scientific experts will be able to continually test and improve behavior change programs by seamlessly incorporating the latest insights from their research into massive random-assignment

experiments. We have formed partnerships with some of the world's largest organizations to reach millions of their students and customers. Learn more about BCFG's work at bcfg.upenn.edu or through this Freakonomics podcast describing BCFG's plans: http://tinyurl.com/bcfg2017.

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

Harvey Grill

Examining the effect of GDF15, a cytokine with receptors in the brain, on food intake and body weight control

Our behavioral neuroscience lab studies chemical and neurochemical signals that act on central neural circuits to control energy balance (feeding behavior, energy expenditure and body weight regulation) and, relatedly, food motivation, food seeking, and food reward. Currently, one interest of the Grill lab is defining the neural and behavioral mechanisms that mediate the food intake and body weight suppressive effects of growth differentiation factor-15 (GDF15), a signal that has attracted considerable attention for its potential to treat human obesity. Our experiments on GDF15 function have shown that GDF15 reduces both food intake and body weight by inducing visceral malaise (including nausea).

Students will be involved in projects that further explore GDF15's effects on food intake control with a focus on determining whether the observed reductions in feeding are mediated by other mechanisms in addition to nausea-inducing effects. These experiments will involve working with rodent animal models, measuring food intake and body weight as well as other neurophysiological/physiological (neural calcium transients, dopamine release) responses to systemic drug delivery. Also planned are using several different behavioral paradigms that evaluate affective responses to food, conditioned aversion, appetitive feeding responses and motivated feeding behavior. In addition to participating in these experiments, students are required to read the relevant scientific literature provided to them and to meet regularly with senior members of the lab to discuss both research progress and details of the literature.

Joseph Kable

Psychological and neural mechanisms of decision making

Students will be engaged in a research project that uses an interdisciplinary approach, combining methods from experimental economics and social and cognitive neuroscience, to understand how

people make decisions. Students will get exposure to neuroscientific methods such as functional magnetic resonance imaging (fMRI), quantitative analysis of behavioral deficits in neurological patients, noninvasive brain stimulation, and eye-tracking. Students will learn how to use computer presentation software (E-Prime, Psychtoolbox, PsychoPy or Qualtrics), data analysis software (Matlab, Excel, or SPSS), and important statistical concepts including t-tests, correlation, ANOVA, non-parametric tests, multiple linear regression, logistic regression, and nonlinear optimization.

Allyson Mackey

Environmental influences on early childhood brain development

We are interested in how experiences in early childhood shape the development of brain structure and function, and ultimately influence cognition and academic performance. We are studying both negative experiences, such as poverty and stress, and positive experiences, such as cognitive enrichment and social support. Do such experiences speed up or slow down brain development, and are the effects global or specific to particular neural circuits? What are the effects of developmental timing on plasticity?

We are looking for undergraduates to help with child recruitment, administering neurocognitive assessments (in the lab, and in schools and museums), acquiring magnetic resonance imaging data, and data analysis. Students also have the opportunity to work directly with children as part of an educational intervention study.

Experience working with children is required (e.g., babysitting, tutoring). Experience in computer programming languages such as Matlab and Python is helpful but not required. Coursework in the Biological Basis of Behavior or Psychology is also helpful. Previously, students in the lab have started by contributing to a large-scale project, and then have developed independent projects that synergize with ongoing lab efforts.

Ayelet Ruscio

Novel Methods for Studying Anxiety and Depression

Anxiety and depression are among the most common and disabling disorders worldwide. Despite the prevalence of these disorders, treatment development has stalled—prompting psychologists to explore new research approaches that may open up new avenues for treatment. Two studies in our lab are using emerging technologies to shed light on anxiety and depression:

Study 1: Using Smartphone Sensors to Measure Stress Reactions in College Students

Anxiety and depression are on the rise among college students. An important step toward effective intervention is to understand what behaviors place students at risk for these problems. Our lab is using passive sensing—collecting data from sensors in people's everyday lives—to

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study behavior unobtrusively. We use the digital traces left by smartphones to learn about how students respond to stress in their daily lives. The PURM student will collaborate on developing methods for isolating, extracting, and analyzing continuous streams of behavioral data from smartphones, which may include GPS, physical activity, text and call logs, and keyboard input.

Study 2: Detecting Language Patterns Associated with Repetitive Negative Thinking in Anxiety and Depression

Repetitive negative thinking (RNT)—like worry and rumination—is common in anxiety and depression, but is poorly understood given the difficulty of measuring private, internal thoughts. This study will explore whether RNT can be detected through the language people use in their day-to-day speech. Using clinical interviews, we have collected language samples from anxious and depressed patients. This summer, we will transcribe these samples, then apply quantitative linguistic analysis to detect patterns in patients' speech. The PURM student will be involved in transcribing language from the interviews, reviewing what is known about RNT to select the language features that will be tested, and conducting linguistic analysis and data analysis.

These projects are ideally suited for students with interests in clinical psychology, technology, computer science, linguistics, bioengineering, and/or measurement.

To learn more about these studies and our lab, please see: http://web.sas.upenn.edu/ruscio-lab/research/purm-program-projects/.

John Trueswell

Speech perception and language learning

Project 1: Speech Perception in Infancy and Early Childhood

This project concerns the perception of spoken language by infants and young children. All babies are born with the cognitive apparatus to acquire any language they hear in their surroundings, but they do not yet have the specific ability to process a particular language, and languages differ in many respects, from the makeup of different vowels and consonants to their grammatical rules. At the same time, speech is never produced in chunks; it is fast, continuous, and transitory. How does the naïve language learner extract words from the speech stream and learn their meanings? The goal of this project is to examine whether infants and young children can learn the meaning of words simply by processing the patterns of stress and intonation in the speech signal. The student will have the opportunity to design research materials and conduct experiments with infants and/or young children at the Language Learning Lab in the Department of Psychology. Experience in psychology and linguistics would be helpful but are not required. Prior coursework in developmental psychology and/or introductory statistics would also be helpful but are not prerequisites. The project is ideal for undergraduate students interested in gaining interdisciplinary research experience in developmental psychology and linguistics/speech science. The student will also have the opportunity to learn to analyse and manipulate speech stimuli from spectrogram displays in Praat.

Project 2: The Language of Reason

Students will learn how to design and administer psycholinguistic experiments that explore how adults learn words and form concepts related to reasoning. Every language has words that describe logical relationships, such as negation ("That's not a dog."), contigency ("If you win, you get a prize.") and reciprocity ("They pushed each other."). These words often take longer to learn, and it's unclear how children do it, especially since these relationships can be difficult to observe if you don't already know what you're looking for. How would you show a child what negation (not, no, un-) is? How about conjunction (and)? Students will be part of an active and vibrant lab interested in psychology, linguistics, and philosophy. Experiments will ask adults, and perhaps children, to recognize and compare events. Some studies may involve eyetracking – the recording of eye movements to determine where people look as they hear sentences and perceive dynamic events. We are especially interested in students majoring in Cognitive Science, Linguistics, Psychology, or Philosophy who have an interest in language and reasoning. Students should be comfortable working with computers.

Rebecca Waller

The Developmental Origins of Callous-Unemotional Traits and Violence *1st year applicants only*

This interdisciplinary project will examine the development of violence and aggression within the ongoing Family And Child Emotion Socialization (FACES) study in the Emotion Development Environment and Neurogenetics (EDEN) Lab in the Department of Psychology. In particular, we are interested in the emotional, social, physiological, and psychobiological mechanisms underpinning callous-unemotional (CU) traits. Children with CU traits show deficits in empathy and guilt, and reduced sensitivity to others' emotions, putting them at high risk for chronic and severe aggression and violence. Advancing our knowledge of the psychological mechanisms underpinning CU traits will help to propel treatment research towards more tailored and specialized treatments to prevent further development of harmful outcomes like violence and aggression. As part of the FACES study, parents and children (aged 7-10 years old) take part in a half-day protocol, where we collect questionnaire, physiological, eye-tracking, electronic, and observational data using advanced video-recording equipment. Undergraduate research assistants are involved in every aspect of the study protocol from recruitment to phone screening to running the study visits and interacting directly with families. Prior PURM students have stayed on in the lab and are involved with multiple publications and ongoing student-directed research projects.

RELIGIOUS AND JEWISH STUDIES

Steven Weitzman

Jewish Philanthropy Research Initiative

This project will involve a student in a new, still developing initiative to promote research in the study of Jewish philanthropy—the use of private wealth for the public good within the Jewish community. The student will help develop a reading list/bibliography meant to be helpful to those doing research in Jewish philanthropy, which means undertaking a research literature review over the summer. The student will also help develop other content for a website, and will be involved in developing the initiative in other ways, including perhaps helping to shape a program on Philanthropy and Democracy in the Jewish community, to happen next academic year. The initiative is a joint venture of Penn's Katz Center for Advanced Judaic Studies and the Feinstein Center for American Jewish History at Temple University.

An interest in Jewish Studies, Jewish communal life, and/or philanthropy is very helpful for this role, as is some ability to develop content and maintain a simple website. The role may entail meeting at the Katz Center which is off campus at 420 Walnut Street. The student will be working with Professor Steven Weitzman, director of the Katz Center, and less directly with Professor Lila Corwin Berman of Temple University.

RUSSIAN AND EAST EUROPEAN STUDIES

Kevin Platt

Russian Poetry in Translation Web Resource

I am the founder and convener of a periodic symposium for the translation of contemporary Russian poetry into English and vice versa., Your Language—My Ear. This grant is for a student to work with me to build an innovative Internet resource: a bibliography of published translations of contemporary (meaning post-1991) Russian poetry. The resource will be included on the Your Language—My Ear website (http://web.sas.upenn.edu/yourlanguagemyear/). This project was already begun by a former Penn student researcher, but there is a great deal of work left to do. When complete, it will be the only Internet resource of its type. I will work closely with the student to identify the relevant authors and publication venues. Additionally, the student will work to update the website, completing construction of archives and bibliography for the most recent iteration of the symposium (which took place in 2019), and preparing it for the next iteration, which is planned for the 2021-21 academic year. Finally, I will work with the student on more focused research into particular contemporary poets and poetry translation projects, based on the student's own interests in specific figures on the contemporary Russian poetry scene.

SOUTH ASIA STUDIES

Teren Sevea

Sufism and Sikhism: Indian Ocean Saints and Shrines

The Penn Undergraduate Research Mentoring Program will provide me an opportunity to incorporate one undergraduate research assistant into my research project on Sufism and Sikhism. A research assistant would assist me with data collection, data analysis and a literature review of English-language sources on the Islamic and Sikh saints and shrines of South and Southeast Asia. I am convinced that it would be mutually beneficial for the student and me to collaborate on this research project devoted to a topic that has not drawn sufficient scholarly attention. This project could be significantly supported by the services of one undergraduate research assistant. A research assistant would assist me with surveying English-language sources pertaining to Islamic and Sikh saints and devotional cults in port cities of the nineteenth- and early twentieth- century Indian Ocean. The undergraduate research assistant would be provided full access to the digitalized newspapers and colonial documents. I plan to collaborate with and mentor the research assistant and look forward to working with him/her to study English sources from libraries and colonial archival collections of the United Kingdom, Netherlands, Singapore, Malaysia, Indonesia and Myanmar, that have been digitalized.

Ramya Sreenivasan

Mapping and identifying kin in North Indian history, 1400 - 1820

I am working on a history of the household in northern India, over a vast geographical space (a thousand miles east to west) but within a single linguistic - cultural - political zone. Within this zone, I track individuals, kin, and clan groups across generations, as they married out of their kin groups and established new lineages.

This socio-economic history also shows how such migrations were an important factor in the emergence of settlements and polities — through grants of land rights, revenue rights, and water rights. I am tracking the movement of elite individuals, the making of new kinship relations, and the shifting frontiers of polities in northern India, between 1400 and 1820.

As I explore strategies to present this material digitally, I seek a research assistant who can help with mapping, making kinship charts, as well as help with the digital presentation of this project.

 No prior familiarity with digital humanities tools is required, nor prior familiarity with South Asian languages. The research assistant will emerge from this project having acquired skills in data plotting, data visualization, mapping, and making genealogical charts; and other such digital humanities tools relevant to social scientists and humanists. (S)he will also develop an understanding of historical method and of the nature of historical evidence, as well as an understanding of the behavior of kin groups over time and space.

Dental Medicine

ENDODONTICS

Sumin Lee

Relationship of mesenchymal stem cells from periapical lesion to the periradicular healing following endodontic microsurgery *2nd year applicants only*

Apical periodontitis is a chronic inflammatory disorder of periradicular tissues caused by aetiological agents of endodontic origin. Persistent apical periodontitis occurs when root canal treatment of apical periodontitis has not adequately eliminated intraradicular infection. The progression of such infection and inflammation results in consequent involvement of periapical tissues, generating a periapical lesion. The development of chronic bone resorptive lesion and the healing processes and down-regulation of inflammation within the periapical lesion are also related to the expression of biomarkers.

Recent studies suggest that mesenchymal stem cells (MSCs) are an excellent tool for the therapy of chronic inflammation, due to their great capacity for tissue regeneration and substantial immunosuppressive properties. Recently, a few papers described that MSCs from the pathological dental tissues possess many similarities with MSCs from healthy tissues and present immunomodulatory properties. The purpose of our investigations is to determine MSCs from inflamed periapical tissue is related to the expression of biomarkers in the periapical lesion and affect the healing of periapical lesion.

The student will be taught how to isolate MSC from collected inflamed periapical tissue and gingiva from patients and characterization of MSC, the enzyme-linked immunosorbent assay. The student will make presentations to the research team and produce a report under guidance of team members. Students who are considering careers in medical or dentistry are encouraged to apply.

ORAL SURGERY AND PHARMACOLOGY

Elliot Hersh

Predicting the Analgesic Response to Ibuprofen in Oral Surgery Patients

The dramatic increase in opioid prescriptions over the recent years has been linked to the concomitant rise in opioid addiction, transition to heroin and death. Young adults' initial exposure to opioid analgesics is often following impacted third molar surgery, with 5,000,000

cases performed in the USA per year. While non-addicting NSAIDs like ibuprofen 400mg (Advil® Liquigels X 2) provide substantial post-surgical pain relief in about 80% of subjects we don't know before surgery who those 80% will be or the 20% who legitimately need a short course of acetaminophen (Tylenol®) plus an opioid added to the ibuprofen. Our previous double-blind, placebo-controlled pilot study (n=29) suggested that individuals producing the greatest amount of urinary prostaglandin metabolites and expression of inflammatory pathways on RNA of peripheral blood mononuclear cells, experience the best response to ibuprofen.   We also have a preliminary data that certain non-coding RNA's are differently expressed PRIOR TO SURGERY in patients with a complete response to ibuprofen 400 mg (no need for supplemental analgesia 4 hours after intake) compared to those with a partial response to ibuprofen (those with some pain relief but required a rescue analgesic within 4 hours).

This is an on-going research project with a total sample size of 80 participants. Twelve have been completed. Urine and blood samples will be taken prior to third molar surgery and at various intervals after dosing with blinded ibuprofen 400 mg liquigels (n=60) or placebo (n=20). With this larger patient sample, we can also evaluate the effect of other variables such as gender and the oral microbiome on analgesic responsiveness. After initial dosing, everyone will be placed on an unblinded 48-hour regimen of ibuprofen 400 mg plus acetaminophen 500 mg. Through the first 10 subjects on this regimen, only one so far has required any potentially addicting oxycodone at home.

The student under the guidance of Drs Hersh, Grosser and Theken will gain experience evaluating radiographs of the jaw, interpreting urine samples for pregnancy and illicit drugs, assisting in surgery, analyzing urine and blood samples for inflammatory biomarkers and antisense RNA. The student will be included in any publication.

PERIODONTOLOGY

Dana Graves

Mechanisms by which diabetes negatively affects wound healing and periodontitis

Dr. Graves's laboratory has been involved in studying many aspects of dental and oral biology. His recent interests focus on two complications of diabetes, impaired wound healing and enhanced periodontal disease. Interestingly, the same factors that contribute to impaired wound healing also contribute to increased periodontal disease. Thus, one project involves an examination of the wound healing response and the other project involves an assessment bacteria induced periodontal bone loss. Both of these projects use genetic deletion to shift the host response, which can rescue the negative effect of diabetes on both complications. A number of parameters will be examined in both projects to quantify the impact of gene deletion and diabetes on critical molecular events that control cytokine production, inflammation, the response of lymphocytes and macrophages and tissue formation. The techniques used include

histomorphometry, computer assisted image analysis, flow cytometry, western blot analysis, immunofluorescence, PCR, chromatin immunoprecipitation assays, etc.

Description: Oral, biology, dentistry, diabetes, hyperglycemia, wound healing, keratinocyte migration, inflammation, homeostasis, fibroblast, periodontitis

PREVENTATIVE AND RESTORATIVE SCIENCES

Fusun Ozer

Anticaterial Effects of Ziolite in Silver Incorporated Glass Ionomer Cements

Zeolite, a porous biomaterial, possesses strong antibacterial properties when modified with silver ions, which are inherently antibacterial. Through this combination, zeolite can release silver ions in a controlled manner, which selectively inhibits the growth of decay causing oral bacteria. In order to observe the physical and antibacterial properties of zeolite and silver-incorporated zeolite, we planned to combine it with glass ionomer cement, a calcium aluminum silicate glass that is used as base material under restorations and possesses a similar composition as zeolite. Since it is known that residual bacteria left beneath the restorative procedures can lead to significantly higher rates of treatment failure due to remaining caries, combining the antibacterial silver nanoparticles incorporated zeolite with a glass ionomer will also have many practical uses in caries prevention attempts. In addition, with the rise of antibiotic resistant bacteria, silver-incorporated zeolite containing glass ionomers may provide an alternative method in preventing the growth of oral bacteria under the restorations.

Recently, silver-modified zeolites have been used in various ways in dentistry due to its ease of use, low toxicity, and biocompatibility. However, there remains to be little research on the incorporation of silver nanoparticles and zeolite into glass ionomers. Due to their small size, silver nano-particles may have an inherent advantage which may increase the strength of the material and also antibacterial properties. Our research aims to explore the antibacterial effects of adding silver-incorporated zeolite into glass ionomers. In addition, we will measure important physical properties (i.e. setting time, surface hardness) of the material in order to maintain the integrity and longevity of the glass ionomer in dental restorations.

The student in his project will help sample preparations and apply hardness tests as well as microbiologial some simple test after getting a training from our dental materials laboratory.

Geelsu Hwang

Assessment of antibiofilm activity of dental material

Years of research have resulted in significant progress in the development of restorative dental materials that are biocompatible without causing acute or chronic inflammation. However, the

susceptibility of the restorative materials to bacterial colonization and subsequent biofilm formation remains a major problem that can result in adjacent tissue inflammation and clinical failure. Extensive efforts have been made to engineer new antibacterial surfaces or improve the performance of existing surfaces by applying surface coatings or modifying surface chemistry. In particular, restorative dental materials have been actively explored for the incorporation of biologically active components such as antimicrobials, resulting in composites exhibiting a slow-release of biocides. However, antimicrobial reservoirs are often subject to progressive decreases in efficacy (short-term effect) through gradual drug release into the surrounding environment, which could also lead to the development of antibacterial resistance. Thus, the production of new and effective non-leaching antibacterial restorative materials that are biocompatible and capable of preventing bacterial adhesion without compromising the mechanical durability subjected to cyclic loading is highly desirable. Students on this project will learn how to evaluate the antibiofilm efficacy of various engineered dental materials using biochemical, microbiological, and confocal imaging methodologies. This project is suitable for students who are interested in integrating engineering and microbiology to prevent infectious diseases caused by microbes.

Francis Mante

Structural Changes in Oral Cancer Irradiated Dentin

Exposure of the oral cavity to radiation during head and neck cancer treatment increases the susceptibility of teeth to demineralization and radiation related caries (RRC). Xerostomia induced by destruction of salivary glands by radiation as well as alterations in the physical properties of enamel and dentin have been implicated in the etiology of RRC.

The purpose of our investigations is to determine the structural changes in dentin and enamel that accompany head and neck radiation treatment and to devise approaches to restore the affected physical properties.

The student's tasks will include dental materials literature review, principles of laboratory research, sample fabrication, data collection and application of basic statistics in hypothesis testing. The student will make presentations to the research team and produce a report under guidance of team members. Students who are considering careers in biomaterials science and dentistry are encouraged to apply.

<u>Design</u>

ARCHITECTURE

Daniel Barber

<u>Architecture, Environment, and Territory: Essential Writings since 1850</u>

"Architecture, Environment, and Territory: Essential Writings since 1850" is a volume in preparation in collaboration with faculty colleagues at Penn and elsewhere. It provides a comprehensive overview of interactions between architecture and environmentalism from the mid-19th century to the late-20th century. It presents, for the first time, both essential writings that illuminate how designers have theorized environmental issues and critical texts by environmental thinkers that showcase how the fields of architecture, urbanism, and planning have incorporated, elaborated upon and, at times, resisted environmental ideas.

With my collaborators we have assembled all of the relevant texts. The research assistant will review the texts, get them into a publishable form (as needed), research relevant images, and assist with text and image permissions. No prior knowledge of architecture or environmentalism is required; the assistant with both gain knowledge in these fields, and become familiar with the publishing process.

Franca Trubiano

<u>Addressing social justice and environmental health issues in the construction industry</u>

Project 1: Fossil Fuels, the Building Industry, and Human Health: Reducing the Risks of Toxicity in Petroleum Based Architectural Plastics

The ubiquitous use of plastics in architectural design and construction obfuscates the very real health and life safety risks which exist when using petroleum-based polymers in the building industry. In the past 40 years, nearly all contemporary building materials have been re-engineered using polymer-based additives for the purposes of increasing a range of performance criteria. Even the most traditional of materials, wood, is typically re-materialized after harvesting with resins in order to increase structural strength and moisture resistance. Very little, however, is disclosed to architects, builders, clients and the general public about the potential health risks associated with adopting such large quantities of nonrenewable and nonrecyclable plastics in buildings. The parts per million of synthetic polymers typically found in newborns confirms the extent to which nearly everything in our built environment is permeated by materials derived from fossil fuels.

This research project is dedicated to understanding and evaluating the very real risks posed by plastics in the building industry and developing protocols for transferring this information to building professionals, the industry's affiliated members, and the general public. This research work first began in Fall 2018, when sponsored by the Kleinman Center for Energy Policy at the Weitzman School of Design of the University of Pennsylvania, when an initial team of undergraduate students collaborated in the production of the following on-line digest, Fossil Fuels Building Industry and Human Health. The work is being presented at various conferences and will be published in the forthcoming book, Examining the Environmental Impacts of Materials and Buildings.

The project's next phase of undergraduate research will be focused on identifying and establishing research links with the university's Perelman School of Medicine, Penn Law, School of Social Policy and Practice, and the Department of Materials Science and Engineering. Undergraduate students from any of these Schools or fields are welcome to apply as they will be involved in research activities that enables them to identify where and to what extent questions of material toxicity are the subject of research and/ or teaching in the schools and departments here mentioned. Students will seek to ascertain the extent to which faculty members and researchers are working in this area, and in particular those whose research is dedicated to the question of polymers, the human health risks of building materials, or more broadly the social and legislative context of human health risks in the built environment. An analysis of research profiles, curriculum, and published literature is the activity profile of this research project.

Project 2: Building the Inclusive City: Social Justice, and the Construction Industry

This research project studies the vast migration of millions of humans in search of work in the building industry. The globalization of design and construction practices means that cities as diverse as North Carolina, Shanghai, New Delhi, Doha, and London are at the front lines of serious transformations taking place in the nature of building labor and urbanization. Rarely however, do designers (including, architects, landscape architects and urban designers) consider how the transnational and transactional space that is the building site impacts those that work therein. Initial research on migrant labor in the construction industry reveals a general lack of transparency and accountability in the supply chain of building; with the result being, that many who labor in the building of cities are disempowered and at risk. In response, this research project, originally funded by the Humanities, Urbanism, and Design (H+U+D) Inclusive City Colloquium 2018-20 at the University of Pennsylvania, calls for a considered analysis, review, and critique of the situation. It aims to identify and articulate action items and strategies in service to the education of designers and policy makers who are called upon to practice and govern in an ever more globalized and networked environments. Undergraduate students from Penn Law, School of Social Policy and Practice, History, Labor economics, Urban Studies, and majors in Architecture are invited to apply. Students will engage in text-based research and analysis of existing bibliographies on the subject.

CITY PLANNING

Megan Ryerson

Commute Knowledge: How Users and Agencies Communicate and Act on Transit Changes

This research seeks to investigate the ways that workers learn and make decisions about the ways they travel via public transit, and how these ways of learning may differ or converge with the ways that formal transit agencies communicate changes to the transit system. By "ways" we mean both the public transit mode (e.g., bus, train, regional rail, trolley), as well as the route (e.g., Bus 42, Bus 9-transfer-Market Frankford Line, Media-Elwyn Line). Within this line of inquiry, we are interested in learning more about how information around transit-based commuting options are disseminated through formal mechanisms such as public agencies, as well as through social communications with neighbors, coworkers, and family. Do these communication patterns emphasize mobility (i.e. speed/distance), accessibility (to goods and services), or both? Do these emphases shift based on who is communicating information about the commute? Finally, what motivates a worker to actually change the route choice for their commute?

The setting for this research will be the newly instituted SEPTA bus Route 49, which began operating a trial period starting in February, 2019. This new bus line affords a unique opportunity to study how workers learn about their commutes and how one formal agency, SEPTA, communicates changes to the transit system. Also, the new General Manager of SEPTA is teaching a class at the Weitzman School of Design (and is a graduate of the program herself), making this an exciting time for Penn Students to study SEPTA and urban transportation here in Philadelphia.

This study seeks to (1) learn how transit users, particularly workers, learn of, and ultimately change their route choices; (2) bring forward lived experience and individual voices of transit users as a supplement to the aggregate analysis of route choice predominant in the transportation planning literature; (3) learn about the ways that a worker's social environments at work, home, and neighborhood, generate and disseminate knowledge on the ways of commuting; (4) compare the ways that agencies, as compared to users, communicate about transit changes; and (5) develop a theory of "commute knowledge" based on learning from riders' and agency actors' communications.

Research Questions

- How do workers learn and make decisions about the ways they travel to work via public transit?
  - How do they choose a particular transit route/mode choice for their commute?
  - How/when do workers decide to change their transit route/mode choice?
- What actions does SEPTA take to disseminate commuting information to workers?

- What are the motivations of SEPTA in these communications in regard to theories of accessibility, mobility, and social equity?
  - From a worker's viewpoint, how effective is SEPTA in communicating route choices and commuting information?
- What role do communications at home, residential neighborhood, or workplace, play in the knowledge acquisition process for workers developing their commute patterns?
  - How do these different venues communicate differently, if at all, about transportation and commuting than does SEPTA?
- How do formal and informal bodies differently generate and internalize "commute knowledge," if at all?

The student will assist Dr. Ryerson and her team with on board surveys, long-form interviews with transit users, data analysis and visualization, and presenting the research to SEPTA. Students with an interest in transportation, equity, and data analysis and methods across disciplines are encouraged to apply.

FINE ARTS

Orkan Telhan

Biological Design Book Image & Lab Assistants (2 positions)

Image Assistant

We are looking for a freshman or sophomore with basic visual design skills (i.e., able to use Adobe Photoshop and Illustrator) to assist the production of a Biological Design Book that is under contract with a major publisher. The work is similar to designing recipes and digital drawings for a cookbook. However, instead of making dishes, the recipes are about making sustainable materials (i.e., bio-based plastics, concrete, etc.) and products that can be grown from microorganisms. The work does not require a background in biology or lab training, but will provide ample opportunities to learn the biology behind the designs.

Lab Assistant

We are looking for a sophomore to help us design physical prototypes for a number of new biological designs that will be featured in an upcoming book. The student is expected to run basic experiments in a studio environment to grow new types of biomaterials. We expect the student to know some basic 3D modeling and printing knowledge or a desire to learn them at a very quick pace. The work does not require a background in biology or lab training, but will require skills to organize ingredients, document experiment outcomes with photographs or video, and prepare reports. There will be plenty of learning opportunities to learn about the principles of polymer chemistry, basic microbiology, and product design.

Education

APPLIED PSYCHOLOGY AND HUMAN DEVELOPMENT

Howard Stevenson

Racial Literacy as Key to Moving Justice Beliefs to Acts

Youth activism has demonstrated the potential to change public opinion toward social change regarding gun control and school reform policies. But how do youth learn the skills to speak their voice on social justice issues ranging from homophobia to racial hatred? A recent classroom intervention was conducted for 17 students at a local Philadelphia School over the course of 3 months. The intervention involved teaching students to be proficient at using racial literacy skills of reading, recasting, and resolving racially stressful encounters that occur in face-to-face social situations. Results found that students reported greater confidence in their ability to 1) accurately identify their emotions, thoughts, and physical reactions to microaggression incidents (mostly racial and sexual identity), 2) reduce their in-the-moment microaggression stress, 3) record their feelings; and 4) speak up against injustice.

Over the summer, the Racial Empowerment Collective will be working in collaboration with the Makuu Center on Penn's campus to conduct a study on undergraduates who want to turn their social justice ideas and beliefs into action steps. This project will involve identifying a group of students who will be taught racial literacy skills, track their daily microaggressions and microaffirmations regarding race, ethnic, and cultural social interactions and to maintain weekly diary records. The records along with quantitative self-report measures will capture participant struggles and growth with racial coping self-efficacy, stress, assertiveness, and decision-making. We are mostly interested in within subject growth over the course of 10 weeks. Participants will be followed from the beginning of the summer to the end of the summer culminating in their involvement in a summer racial literacy training institute. Qualitative measures regarding participant testimonials of their experiences will also be obtained. A key factor in this work is how to capture participant growth in applying their justice views and values to daily social interactions where injustice moments occur.

We expect the research assistant to conduct on-line preparation of the psychological measures, collect the data, support research recruitment of participants and explain the purpose of the research. Eventually, the student will be prepared to co-present the findings of this work in local and on-campus conferences and presentations, including teaching workshops on campus on how to develop racial literacy skills. The research assistant(s) will also help prepare the Summer Racial Literacy Institute use of electronic data collection research of institute participants regarding their growth in racial literacy skills acquisition during the two sessions of the institute in June and August. The research assistant will also work in conjunction with the Makuu Center staff to develop protocols and data collection processes. The student will also receive mentoring

from Dr. Howard Stevenson of the Racial Empowerment Collaborative and Dr. Brian Peterson of the Makuu Center.

READING/WRITING/LITERACY

Ebony Elizabeth Thomas

Humanizing Stories: Using Social Media for Literary Diversity and Justice

Humanizing Stories is an ongoing digital research and advocacy project prioritizing and promoting children's and young adult literature, media, and culture that is in "pursuit of a fuller humanity" (Freire, 1970, p. 47) through representations of diverse and richly complicated people and communities that offer alternative points from which to view and imagine the world (Myers, 2014, n.p.). This action research project seeks to discover justice-oriented, anti-oppressive, empowering, and emancipatory stories for all young people through social media engagement with stakeholders in the children's publishing and media world, parents and families, and youth and young adults engaged in talking about children's literature and YA fiction.

Selected students will, alongside graduate student researchers and the faculty principal investigator:

- Research, critique, and recommend texts that speak from marginalized and often silenced perspectives and voices on those individuals' and communities' terms via an established social media account, @HealingFictions.
- Create web resources to guide educators, families, and communities toward children's literature, media, and material culture that celebrates the stories and lifeworlds of every child.
- Administer a digital survey evaluating users' responses to the website and existing social media accounts.

TEACHING, LEARNING, & LEADERSHIP

Rand Quinn

Organizational Status and Reputation in the Charter Philanthropy Field

Private philanthropy exerts an increasingly prominent influence in many areas of social life, and in recent years, scholars have brought attention to the processes and impacts of foundation activity in public education. A "new" philanthropy has brought foundations to the forefront of education policy and politics and created interorganizational networks through grantmaking (in other words, networks formed by the connections between funders and their grantees).

Our project traces this influence in the specific case of Charter Management Organizations (CMOs) — nonprofit organizations operating multiple charter schools. The growth of CMO philanthropy, and its place in the new education landscape, provokes several research questions: What are the patterns that emerge when we examine foundation grantmaking to CMOs from when the form began in the early 2000s to the more recent past? What aspects of CMOs matter to foundations in their funding decisions? and How do CMOs distinguish themselves from their peer organizations in the competition for foundation support? These are key questions in our project.

Over the summer, you will work with us on research activities including: (1) assessing the completeness of an existing database of grants in the CMO philanthropy sector; (2) collecting and cleaning new grants data; (3) conducting a literature review on conceptualizations of school quality and charter schooling; (4) coding qualitative data from interviews with CMO leaders and funders. Knowledge of Stata is a plus. You will become a member of our research team which also includes Amanda Jones-Layman (PhD candidate) and Ji Eun Park (PhD candidate).

Engineering and Applied Sciences

BIOENGINEERING

Daniel Kacy Cullen

Translational Neural Engineering for Neurotrauma

The Cullen Lab is interested in seeking fundamental knowledge about causative mechanisms of central and peripheral nervous systems failure and regeneration following disease and trauma. Our lab works to use this knowledge to engineer biologically-inspired solutions to diagnose and to treat damaged nervous system tissue. One major thrust of our lab is to engineer translational treatments for traumatic brain injury (TBI). Undergraduate students will have the opportunity to work on one of two projects. The first focuses on building bridges to guide new neurons toward sites of injury in the brain; the second aims to hijack immune cells to promote tissue regeneration after TBI.

Guiding neurons toward sites of brain injury:
Although neuronal loss following brain injury is generally considered permanent, new neurons are born in select locations in the mammalian brain and then integrated into specific neural circuitry. We have created the first implantable engineered microtissue that structurally and functionally emulates the glial tube of the rostral migratory stream. This project will evaluate the efficacy of this approach to redirect endogenous newborn neurons to sites of focal degeneration in a preclinical model of traumatic brain injury, which if successful, would provide a regenerative medicine strategy for neuronal replacement potentially capable of mitigating the often devastating — and currently untreatable — cognitive and motor deficits in afflicted patients.

Hijacking Immune Cells to Promote Regeneration After TBI:
Monocyte-derived macrophages (MDM), the primary innate immune cells, are essential for tissue regeneration following trauma, which they orchestrate by switching from inflammatory to anti-inflammatory behavioral phenotypes. However, after TBI, MDM become stalled in a prolonged inflammatory phenotype that prevents tissue regeneration and exacerbates pathology. Within this project, undergraduates will investigate the contributions of MDM to neuroinflammatory cascades in brain after traumatic brain injury (TBI) and hijack MDM behaviors by intracellularly loading them with immunomodulatory microparticles. Students will work with porcine brain tissue to characterize histological changes after TBI; fabricate immunomodulatory microparticles; and characterize the behaviors of reprogrammed MDM.

Undergraduate students will work closely with a postdoctoral researcher and a doctoral student in the lab to gain skills including fabricating and characterizing tissue-engineered neuronal pathways; designing and testing appropriate biomaterial encasement strategies; utilizing living scaffold constructs to redirect immature neurons in both in vitro and in vivo studies; executing

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large animal tissue post-processing; optimizing microparticle fabrication; and characterizing microparticle efficacy in vitro. Undergraduate summer students will also be challenged to read and present on relevant scientific literature and to present scientific findings to their peers. Undergraduate students will be included in weekly lab meetings and student-led discussions in order to teach experimental design, hypothesis development, and methodology for unbiased analysis. At the end of the summer term, the undergraduate will formally present their project and findings to the entire lab. The Cullen lab is seeking 1-2 students with a bioengineering and/or neuroscience background.

Cesar de la Fuente

Engineering Living Medicines

The De la Fuente laboratory relies on protein design, synthetic biology, bioengineering, microbiology, and computational biology to establish foundational platforms for the engineering of biological systems. We use the principles and tools of these diverse disciplines to tackle a wide range of global health challenges. Our overarching goal is to find solutions to the world's hardest biomedical problems, including antibiotic resistance, infectious diseases and microbiome engineering. More specifically, we are pioneers in the development of computer-made antimicrobial peptides (AMP), small protein molecules that can kill even the most drug-resisting bacteria. We have created an extensive AMP library with diverse activities against multiple pathogenic bacteria, and currently study how they can be used to improve human health.

In this project, the student will be involved in engineering probiotic bacteria to produce useful therapeutic molecules in the mouse and human gut, focusing on AMPs as a means to tackle life-threatening gut infections. In vivo AMP delivery remains an important issue as these molecules can be degraded by peptidases in the body, therefore expressing AMPs in living probiotics will protect them from degradation and induce their production directly inside the gut when desired. The student will be trained in microbiology, genetic engineering and molecular biology techniques and will take part in the multidisciplinary environment of the laboratory comprising, chemists, computational biologists, synthetic biologists and microbiologists. The student will participate in the weekly lab meetings and journal clubs and will be encouraged to actively participate in project development, exposing their ideas and proposing new ideas and experiments.

Christopher Fang-Yen

Using robots and imaging to study the mind of a worm

Using light and genetics to understand how worms move
Our lab is interested in understanding how neural circuits generate behavior, using the roundworm C. elegans as a model. We will use light-sensitive ion channels (optogenetics) to perturb the worms' motor circuit and analyze the resulting behavior using behavioral imaging.

Tasks will include microscopy, strain maintenance, data acquisition, and data analysis. Previous lab experience and some familiarity with computer programming would be helpful.

Robotic imaging and manipulation of worms
The Fang-Yen laboratory (http://fangyenlab.seas.upenn.edu/) is developing robotic systems for high throughput phenotyping and manipulation of C. elegans, a millimeter-long worm widely used as a model organism in biology. Current projects include programming for automated analysis of imaging data and robotic methods for transferring worms and performing genetic analysis. The student researcher will conduct experiments using the robots and help develop software. Helpful prerequisites include experience with the C++ and/or Python programming languages and some laboratory experience.

Brian Litt

Machine Learning in the Treatment of Epilepsy

Project 1 : Brain-Computer Interfaces
In the past seven years, implantable closed-loop brain-computer interfaces have been developed to target pharmacoresistant epilepsy by alternately recording cortical signals and providing electrical stimulation in response to the detection of seizure onset. Optimization of seizure detection techniques, stimulation parameters, and target location may be bolstered by leveraging electrographic and imaging data gathered from the patient while in the epilepsy monitoring unit. In this project, we will be using a combination of machine learning and network approaches to obtain candidate biomarkers that are indicative of therapeutic success. The overall goal is to understand how the implant location of closed-loop devices for seizure suppression is associated with patient outcome. Through this project, students will be introduced to algorithm optimization, software development, and/or data analysis after an initial learning phase where they may further develop a knowledge of relevant programming tools.

Project 2: Effects of Levetiracetam on Post-Surgical Epilepsy Patients
Epilepsy is a chronic brain disease defined by the propensity to have recurrent seizures. Identification of preventative or disease modifying therapies (so called antiepileptogenic therapies) is a major priority in epilepsy research. There are two FDA-approved antiseizure drugs (levetiracetam [Keppra] and brivaracetam [Briviact]) with disease modifying properties in animal models, but it is currently unknown whether this effect translates to humans. One way to infer an antiepileptogenic effect in humans is to examine the outcomes of patients who have had epilepsy surgery. Epilepsy surgery is a potentially curative treatment, but most patients need to continue to take antiseizure medications after surgery. There is preliminary data suggesting that patients taking levetiracetam are less likely to have recurrent seizures after epilepsy surgery compared to those taking other antiseizure medication. The proposed project is a retrospective analysis of a cohort of patients who underwent epilepsy surgery at the Hospital of the University of Pennsylvania. The student will gain exposure to the field of epilepsy and develop proficiency in the following skills: clinical chart review, database development and management, statistical analysis, and manuscript writing.

Michael Mitchell

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

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.

CHEMICAL AND BIOMOLECULAR ENGINEERING

Bomyi Lim

Characterization of Pol II elongation rate in living Drosophila embryos

My lab has an expertise in using live-imaging based assays and quantitative analysis to examine one of the most exciting problems in modern biology: the nature of transcriptional regulation. The undergraduate students joining my lab will use a combination of molecular cloning, live-imaging, and quantitative analysis tools to test the hypothesis that RNA polymerase II (Pol II) elongation rate is a key parameter in dynamic gene control.

I propose to study how elongation rate and its cell-to-cell variability changes in various molecular backgrounds, such as in different gene length, intron density, and type of enhancers and promoters. Each molecular background would require designing three or more transgenic constructs (e.g. 1kb, 5kb, and 10kb gene length), and subsequent live-imaging and quantitative image analysis of multiple biological replicates. I expect undergraduate students to take responsibility of testing one variable (e.g. gene length), from designing experiments to analyzing the data.

As a start, students will learn molecular cloning, such as traditional DNA recombination techniques as well as more recent CRISPR/Cas9-based genome editing approaches. Concurrently, they will get a chance to collect live imaging data of transcriptional dynamics, using a cutting-edge confocal microscope in the lab. Finally, students will learn how to write custom-built Matlab codes to perform quantitative image analysis. This whole process will give students a chance to experience various aspects of conducting a research project in the lab. Since the project involves both traditional biological experiments and quantitative analysis, students will obtain insights from multiple disciplines as well.

COMPUTER AND INFORMATION SCIENCE

Insup Lee

Generation of statistically independent time series *2nd year applicants only*

Many modern tools of data science rely on assumptions of statistical independence between random variables. When such assumptions are violated, incorrect results often follow, from missing important events to raising an overwhelming number of false alarms. In time series, which are produced by smart devices and complex systems, independence can be particularly complex and unpredictable. Our group is developing techniques for checking independence assumptions in time series based on statistical tests. Since these tests are prone to random errors themselves, we need to ensure that they perform reliably across many inputs.

The proposed project is to develop a generator of synthetic time-series datasets with the given assumptions of independence (or lack thereof). The student will work with probability formulas to design data generation based on independence/dependence assumptions, as well as write Python code to automate the generation process. This project offers an unusual inside perspective on sampling and data generation processes, as opposed to the analysis of existing datasets.

The student should have taken a probability/statistics course and be familiar with at least one programming language (ideally, Python). The student will benefit by getting the experience of independent research in applied mathematical modeling, as well as improving their software development and data management skills.

Lyle Ungar

Deep Learning for "Thin Slicing" Teacher Assessment *2nd year applicants only*

People are remarkably good at rapidly assessing others, for example, using 2 seconds of video of a professor to estimate the rating that the professor will get at the end of a semester. Many studies have looked at what low level (speaking speed, eye contact, facial attractiveness) and

high level (confident, likable, optimistic...) features predict higher ratings, but little has been done to automate such assessment. Can computers pick up on these features -- or others-- that predict ratings? We propose to use recent advances in deep learning to train models that predict teacher rating from video and to analyze what cues these models are relying on.

Stephanie Weirich

Understanding Academic Stress in Engineering

More and more, instructors in Engineering and Computer Science are observing increased signs of stress, anxiety, depression, and other mental health-related problems among their undergraduate students, stemming from fast-paced, rigorous courses, large classes that can lead to feelings of anonymity, and pressure to find a job or internship at a top company.

Given that instructors care about not only their students' academic success but also their mental health and wellness, this project seeks to answer the following research questions:

- Do students studying Engineering and Computer Science exhibit more signs of stress, anxiety, depression, etc. compared to other student populations, e.g., non-Engineering students, the general college-age population, etc.?
- If yes, then what are the primary causes of those symptoms, and are there differences between different genders, races, socioeconomic groups, etc.?
- What actions can CS educators take to reduce levels of stress, etc., but still maintain a high level of academic rigor?
- How effective are these actions, and what effects do they have on student learning?
- The student(s) selected to work on this project will collaborate with Computer Science professors Stephanie Weirich and Chris Murphy to:
- Review existing literature regarding undergraduate student mental health, particularly in Engineering and Computer Science
- Analyze survey data collected from Penn Computer Science students
- Conduct interviews of undergraduate Engineering students
- Write a paper describing their findings

Students on this project should have some experience with statistics and programming, and will gain an understanding of student mental health, educational best practices, and human subject research.

ELECTRICAL & SYSTEMS ENGINEERING

Deep Jariwala

Technological challenges with diamond and vacuum electronics

Modern electronics based on Silicon are ubiquitous and operate with high fidelity at scale. However, electronics are also desired in extreme environments such as in air-craft engines, satellites and space vehicles. Often, silicon based electronic devices that operate well on earth are unfit for such extreme applications and quickly fail or degrade in their operation. As a result, new materials are constantly desired that can form the basis of high temperature electronics. The continuous reducing dimensions of silicon based microelectronic devices makes it difficult to fabricate and maintain the pristine quality of semiconductor material. As dimensions approach quantum mechanical regime, the basis of transistor operation is called into question. To partially address the above technological challenges, we propose two projects below which are available for undergraduate students to work on during the summer.

1. Diamond Electronics:

This project proposes the use of diamond films as an active electronic material. Diamond is a well-known electronic and thermal material with very high electrical conductivity for positive charges and also excellent thermal conductivity. Over the past three decades, thin film synthesis of artificial diamond in the lab has been perfected. However, while the material is available to enable reliable electronics from the same one has to make complementary field-effect transistor devices from diamond which are challenging to fabricate. In addition, making metal contacts and reliable insulator interface are persistent challenges for diamond. In this project, the student will explore basic electrical properties of diamond thin films, including surface treatment with hydrogen, conductivity measurements and integration of atomically-thin two-dimensional (2D) materials as contact and gate dielectric layers to ultimately fabricate diamond transistors. The undergraduate student will directly work with a PhD student and postdoctoral scholar to learn basic sample preparation and characterization skills in the lab and then perform data analysis. Learning to do technical literature research and scientific presentations will be key parts of the training during the program.

2. Vacuum Electronics:

To overcome the dilemma of reducing dimensions and associated fabrication challenges in silicon, this project proposes to go back to a 70 years old technology albeit equipped with modern materials and nanofabrication capabilities. Early electronics (including the ENIAC at Penn) were built using vacuum tubes which were bulky, unreliable and consumed large amounts of power. They were abandoned in favor of silicon and semiconductor technology due to lack of the ability to scale down vacuum tubes to micrometer sized dimensions. However, with the advent of nano fabrication techniques and availability of atomically thin van der Waals materials, vacuum electronics can be re-imagined to have channel dimensions below 10 nm and maintain

device performance superior to that of silicon. Still, precise assembly and a theoretical model for such structures is pending. In this project, the student will explore computational modelling and experimental sample preparation technique to make vacuum gap device by precise assembly of atomically thin two-dimensional (2D) materials. The undergraduate student is expected to start with preliminary and simple sample preparation techniques in the lab via van der Waals assembly of 2D materials using a microscope and micromanipulator and follow up with finite element modelling to charge transport in commercial software package simulators such as COMSOL, Synopsys Sentauras and Lumerical Device. The undergraduate student will directly work in supervision with a PhD student and postdoctoral scholar to learn the operation of modelling software package, basic experimental sample preparation and characterization skills in the lab and then perform data analysis. Learning to do technical literature research and scientific presentations will be key parts of the training during the program. Interaction with the professor will be on a weekly basis to go over the progress.

Alejandro Ribeiro

Learning Decentralized Controllers for Robot Swarms with Graph Neural Networks

Consider the problem of finding distributed controllers for large networks of mobile robots with interacting dynamics and sparsely available communications. The objective is to learn local controllers that require only local information and communications at test time by imitating the policy of centralized controllers using global information at training time. By extending aggregation graph neural networks to time-varying signals and time-varying network support, the idea is to learn a single common local controller that exploits information from distant teammates using only local communication interchanges. The objective is to apply this approach to the problem of flocking to demonstrate performance on communication graphs that change as the robots move and examine how a decreasing communication radius and faster velocities increase the value of multi-hop information.

MATERIALS SCIENCE AND ENGINEERING

Ritesh Agarwal

Chiral quantum photodetectors for quantum information processing

Quantum information science is revolutionizing our technologies in computing, communication, and sensing. Common quantum information technologies rely on qubits that can each adopt two possible states. For example, with single photons, two orthogonal polarization states of each photon (two spin states) form a qubit. Although the superpositions of qubits can dramatically enlarge information density compared to classical bits, it is challenging to produce on-chip single photon emission with controlled polarization state, route them into designed waveguides followed by their on-chip detection without the use of any external optical elements.

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Recent advances in metamaterials and quantum 2D materials promise a new dimension with the controlled generation, manipulation and detection of photons that carry unique chirality. We will utilize the unique geometry, symmetry and properties of 2D materials to rationally design chiral optical photoresponse for reading out chiral states of single photons in photodetectors. The work will involve synthesis of 2D materials, fabrication of devices followed by their optical characterization to study their photoresponse to different chiral optical excitation. If successful, these devices can enable increased information processing capabilities of future quantum computers. The student will work with a senior graduate student and assist in all the mentioned tasks.

Russell Composto

Polymer Infiltration into Nanoporous Metals as Bi-Continuous Hybrid Materials

Polymer composites, composed of organic polymer chains and inorganic filler materials, are attractive for a variety of applications, ranging from mechanical reinforcement to enhanced gas separation properties. Most past research on polymer composites has focused on the addition of discrete filler materials added to the polymer. However, many applications would benefit from a continuous network of the inorganic material, such as ion conductivity. We focus on the development of bi-continuous polymer composite materials created by infiltrating polymer chains into nano-porous metal films and compare the resultant properties to their discrete analogues. This work will focus on nano-porous gold (NPG) and gold nanospheres. The broad tunability of these polymer/metal hybrids represents a unique template for designing functional network composite structures for applications from flexible electronics to fuel cell membranes.

The work will involve the fabrication of these synergistic metal-polymer hybrids followed by their thermal, mechanical, and optical characterization. If successful, this project can enable an entirely new class of polymer nanocomposites with industrially relevant applications such as membranes and energy storage devices. Additionally, students will be exposed to a wide variety of world class characterization methods, including scanning electron microscopy, nanoindentation, time-of-flight secondary ion mass spectrometry, ellipsometry, and atomic force microscopy. The research project will culminate in a research presentation and ideally lead to a co-authored published paper.

Liang Feng

On-chip Photonic Circuits of Twisted Light

Light typically consists of a stream of linearly polarized photons, traveling in a straight line and carrying a linear momentum. However, light carrying an orbital angular momentum (OAM) propagates in a twisted helical way with a corkscrew-shaped wavefront. Such twisted light is characterized by an integer quantum number corresponding to its OAM. It has been recognized that this twisted light can be used as great information carriers since the degree of freedom of

OAM is unbounded. The combined use of twisted light with other multiplexing/demultiplexing techniques is expected to enable the entirely new high-speed secure optical communication and quantum teleportation systems in a multidimensional space with enhanced communication security.

The goal of this project is to experimentally demonstrate an on-chip photonic structure to guide, sort and direct twisted light of different OAM quantum numbers within chip-based photonic circuits. This will involve nanophotonics designs, novel nanomanufacturing schemes, and optoelectronic characterizations.

Shu Yang

Snail-Epiphragm-Inspired Solid Superglues that are Reworkable *2nd year applicants only*

Adhesives are ubiquitous in daily life and industrial applications. However, achieving both super-strong adhesion and reversibility has been challenging. It has been shown that mucus secreted by snails allows them to maintain conformal contact with the rough surfaces of rocks or trees when they are active. Upon drying, the shear modulus of this mucus increases from 100 Pa to ~ 1 GPa, forming a stiff epiphragm that is interlocked with the target surface, rendering strong adhesion to rough surfaces. The adhesion is reversible—it can be unglued by rehydration—allowing snails to resume activity. Inspired by snail epiphragm, Yang and collaborator, Prof. Anand Jagota at Lehigh University, have recently reported a snail-epiphragm-inspired adhesion mechanism using poly(hydroxyethyl methacrylate) (PHEMA) hydrogel (see Cho, H. et al. Intrinsically reversible superglues via shape adaptation inspired by snail epiphragm. Proc. Nat. Acad. Sci. U. S. A., 201818534 (2019)). It has superglue-like adhesion strength that is also reversible. PHEMA gel is applicable to both flat and rough target surfaces via a shape-adapting mechanism.

The goal of this project is to examine other materials systems to validate our adhesion mechanism. Specifically, the student will 1) formulate various biocompatible and bioabsorbable hydrogels with different additives. 2) Optimize the formulation and test adhesion properties. And 3) explore possible applications in biomedical devices. The student will have a chance to work with materials scientists and mechanical engineers.

The student will be mentored by a senior PhD student or postdoc fellow in Prof. Yang's lab.

MECHANICAL ENGINEERING AND APPLIED MECHANICS

Igor Bargatin

Designing next-generation solid-state energy transformation devices *2nd year applicants only*

Global demand for energy is increasing rapidly. We need to match this increase with highly efficient energy conversion devices in order to maximize our use of available resources and minimize our environmental footprint. Solid-state devices, such as thermionic and thermophotovoltaic energy converters, are advantageous because they transform heat into electricity at efficiencies surpassing forty percent with no moving parts.

In the Bargatin Research Group we are actively engaged in developing and testing these energy converters. A key process that we use is photolithography, which is similar to film photography in that a specially engineered template mask is used to transfer a device-specific pattern to a silicon wafer through exposure to ultraviolet light. While conceptualizing how a completed energy conversion device will look and function is straightforward, developing the photolithography masks used to fabricate it can sometimes be quite challenging. We seek an eager and hard-working undergraduate with a strong MATLAB programming background and computer aided design (Solidworks) experience to assist us in designing masks for our innovative energy converter prototypes. This student will have the opportunity to collaborate with graduate students and postdoctoral researchers to understand and leverage the special physics governing these solid-state energy converters in order to develop these critical photolithography tools. Successful mask designs will be implemented in the Penn Nanofabrication Facility in order to create new energy conversion device components, which the student will be able to test in our laboratory.

The student will mentored by Mattew Campbell, the postdoc in the group, as well as Prof. Bargatin.

Haim Bau

Molecular diagnostics at the point of need

Our Micro & Nanofluiics Lab develops miniaturized systems and assays for multiplexed, molecular detection at the point of need (field, farm, home, clinic, food processing plants) to assist health care providers and farm personnel make educated decisions and control spread of diseases. Our systems accept human, animal, or environmental samples, isolate nucleic acids from the samples, and use isothermal nucleic acid amplification methods to detect the presence of nucleic acids characterizing target organisms. To reduce our systems' costs, we rely on smartphone for signal acquisition (with cell phone camera), data processing and analysis, patient counseling, and data transmission to the cloud. We collaborate with researchers from the

Medical School and the Vet School. For additional information, visit http://bau.seas.upenn.edu. Our lab is interested in engaging students to assist us, among other things, with:

1.   Programming a smartphone (familiarity with Android programming required) for data acquisition, processing, transmission, and/or patients' counseling when s/he self-diagnoses.

2.   Mechatronics: integrate actuators to control microfluidic devices such as lab on a disc. Familiarity with mechatronics is required.

Robert Carpick

Synthesis and Characterization of Novel Hydrogel Coatings for Intrinsically Lubricated Condoms

Hydrogels are water-containing rubbery polymer networks whose physical properties can be fine-tuned to match biological systems, generating wide use in biomedical applications including drug delivery, tissue engineering, contact lenses, and wearable devices. Hydrogels can exhibit extremely low friction; however, the physical mechanisms controlling hydrogel friction are very poorly understood. In this project, we are studying and leveraging hydrogels' novel properties for potential use as lubricious coatings under physiological environments to transform the surface properties of condoms and other sexual health products (e.g., microbicidal applicators and enema bottles), particularly by populations at high risk for HIV infection, such that they exhibit low friction and high durability without any additional lubricant.

Recent work, including ours, has shown that hydrogel's lubricating properties can be broadly tuned. Moreover, hydrogels can indeed be applied as thin coatings onto latex and silicone rubber (PDMS) to produce low friction. However, the characterization of the lubricating properties of these coatings was extremely limited. Our hypothesis is that synthesis of novel hydrogel coatings and characterization over physiologically-relevant compressive pressures, sliding speeds, and temperatures using our unique tools will uncover the lubrication mechanisms, enabling the rational design of condoms and related applications that are intrinsically lubricating. The specific aim of this ongoing project is to synthesize and characterize a set of novel hydrogel coatings on latex to scientifically determine the potential for improving the efficacy and durability of hydrogels in HIV prevention applications. The project combines the topics of hydrogel synthesis, multi-scale tribology (friction science), and biomedical prevention to develop a fundamental understanding of hydrogel friction.

We seek an undergraduate to work on either or both of the two tasks below:

1.   Hydrogel synthesis and property characterization.

Here, the student will to learn how to synthesize hydrogels, and how to characterize key properties including the degree of crosslinking and the elastic modulus in the dry state by dynamic mechanical analysis (DMA), the elastic modulus in water by atomic force microscope (AFM) and nanoindentation, and mesh size measurement using small angle x-ray scattering (SAXS). As well, the student will be trained on a mini-traction machine (MTM) to perform

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comprehensive macroscopic friction measurements as a function of load, speed, and temperature of the hydrogels.

2. Hydrogel friction and lubricity characterization

The student will conduct friction characterization, using the MTM instrument for macroscopic friction characterization, and will also learn how to use an AFM for nanoscale friction characterization. Measurements of hydrogel friction at small scales, including resolving the spatial uniformity and the nanoscale contact mechanics behavior, will be pursued.

Jordan Raney

Autonomous kirigami

Kirigami combines the well-known folding patterns of origami with cuts. These structures can be rearranged in interesting ways, and the structural reconfiguration can produce dramatic transformations in properties. For example, a highly-flexible structure can become very rigid, or change acoustic properties. In this project, we will combine this notion of structural reconfigurability with active materials that respond to environmental cues such as temperature or light. The goal is to produce kirigami structures that can jump, crawl, or transform their function based on their environment.

Law

LAW

Claire Finkelstein

Advancing the Rule of Law *2nd year applicants only*

The Center for Ethics and the Rule of Law (CERL) is an academic center that unites preeminent scholars and practitioners from around the world to engage in multi-disciplinary conversations and issue policy recommendations on the legal, ethical, and political issues of national security and contemporary conflict. CERL offers the opportunity for an undergraduate to join the CERL team in Summer 2020 and engage in activities that will advance both his/her research skills and subject matter knowledge as well as CERL's mission to promote and preserve the rule of law. The student will work in the two areas below.

Project 1: Protecting Democracy: Election Security in 2020

While there is little dispute about Russia's actions or intentions in 2016, there is also little consensus about what to do about future interference by Russia or other foreign actors in U.S. elections. Weaponized social media campaigns, hacking of voter registration databases, theft of private campaign communications, and the injection of dark money into political campaigns have thrown the legitimacy of our electoral process into question. Now there are increasing concerns about the security of electronic voting machines and their ability to withstand hacking attempts to alter votes.

CERL will present a one-day symposium that will bring together academics, lawyers, policymakers, and government officials to identify the impediments to holding elections free from both foreign and improper domestic influence, discuss government and private sector preparations for the 2020 election, and propose concrete solutions for states and the federal government to implement in the future. The student will help CERL bring this symposium to fruition through his/her research and recommendations in the subject area and qualified experts as speakers.

The student will also be mentored by Christopher Walsh, CERL's executive director.

Project 2: National Security and the Threat of Violent Extremism

When citizens of the United States consider the threat of terrorism, they tend to think in terms of threats posed by groups and individuals outside of our borders. The 9/11 terrorist attack was by any measure the most vivid example within the United States of the threat posed by external groups. Yet the threat of terrorism does not arise just from members of external groups like Al Queda and ISIS. Increasingly, the threat arises from groups within western democratic societies,

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especially from the resurgence of groups and individuals espousing white nationalism and white supremacy.

Dealing with the national security threats stemming from violent extremism pose unique problems for countries with longstanding traditions in law and in practice of political freedom and freedom of speech. CERL will hold a two-day conference to examine the nature and extent of these problems posed by violent extremism and possible tools for addressing them. The student will help CERL bring this conference to fruition through his/her research and recommendations in the subject area and qualified experts as speakers.

The student will also be mentored by Christopher Walsh, CERL's executive director.

Paul Robinson

The Individualization of Criminal Liability Rules

We ordinarily think of criminal law as properly applying the same to everyone. Yet, sometimes two people can perform the same criminal act intending the same prohibited result yet criminal law rules may impose liability on one but not the other. A person kills their sleeping spouse. This is normally murder but many states may provide a defense if the person believed that the killing was the only way to save her own life. Even if her belief was wholly mistaken, she may nonetheless have a defense if it was a "reasonable mistake" given the history of domestic violence against her. The issue of "reasonableness" arises in a wide variety of criminal law doctrines, including for example provocation, all offenses of recklessness and negligence, the duress defense, all mistake as to justification defenses, as well as being a recurring issue in sentencing.

The larger point is that in assessing blameworthiness the criminal law commonly seeks to take into account special characteristics of an offender. An offender who is unable to meet the requirements set for the "reasonable person" ought not be punished for this inability. No one would want to punish an offender for having low intelligence, for example. True blameworthiness upon which criminal liability can be properly imposed requires that the law take account of what we reasonably could have expected of the offender. On the other hand, it seems clear that the criminal law ought not completely individualize its standards. Racial bigots, political extremists, and the chronically bad-tempered hardly deserve to have the criminal law to individualize its liability standards to take account of their particular characteristics.

What may be the most important unresolved puzzle in modern criminal law theory is sorting out a principal that will clearly distinguish the characteristics of an offender that ought to be taken into account from those that ought not be. One might be able to identify some clear examples of each kind: the law should take into account significantly reduced intelligence and ought not take into account racial bias. But there are a wide variety of characteristics of unclear status: Should high intelligence increase our expectations for an offender? Should a belief that every white person is a racial bigot be taken into account? Should the criminal law adjust its standards for old persons, selfish persons, poorly-educated persons, persons from other cultures?

Further complicating the puzzle, could it be that the factors appropriate for individualization dependent upon the circumstances of the case or the legal doctrine being applied? And if we decide that it is appropriate to take a factor into account, such as an offender's culture, does that mean all aspects of that culture – not only making general allowance for newly-arrived immigrants but also an immigrant's belief in the propriety of genital mutilation? These are critical issues to sort out because they can affect the criminal law's treatment of a wide variety of cases. And without an identifiable principal to guide the law, the results can be unpredictable and uneven, and often dependent upon the personal prejudices of the decision-makers.

Students will do research on a wide range of real-world individualization issues, will write up case narratives based upon that research, will search the scholarly literature of a variety of disciplines that touch upon the issues, and will help with empirical research testing ordinary people's intuitive justice judgments about the cases. Questions about the project and the planned work can be directed to Professor Robinson at phr@law.upenn.edu. Information about Professor Robinson is available on his homepage at http://phr.law.upenn.edu.

Christopher Yoo

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

1 World Connected, a research project of the Center for Technology, Innovation and Competition of the Law School, is an evidence-based research on the Internet access initiatives for the unconnected communities, or in other words the next billion users, the next four billion, or the bottom of the pyramid. Our goal is to do a systematic analysis of Internet connectivity initiatives implemented by governments, technical community, private sector, and civil society around the world, and identify pathways for sustainable Internet connectivity initiatives. From 2017 to 2019, we conducted 120 in-depth interviews with program practitioners and implementers and generated 120 case studies on these initiatives. The case studies include supply-side efforts to extend the geographic coverage of the Internet as well as demand-side efforts designed to build capacity in the areas of digital literacy, gender equality, health, agriculture, mobile money, and e-government). This year, we aim to further analyze our data by coding the initiatives by longevity and public-private partnerships to understand the relationship between longevity, partnerships, and other factors. The findings of this study would inform policy makers and practitioners in the area of technology and development.

Students' Duties and Responsibilities:

- Do a literature review on the success and sustainability of technology-based initiatives in the Information and Communication Technologies and Development (ICTD) literature
- Code the 120 entries with respect to longevity, partnerships, and other necessary factors
- Help with the data analysis

- Create data visualizations
- The academic and professional skills, experiences, and benefits a student would derive from working on your project:
- You will improve your writing skills, which will help you with your term papers in your future classes.
- You will develop an understanding on the Information and Communication Technologies and Development (ICTD) scholarship, and the roles different stakeholders such as public and private sector play in the scalability and sustainability of technology-based development projects.
- You will develop your coding and data analysis skills by working on a large dataset with different types of numerical and categorical variables.

Names and roles of other individuals involved in mentoring the student: Müge Haseki, Postdoctoral Researcher

Medicine

ANESTHESIOLOGY AND CRITICAL CARE

Seema Bhatnagar

Determining neuroinflammatory processes underlying stress effects on behavior

In this project, our goal is to identify neuroinflammatory processes that underlie vulnerability to the effects of stress and to identify inflammatory biomarkers in blood that predict or reflect vulnerability to stress. Projects will involve reading background literature, analyzing neural indices using a variety of techniques like immunocytochemistry and PCR, and analyzing behaviors in animal models of stress. Students will be supervised by post-doctoral fellows who will guide them in reading the literature, learning new techniques, analyzing data and presenting data to the lab group. Students are encouraged to explore ideas and learn about other projects in the lab through lab meetings and informal meetings.

Maurizio Cereda

Imaging the progression of acute lung injury

The goal of my research is to find new strategies to attenuate - or prevent - severe acute respiratory distress syndrome (ARDS), with the ultimate purpose of developing more targeted lung protective strategies (including innovative modalities of mechanical ventilation and new drugs). Characterized by diffuse inflammation of both lungs, ARDS is a hypoxic syndrome that has no specific treatment and causes patients to require mechanical (artificial) ventilation to survive: 64% of them will eventually die. Preventing severe ARDS could be the best way to reduce mortality. Since mechanical ventilation in the prone position increases survival in patients, we hypothesize that prone positioning may also affect the propagation and evolution of pulmonary inflammation. The effect of body position may be additive or synergistic with those of pharmacological agents that modulate lung injury. Using large animal models of injury, we concentrate on the mechanisms that lead to topographical dissemination of initially localized or mild pulmonary inflammation (i.e. acid aspiration, extrapulmonary sepsis). The combined use of CT and MRI allows us to obtain morphological and functional information on pulmonary responses to lung injury and mechanical ventilation.

Our long term goal is to attenuate the mechanisms leading to severe respiratory failure: we develop methods to predict the progression of acute lung injury and strategies to contain it, improving survival. Our laboratory has perfected a realistic model of early lung injury in pigs, in which we measure injury propagation using multimodal high-resolution imaging. The animals are on a mechanical ventilator in a simulated ICU environment for 24 – 30 hours. Our imaging

armamentarium includes serial computerized tomography and hyperpolarized magnetic resonance imaging, in addition with tissue and blood biomarkers of inflammation; we are studying the functional and biologic consequences of illness and therapy. Our studies will enable personalized treatment of patients with acute respiratory failure.

Students will assist in data collection and analysis, with particular involvement in 3D image processing, facilitated by various analysis techniques including deep learning. For those interested, students can learn animal preparation and surgery techniques, manage mechanical ventilation and other life support techniques, run the biological experiments associated with the project, and perform tissue analysis. Students should have basic laboratory skills. Computer programming experience is appreciated but not required.

Aaron Masino

Machine learing applications in pediatric medicine

The Masino Lab conducts research on the application and development of machine learning methods to address challenges in the biomedical domain. Our primary focus areas include: 1) natural language processing (NLP) methods to extract information from electronic health record (EHR) text data; 2) deep learning methods to analyze streaming physiological data; 3) methods to facilitate machine learning analysis of large EHR datasets; and 4) application of machine learning methods for predictive analytics in pediatric medicine.

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

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

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

Project 2: Natural language processing for clinical text analysis

The objective of this project is to develop novel NLP methods using recent advances in word embedding representations and neural attention mechanisms for deep learning models to automatically extract discrete information from EHR text for use in research and clinical applications.

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

Alex Proekt

Machine learning to understand the brain

We are looking for dedicated and talented undergraduate researchers to help design and build machine learning and data modeling techniques for artificial and biological intelligence systems. We are interested in understanding the features of network dynamics that facilitate the system's ability to respond to the environment in an adaptively advantageous way. In biological systems this means modeling the behavioral output of the system. In artificial systems this means looking at the structure of the dynamics arising from the network and relating them to the demands of the task the network was trained on. Your role in this line of research will be to help optimize machine learning algorithms to various tasks.

Possible projects:

- Help optimize machine learning algorithms designed to uncover underlying dynamics of neural recordings.
- Build and maintain databases of reinforcement learning agents trained on a variety of environments.
- Build simple games that can used as training environments for artificial agents.
- Deploy model fitting packages to discover dynamics of both biological and artificial networks.
- Desired skillsets (or a willingness to learn):
- Programming (Python and MATLAB)
- PyTorch (machine learning package for python)
- A plus if you've taken:
- Physics (thermodynamics, dynamical systems)
- Linear algebra

Huafeng Wei

Dantrolene as treatment for Alzheimer's disease

Dantrolene is a drug to treat malignant hyperthermia in anesthesia practice. Our recent studies showed dantrolene is neuroprotective in induced pluripotent stem cells (iPSC) from patients with Alzheimer's disease and in different animal models of Alzheimer's disease. We are continuing to study the mechanisms of dantrolene neuroprotection in Alzheimer's disease iPSC cells and its therapeutic and side effects in new animal models of Alzheimer's disease.

BIOSTATISTICS, EPIDEMIOLOGY, & INFORMATICS

Mary Regina Boland

Investigate Environmental Factors that May Dispose Women to Adverse Pregnancy Outcomes (e.g., Stillbirth)

Learn how to utilize the statistical software language R for use in visualizing communities and regions within the Philadelphia Metropolitan Area. This includes geographic variables such as zip code, or census tract. This project will involve using publically accessible information on communities, including parks and pools and investigating the proximity between these public resources and locations of women with adverse pregnancy outcomes. Programming experience is not required, but interest in learning to code is necessary. The student will be able to work with others in the lab investigating adverse pregnancy outcomes. The student's contributions would hopefully be included in a subsequent publication on factors related to adverse pregnancy outcomes.

Kristin Linn

Using Data Science to Inform Studies of Family Opioid Exposure on Childhood Neurodevelopment

Parental opioid use is associated with risk of adverse neurodevelopmental outcomes in children, both through prenatal exposure, and through changes to the parent-child relationship. The National Institute of Health is planning the HEALthy Brain and Cognitive Development study, a large study of 7500 children from birth through age 8, to better understand the impact of parent opioid use on child brain development. In the Summer of 2020, we will be working to inform the design of HBCD. We will be collecting data on parental substance use, family demographics, and child characteristics (age, cognition, mental health) to predict neuroimaging success and to assess links between environmental exposures and neurocognitive development. These data can be used to inform sampling strategies, accounting for the study completion rates of critical sub-groups, and make decisions about which measures to prioritize in early childhood.

Students contributing to this research will learn about neurocognitive assessment, magnetic resonance imaging, and brain development. They will develop skills in programming, data visualization, and statistical modeling that are broadly useful for careers in research and data science. Students will also develop clinical skills through working with vulnerable populations, both parents and children, who are coping with poverty and substance use.

At least one semester of statistics is required. Some experience programming in R, Python, or another language is strongly preferred.

Li Shen

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

The central theme of my lab is focused on developing computational and informatics methods for integrative analysis of multimodal imaging data, high throughput "omics" data, cognitive and other biomarker data, electronic health record data, and rich biological knowledge such as pathways and networks, with applications to complex disorders. The following are two specific projects designed for two PURM students, respectively.

Project 1: Linking brain imaging and genetics with molecular evidence

Brain imaging genetics studies the relationship between genetic variations and brain imaging quantitative traits (QTs) and offers enormous potential to reveal the genetic underpinning of the neurobiological system that can impact the development of diagnostic, therapeutic and preventative approaches for complex brain disorders such as Alzheimer's disease (AD). One major challenge of brain imaging genetics in AD studies is lack of intermediate-level omics data to capture the molecular effects linking genetics to brain QTs. In this project, we will develop new informatics strategies to bridge this gap, where valuable existing data in the omics domain will be leveraged to link brain imaging and genetics. The student is expected to work with myself and my team members to perform integrative analysis of brain imaging genetic data from landmark AD studies as well as brain tissue specific omics data from major reference databases. Participating in the project will give the student experience with brain imaging genetics, bioinformatics and AD research. Basic knowledge of neuroscience and genetics and basic experience with quantitative analysis and programming would be helpful.

Project 2: Integrating brain imaging and genetics for outcome prediction

Multimodal brain imaging is a powerful tool to study Alzheimer's disease (AD). Combining multimodal brain imaging and genetics for outcome prediction in AD studies is emerging as a promising research area, and holds tremendous promise for a better understanding of disease mechanism from genetic risk and/or protective factors, to altered brain structure, function, and connectivity, as well as to disordered cognitive and behavioral outcomes. In this project, we will develop and implement machine learning methods that enable accurate prediction of AD outcomes via combining genetics and multimodal imaging data as well as embracing the complex structure of these data. The student is expected to work with myself and my team members to develop and implement the learning models and apply those to the analysis of multidimensional brain imaging, genetics and outcome data from landmark AD studies. Participating in the project will give the student experience with brain imaging genetics, machine learning, and AD research. Basic knowledge of computer science and statistics and basic experience with quantitative analysis and programming would be helpful.

Ryan Urbanowicz

Machine Learning Strategies for Mining Complex Patterns from Biomedical Data

Developing and applying smarter machine learning (ML) is critical to biomedical data mining and many other real world applications. The URBS-lab is focused on investigating interpretable ML and artificial intelligence methods that can select features and generate predictive/interpretable models, in the presence of complex associations. Tackling these challenges can improve: our understanding of disease etiology, risk prediction, and personalized medicine.

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

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

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

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

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

CANCER BIOLOGY

Eric Brown

Bioinformatic analysis of sites of genomic instability *2nd year applicants only*

DNA polymerase stalling activates the ATR checkpoint kinase, which in turn suppresses fork collapse and breakage. As describe in Shastri et al., Molecular Cell, 2018, we have described use of ATR inhibition (ATRi) as a means to identify genomic sites of problematic DNA replication in murine and human cells. Over 500 high-resolution ATR-dependent sites were ascertained using two distinct methods: replication protein A (RPA)-chromatin immunoprecipitation (ChIP)

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and breaks identified by TdT labeling (BrITL). The genomic feature most strongly associated with ATR dependence was repetitive DNA that exhibited high structure-forming potential. Repeats most reliant on ATR for stability included structure-forming microsatellites, inverted retroelement repeats, and quasi-palindromic AT-rich repeats. Notably, these distinct categories of repeats differed in the structures they formed and their ability to stimulate RPA accumulation and breakage, implying that the causes and character of replication fork collapse under ATR inhibition can vary in a DNA-structure specific manner. Collectively, these studies identify key sources of endogenous replication stress that rely on ATR for stability.

Following publication of these studies, we have continued to analyze these and other data sets to uncover novel repetitive sequences and genomic contexts that promote instability. For this effort, we have developed new computational tools to identify such destabilizing features. The summer project available would afford opportunities to make these novel discoveries through bioinformatic and computational methods. These studies would be performed in collaboration with Dr. Rahul Mandal, a postdoctoral researcher in the Brown laboratory. Practical training in bioinformatics and programing will be provided as a nature consequence of this work.

Applicants should have experience in rudimentary computer programing (e.g. R). Additional background in genome biology would also be beneficial, but not required. Novel discoveries would warrant authorship on resulting publications.

Lewis Chodosh

Mechanisms of Breast Cancer Dormancy and Recurrence

Breast cancer is the leading cause of cancer mortality in women, mainly due to incurable metastatic recurrence arising after initial treatment. Recurrent tumors arise from a presumptive pool of residual tumor cells (RTCs) that persist in a dormant state after treatment. The mechanisms enabling dormant tumor cell survival and recurrence are poorly understood. Hence, identifying the pathways underlying tumor dormancy and recurrence is critical to reduce breast cancer recurrence and mortality.

Our laboratory has developed genetically modified mouse models for human breast cancer that recapitulate key steps during breast cancer progression. Transgenic mice that conditionally express the HER2/neu oncogene (MTB/TAN mice), develop mammary tumors upon oncogene induction, and conversely, tumors regress following oncogene down-regulation. However, a small number of RTCs survive oncogene inhibition and persist in a dormant state, and ultimately seed spontaneous recurrent tumors.

To explore potential pathways that may be required for RTCs survival, our lab generated gene expression data sets from MTB/TAN derived tumor cells in dormancy. Interested students will have a critical role in validating candidate pathways mediating RTC survival. We are interested in recruiting one student who will be mentored by a graduate student Mr. Takashi Nakamura. The student will learn the basics of cell culture (to perform in vitro dormancy assays), flow

cytometry and digital droplet PCR (to quantify the proliferating tumor cells), and fluorescence microscopy (to define the activation status of signaling pathways in dormancy).

Previous lab experience is not a prerequisite; we can adapt the project to the student's skill set and interest.

Sandra Ryeom

Metastasis and the tumor microenvironment

We are interested in understanding how cellular populations in the tumor microenvironment contribute to metastatic progression. We are focused on the angiogenic and stromagenic switch in the lung and liver as sites of metastases. Our lab utilizes mouse models and human and mouse organoids to model metastasis and the pre-metastatic niche.

Xiaolu Yang

Molecular and cellular mechanisms that protect against cancer and neurodegeneration

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

Cancer, which encompasses over 100 diseases that occur in most cell types and organs of the human body, remains a leading cause of death in the US and the world. The relentless and autologous cell proliferation that characterizes cancer is normally prevented by an elaborate tumor suppressive network. A central hub of this network is the preeminent tumor suppressor p53, whose mutations are the single most common genetic lesion in human tumors. We are investigating the functions and regulation of p53. Our recent results revealed an important role for p53 in modulating metabolic pathways that are crucial for cell proliferation. We are continuing to investigate the function of p53 as both a sentinel and a regulator for metabolic activities. Moreover, we are studying metabolic alterations that drive tumor initiation and progression.

Neurodegenerative diseases are becoming increasingly prevalent as the human population ages. They are highly debilitating and inevitably fatal, yet remain incurable. These diseases, including Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis (Lou Gehrig's disease), and polyglutamine diseases, are associated with misfolding and aggregation of proteins and peptides in the central nervous system, which ultimately lead to neuronal cell death. PQC systems are critically important in contending with protein misfolding and aggregation. However, these systems, especially those in animal cells, are still poorly understood. Our lab recently identified a novel PQC system in animal cells that is multifunctional, powerful, and

mechanistically distinct from canonical PQC systems. We are investigating the mechanism of action of this system and its role in aging and various neurodegenerative diseases.

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

CARDIOVASCULAR MEDICINE

Julio Chirinos

Novel imaging Phenotypes for Prognosis in Cardiovascular Disease

We will utilize a database of PennMedicine patients who have undergone an echocardiogram at our institution. We will train machine learning models to detect key abnormalities using pre-labeled training datasets. We will then assess the ability of various models to prognosticate patients with heart disease and will compare this prognosis against human interpretation.

Victoria Vetter

Prevention of Sudden Cardiac Death in Youth:Automated External Defibrillators (AEDs) in Philadelphia Parks and Recreation Centers

Sudden cardiac arrest (SCA) occurs when the heart suddenly and unexpectedly stops. Without intervention, sudden cardiac death (SCD) occurs. SCA is the third leading cause of death in the United States (US), with over 395,000 out-of-hospital sudden cardiac arrest/year, one every two minutes. In addition, SCD claims the lives of approximately 7000 US children and adolescents yearly. Sudden cardiac death can be prevented by using cardiopulmonary resuscitation (CPR) and automated external defibrillators (AEDs), small portable computerized devices that deliver an electric shock (current) to the heart to restore the normal heart rhythm. While survival in the community is only 10-12% after a SCA, survival in a school or recreation center with an AED and emergency response plan can be over 85%.

Youth Heart Watch (YHW) is a sudden cardiac arrest and sudden cardiac death prevention program at the Children's Hospital of Philadelphia (CHOP) whose aim is to prevent sudden cardiac death among children and adolescents by serving as a resource to help schools and recreation centers develop AED programs and save lives.

In Philadelphia ten years ago, an initiative by the Daniel E. Rumph II Foundation resulted in the placement of refurbished Police and Fire Department AEDs in all 150 Recreation Centers in the city of Philadelphia. The Recreation Centers are used for playing various sports, especially basketball, for swimming, summer and afterschool recreation, and other programs for children

and community members. Unfortunately, there was no plan for upkeep of these AED units or their replacement as they outdated, and the electrode pads have expired in all but 25 of the units, making them inoperable. Over 15 units are totally nonfunctional due to age. We have begun an initiative with the Philadelphia Parks and Recreation Department to correct these deficiencies. We have secured a donor to replace all the electrode pads (125) and the 15 units that need to be replaced immediately, and are putting together a coalition to raise funds to replace all 135 of the outdated units. We have developed a REDCap (scientific database) survey for Recreation Centers in Philadelphia and have information from all the Recreation Centers that will be exported into REDCap for further analysis.

The students will help clarify and clean these data. The student(s) will participate in contacting recreation center employees, working on this database, collecting and entering additional data, and evaluating the data. The research goal is to determine the best practices for implementing this type of public health effort in a City-run program to ensure that these Centers are HeartSafe. The student(s) will be trained in CPR and AED use and will learn how to teach this skill to the Recreation Center Staff. Under our supervision, they will interact directly with the staff of the Recreation Center to help with implementation of the Youth Heart Watch Recreation Center AED Program. On the visits to the Recreation Center, we will go over methods to develop a Cardiac Emergency Response Team and Plan and will educate the staff on sudden cardiac arrest recognition. In addition, the student(s) would have the opportunity to shadow pediatric cardiologists in their clinics at CHOP, learn how to read electrocardiograms, and learn about cardiac conditions for which AEDs may be needed.diatric cardiologists in their clinics at CHOP, learn how to read electrocardiograms, and learn about cardiac conditions for which AEDs may be needed.

CELL AND DEVELOPMENTAL BIOLOGY

Michael Granato

How do regrowing axons know where to grow?

Axons wire the nervous system. Their length makes them vulnerable to injury, but axons in the peripheral nervous system can regenerate. In order to reconnect with their original synaptic targets, regenerating axons must navigate multiple choice points to select the appropriate target. Incorrect targeting during regeneration can have devastating consequences, such that only 10% of adults with peripheral nerve injuries ever fully recover. We use the larval zebrafish pectoral fin, similar to mammalian forelimbs, as a model system to study axon guidance in regeneration. The motor axons that innervate the pectoral fin can specifically regenerate back to their original muscle fibers within two days, indicating that there must be environmental cues that instruct the axons where to grow. To identify these cues we have performed RNA sequencing on denervated pectoral fins after injury and have an exciting list of ~50 up-regulated genes ready for followup.

Students will work with postdoctoral fellow Lauren Walker to:

1)   Perform in situ hybridizations to both validate the upregulated gene list and determine if there is regional specificity within the pectoral fin to the expression of candidate genes after injury

2)   Characterize newly-generated CRISPR mutants and test for functional roles for candidate genes in axon growth or guidance after injury

Students will gain experience in zebrafish husbandry, CRISPR, molecular biology techniques such as PCR and cloning, in situ hybridization, confocal microscopy, and timelapse imaging. Students will participate in weekly lab meetings and journal clubs, read primary literature, and get hands-on experience in cellular neurobiology.

Shawn Little

Precise control of gene expression during embryonic development

Embryonic development requires cells to divide and differentiate at precise times and locations. Misregulation of gene expression and cell division underlies many congenital disorders, so it is crucial to understand how cells generate precise control of gene regulation. But at a fundamental level, gene expression is highly variable, or noisy, because of the random nature of molecular interactions that underlie gene activation. Moreover, embryonic development usually proceeds normally under fluctuations in environmental conditions. How can cells make the correct decisions about gene expression in the face of environmental variability and molecular noise? This project will explore the molecular basis of precise gene expression using the embryos of the fruit fly Drosophila melanogaster as a model system. Our lab has found that cells can compensate for a aberrancies in genetic dosage by raising or lowering transcription rates, but how this is achieved at a molecular level is unclear. In this project, students will use a cutting-edge single-molecule microscopy pipeline that we established to measure gene expression in individual cells. Students will examine gene expression in embryos with aberrant copy numbers of important differentiation genes, directly measuring transcription during the process of compensation. Students will assist a postdoctoral fellow, Joseph Zinksi, in using genetic approaches to identify components of the transcriptional machinery required for compensation. Students will gain hands-on experience in genetics, single molecule microscopy, and quantitative image analysis. Students will attend weekly lab meetings and present their findings twice annually at the meeting, gaining important experience in science communication. No prior experience is required.

Patrick Seale

Fat cell development and obesity pathogenesis

Our lab investigates fat cell and tissue biology, with a particular emphasis on the central role of fat tissue in obesity pathogenesis and metabolic syndrome. Fat tissues are heterogeneous and

highly plastic tissues that play critical roles in regulating many physiological processes, including energy balance, insulin sensitivity, vascular function, blood pressure and body temperature. Our research is currently focused on two main areas: (1) brown fat cell development; and (2) fat tissue expandability. We are searching for genetic and metabolic factors that control the function of heat-producing brown fat cells in various fat tissue depots. This specialized type of fat cell has the capacity to dissipate chemical energy in the form of heat and can thereby protect animals against obesity and metabolic disease. We are also investigating the mechanisms that control fat tissue growth and remodeling in obesity and aging, with the goal of identifying novel targets to promote healthy fat tissue expansion and reducing fibrosis. Our research uses a variety of methods, including: genomic techniques (RNA sequencing, chromatin immunoprecipitation), in vivo physiological assessments in mouse models (high fat diet feeding, testing insulin action, energy expenditure), histological analysis, transcriptional analyses.

The student researcher will work on an ongoing project in the lab, in collaboration with a Ph.D. student or postdoctoral researcher. He/she will be involved in designing, carrying-out and analyzing experiments from start to finish. These experiments will involve both mouse and cellular models. The student will also have the opportunity to present his/her findings at weekly lab meetings and to contribute to research papers. The student will acquire a broad range of technical skills and will be exposed to many other methods and projects while working in the lab. He/she will work and collaborate with an excellent and diverse team of student and PhD level researchers and develop a good sense of life as a basic medical science researcher.

DERMATOLOGY

George Cotsarelis

Hair follicle stem cells and skin regeneration

Our lab seeks to understand how adult stem cells regenerate skin and its appendages including hair follicles and adipocytes. While embryonic skin can heal perfectly after being wounded, adult skin seems to lose such capacity and forms scar under most circumstances. One of our research goals is to study the role of epigenetic changes during adult skin wound healing process.

Previously we have shown that applying epigenetic modification drugs to the wounded skin enhanced regeneration and reduced scar formation in mice. We performed ATAC-seq (a technology that identifies epigenetically modified genes) in wounded skin using different mouse models and compared data between mice that regenerated their skin and mice that formed scar tissue. We identified a number of candidate genes that could potentially contribute to better regeneration outcomes. Our next step is to further characterize these genes, understand their mechanisms in enhancing regeneration and find ways to manipulate these genes to achieve scarless wound healing.

This is a currently on-going project. By participating in this project in a 10-week summer session the student will gain knowledge in adult stem cell field and learn about the current breakthroughs and challenges in wound regeneration and skin biology. They will work with mouse models, learn techniques related to the state-of-art single cell RNA seq, cell culture, immunohistochemistry, lentiviral construct production and cell infection, molecular and functional analysis of candidate genes. They will also participate in lab meetings and interact with other researchers in the lab to learn about experimental design and data interpretation.

FAMILY & COMMUNITY HEALTH

Frances Barg

Guatemala Health Initiative: Facilitating health in a Mayan community

We are seeking one to two promising students who will work long term with the Guatemala Health Initiative to conduct research in the rural highlands of Guatemala. Since 2005, the Guatemala Health Initiative (GHI) has coordinated interdisciplinary research, education, and service programming involving the School of Nursing, School of Medicine, School of Arts and Sciences, Wharton, and the School of Engineering and Applied Sciences. GHI partners with the Hospitalito Atitlán (HA) in the Mayan communities of Santiago Atitlán, Guatemala and in two other locations in Guatemala (Sacatepequez and Trifinio (Cotepeque)), to develop and organize community initiated programs aimed toward improving the health of the community.

In this position, each student will work with faculty and community partners on one of three projects: a diabetes screening, treatment and community education program, a project addressing anemia on fincas in the rural districts surrounding Santiago Atitlan or another project that will be identified by our community partners in Guatemala. In each of these projects, students will be responsible for primary data collection and data management. Students will learn interviewing skills, database management skills and mixed methods research skills. In addition, students will gain important perspectives on factors affecting the implementation of global health programs. Students will spend 10 weeks in Guatemala in a home-stay (from late May to early August,) supervised by the GHI. Students work under the direction of Dr. Fran Barg, a medical anthropologist and Dr. Kent Bream a family physician and global health specialist.

Qualified applicants will have strong Spanish language skills, excellent organizational skills, a high tolerance for working and living in an environment very different from their own, good interpersonal skills and a desire to be a team player. Students from all schools and all majors are welcome. We are particularly interested in students who are looking for a long-term research commitment.

GASTROENTEROLOGY

Rotonya Carr

Perilipin polymorphisms in Non-alcoholic fatty liver disease

Non-alcoholic fatty liver disease (NAFLD) is a chronic liver disease that affects approximately 25% of the adult population worldwide There is currently no cure for NAFLD, and as a result, NAFLD is now one of the most common causes of cirrhosis, liver disease related mortality, and liver transplantation. This project seeks to examine how a recently described polymorphism of a human gene (Perilipin 2) involved in lipid (fat) storage in liver cells impacts the development of NAFLD. The student will use a genetically-modified mouse model of NAFLD to investigate how this polymorphism perturbs lipid pathways in the liver and whole body metabolism. Understanding how this genetic factor impacts NAFLD development has potential to lead to the development of novel diagnostic and therapeutic strategies for management of this disease in people.

The student will work with members of the Carr lab to learn basic molecular biology techniques including western blotting, RNA isolation and gene expression analysis, biochemical assays, and microscopy. The student will also learn how to utilize in vivo physiology techniques such as glucose tolerance testing. Because the gastroenterology (GI) division has a center for GI research, the student will also attend didactic lectures that range from scientific talks to professional development seminars. The student will also have opportunity to interact with members of other labs on the floor. While there are no pre-requisites for this position, some experience with pipetting and a basic foundation in chemistry and biology are helpful. Primary supervision will be by Dr. Eleonora Scorletti.

Kirk Wangensteen

Biology of the Liver: Repopulation Meets Cancer

Help us tackle important problems in liver biology! Our lab is conducting exciting research on the genetics of liver repopulation and cancer. We have developed cutting edge genetic tools to elucidate genetic pathways involved in carcinogenesis and liver repopulation in the setting of toxic injury. We aim to discover pathways that lead to drug sensitivity and resistance in HCC. We are performing CRISPR screening in live mice! We are looking for undergraduates to help us address important questions in liver biology.

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GENERAL INTERNAL MEDICINE

Peter Groeneveld

Fraud and Abuse in the US Health Care System *2nd year applicants only*

The purpose of the project is to characterize differences across states in their anti-kickback statutes (laws that prohibit health care providers from receiving or giving kickbacks for referrals), and to characterize physicians who have been convicted of violating these statutes.

Under the supervision of Research Assistant Professor Genevieve Kanter, the student will:

(1) develop a 50-state evaluation of variations in anti-kickback statutes

(2) analyze characteristics of physicians who have been convicted of anti-kickback violations.

Students will gain in-depth knowledge of an important tool in the regulation of health care, develops skills in the research of laws and regulations, and develop skills in analyzing data.

Students should have an interest in health care law/regulation/policies and have demonstrated experience in activities reflecting careful attention to detail. Experience with data/statistics and programming is a plus.

GENETICS

Laura Almasy

Polygenic Effects on Psychiatric Disorders and Neurocognitive Function

It is well established that there is a substantial genetic component to risk of psychiatric disorders as well as to individual variation in brain structure and neurocognitive performance. In recent years, it has become clear that these complex traits are influenced by hundreds or thousands of DNA variants. Consequently, the field of psychiatric genetics has largely moved from trying to identify the effects of individual genes or variants to studying the aggregate effects of many genes and variants through tools such as the polygenic risk score. A polygenic risk score is an estimate of a person's genetic risk to develop a disorder or, for a quantitative trait, a predictor of their anticipated trait value based on genetics. We are interested in the interaction of polygenic risk with environmental factors as well as in layering risk scores from multiple traits to try to understand the etiological connections between brain structure and function and risk of psychiatric disorders.

This project will involve conducting computational analyses to generate polygenic risk scores and assess their correlations with psychiatric and neurocognitive measures. This "dry lab" project is well suited to students with a basic knowledge of genetics and an interest in learning

novel methods of computational analysis. The student who works on this project would gain experience with genetic analysis of quantitative traits and polygenic risk scores and familiarity with concepts of genome-wide association studies. Data is already in hand and ready for immediate analysis. Students will have a chance to interact with collaborative groups of investigators in the US and Canada and will be invited to be a co-author on publications and presentations reporting the results of these analyses. There are opportunities for multiple students to work on this project. Students would use similar methodologies but would study different combinations of neurocognitive risk factors and psychiatric disorders in different data sets. Available data sets include a study of the effects of genetic copy number variation on neuropsychiatric function, a study of normal neurocognitive growth and development, a study of alcohol use disorders, and a study of autism spectrum disorders.

Iain Mathieson

Predicting living stature from skeletal remains *2nd year applicants only*

Estimating a person's stature based on their skeleton is an important tool in forensics, archaeology and anthropology. Typically, skeletons are not complete and only some elements can be measured, for example, the femur and other long bones. Therefore, we want to develop approaches to predict stature given partial skeletal measurements. From a statistical point of view this is a multiple regression problem with missing data. Most existing approaches use only a simple regression of stature against total long bone length for a training dataset. This project involves developing more sophisticated predictors that can impute the dimensions of missing elements and use them to predict stature, trained on an archaeological database of several thousand skeletal measurements. Finally, we can incorporate genetic predictions of stature which we have computed using ancient DNA from several hundred ancient individuals to create a more powerful prediction framework. This project involves statistical modelling and data analysis in the R programming language, and would be ideal for a student with some experience in those areas.

Sarah Tishkoff

Characterization of Genomic and Phenotypic Variation in Ethnically Diverse Africans

Africa is thought to be the ancestral homeland of all modern human populations within the past 300,000 years. It is also a region of tremendous cultural, linguistic, climatic, and genetic diversity. Despite the important role that African populations have played in human history, they remain one of the most underrepresented groups in human genomics studies. A comprehensive knowledge of patterns of variation in African genomes is critical for a deeper understanding of human genomic diversity, the identification of functionally important genetic variation, the genetic basis of adaptation to diverse environments and diets, and the origins of modern humans. We have generated high coverage whole genome sequence data from ethnically diverse Africans.

We are using computational and functional genomics approaches to characterize single nucleotide variants, structural variants, and regulatory variants and to determine their functional impact on adaptive traits and disease risk. The student working on this project will assist with analyzing genomic and/or gene expression data from ethnically diverse African populations in order to reconstruct population history and identify genetic variants associated with variable traits, including disease risk. Competitive candidates will have strong computational and/or molecular biology skills and, ideally, a strong understanding of biology.

Zhaolan (Joe) Zhou

Modeling neurodevelopmental disorder in mice

CDKL5 Deficiency Disorder (CDD) is a neurodevelopmental disorder characterized by early onset of epilepsy and lifetime intellectual disability. It is caused by mutations on the X-linked gene encoding cyclin-dependent kinase like 5 (CDKL5). Despite of the known and simple genetic cause, the molecular mechanisms by which dysfunction of CDKL5 impairs brain function leading to clinical symptoms defined as CDD remain poorly understood. Currently, there is no effective treatment or cure for CDD. To address the pathogenic mechanisms of CDD, we have developed a series of mouse models recapitulating genetic mutations in CDKL5 and plan to utilize these mouse models to answer two fundamental questions: 1) What are cellular phenotypes associated with CDKL5 loss in vivo in mice? 2) What are the molecular underpinning of epileptic phenotypes in CDKL5 mutant mice? Ideally, we expect to recruit two undergraduate researchers to investigate the above two projects.

Specifically, project one involves the use of confocal imaging to examine neuronal morphology in mice with and without functional CDKL5 expression. For this project, we are in the process of generating experiential mice where individual excitatory neurons can be visualized using stochastic green fluorescence protein (GFP) expression. Thus, neuronal dendrites and spines, reflecting neuronal connectivity, can be monitored and quantified upon sectioning and confocal imaging. The second project is to determine the extent to which CDKL5 mutant mice exhibit epileptic phenotypes by video-EEG recording and examination. Follow-up experiments include the assessment of candidate signaling pathways using a variety of techniques, such as Western blotting and immunostaining.

Students in biology related majors are encouraged to apply. Priority will be given to candidates with neuroscience background and experience working with mice.

HEMATOLOGY AND ONCOLOGY

Stephen Bagley

Personalizing care for neuro-oncology patients through next generation sequencing of circulating tumor cells and cell-free DNA

The Liquid Biopsy Lab, led by Director Dr. Erica Carpenter, MBA, PhD, focuses on the identification, capture, and analysis of Circulating Tumor Cells (CTCs) and cell-free DNA (cfDNA) 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 that obviates the need for serial biopsies in a population of patients for whom these procedures are difficult, risky, and insufficient. The focus of the lab is driven by the needs of investigators and clinicians, such as Dr. Stephen Bagley, MD, MSCE, who will serve as co-mentor for this project. The student will focus on the development of highly sensitive approaches for the isolation and next-generation sequencing of cfDNA isolated from the blood of neuro-oncology (brain cancer) patients enrolled on Dr. Bagley's clinical trials. The student will conduct assay development, perform sample preparation, summarize/analyze results, and will be exposed to the clinical aspects of neuro-oncology patient treatment. There may be clinical shadowing opportunities with Dr. Bagley 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.

IMMUNOLOGY

Laura Su

How T cells compete for success

We are interested in understanding the dynamics of T cell response over time. We have an ongoing yellow fever vaccine study, where we track T cell responses before and after vaccination. We are using T cell receptor (TCR) as an unique identifier to track cells longitudinally in the same individuals. Our goal is to understand why some T cells expand while other T cells die away after encountering antigens. We are looking for a student who is excited about immunology. Coding experience is not necessary but can be helpful for analyzing TCR sequences.

Learning plan:

Be part of a team to (1) identify yellow fever-specific T cells, (2) perform single cell TCR sequencing, (3) analyze TCR sequencing data.

INFECTIOUS DISEASES

Harvey Friedman

Developing a vaccine for preventing genital herpes

Our lab is working on a vaccine for prevention of genital herpes. We perform experiments in mice and guinea pigs to evaluate the protection provided by the vaccine. The project for the student will be to test serum samples for immune responses to the vaccine. These samples will be collected by lab members, and not by the students. The assays performed by the students will mainly involve measuring antibodies produced by immunization. This project may appeal to someone interested in biomedical research and who wants to learn about bench research. Someone interested in an MD or PhD degree in biomedical research will likely find the project interesting and challenging.

MEDICAL ETHICS AND HEALTH POLICY

Norma Coe

End of Life Care and Informal Care *2nd year applicants only*

Two potential projects for the summer student. Project 1 is on end of life (EOL) care and will examine the last 20 years of health care system changes and innovation on the quality of EOL care, including geographic variation, variation by disease, and which policies have the most influence over patients and providers. Project 2 will examine the causal impact of receiving informal versus formal long-term care on key and multi-faceted health outcomes for the care recipient.

The PURM student will primarily contribute to supporting manuscripts and publications for these two grants. The student will have the opportunity to work on literature reviews, internet searches, summarizing statistical output, formatting charts and tables, working with EndNote, and formatting manuscript submissions. The student will have the opportunity to learn about the entire research process by joining in regular meetings of the research teams, all of which will have projects at various stages from inception to publication. If a student comes in with intermediate to advanced SAS, R, or STATA skills there may be opportunities to work directly with data as well.

Jonathan Moreno

Neuroethics and visual image reconstruction

I continue to be interested in developments in neuroethics. A series of technological platforms have been developed especially in the US and Japan for the reconstruction of visual and auditory images using fMRI and advanced computing (computational neuroscience). This project would involve understanding the science and drawing out the ethical, philosophical and policy implications of these experiments. Some experience in a neuroscience lab would be helpful but not essential. The mentee would also be encourage to audit my summer 2020 master's-level course on neuroethics.

MICROBIOLOGY

Jay Zhu

Pathogenic bacteria-gut microbiome interaction

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

NEUROBIOLOGY AND BEHAVIOR

Wade Berrettini

Mobile DNA in Cocaine Use Disorder

Our lab studies the genetic basis of psychiatric and substance use disorders. The goal of this project is to begin to understand the role of mobile DNA elements, specifically L1 retrotransposons, in cocaine use disorder. Students will utilize fundamental genetic lab techniques (e.g. DNA isolation and PCR) to independently perform experiments, under the supervision of other lab members.

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NEUROLOGY

Kathryn Davis

Machine learning of EEG to help diagnose epilepsy

Epilepsy affects 1 in 26 people and causes significant morbidity worldwide. Diagnosing epilepsy is often challenging, and delayed and incorrect diagnosis hurts patients. The goal of this project is to apply machine learning algorithms to EEG for computer-assisted diagnosis of epilepsy. We will examine the EEGs of patients being evaluated for a possible epilepsy diagnosis and use machine learning algorithms to classify their EEGs to see if quantitative EEG analysis can accurately diagnose epilepsy.

As a student working on this project, your role will include implementing a machine learning algorithm in Matlab, clinical chart review, and/or preparing EEGs for review (your specific role will be based on your interest and experience). You will gain skills in coding, clinical chart review, and machine learning, and you will learn a lot about how we clinically diagnose epilepsy. You will also be an author on resulting publications. Experience with Matlab is preferred but is not necessary.

Jay Gottfried

The Fine Structure and Function of the Human Olfactory System

Research in our lab focuses on the most unheralded yet most mysterious of the senses: smell. There are two unique and singular properties of the olfactory system. First, the olfactory system is virtually synonymous with memory, emotion, and decision-making, with projections from the nose terminating directly on limbic brain regions such as the amygdala, entorhinal cortex, and insula. These anatomical connections likely explain why smells are so often associated with memory "flashbacks" that reactivate potent emotional and autobiographical memories. The second intriguing property is that smell loss is often the very first symptom of neurodegenerative diseases such as Alzheimer's or Parkinson's, even before the emergence of overt symptoms and signs. This PURM project will focus on characterizing the anatomy, circuitry, and gene expression profiles in human olfactory tissue samples obtained from autopsy patients and from patient biopsies. Students will have an opportunity to gain direct hands-on experience with sectioning human brain specimens, using immunohistochemical assays to stain the tissue, imaging the tissue slides on a confocal microscope, and analyzing the digitized data. These experiences should provide students with a solid conceptual and methodological foundation in wet-lab neuroscience and neuroanatomical techniques. Dr. Jay Gottfried, MD, PhD, is the PI of this project, and he and his colleagues, including research associate, Dr. Lulu Korsak, and research technicians Sarah Kwon and Sepideh Cheheltani, will all be directly involved mentoring the students. No prior experience is necessary, other than having an interest and curiosity in doing basic science research on human brains!

Roy Hamilton

Transcranial Magnetic Stimulation in Post-Stroke Aphasia

Aphasia – an acquired loss of language ability – is the most common, devastating cognitive impairments following stroke. Unfortunately, the mainstay of treatment, speech-language therapy (SLT), is only modestly beneficial. Early evidence suggests that transcranial magnetic stimulation (TMS), may serve as an efficacious adjuvant to SLT, as it is thought to promote changes in language-relevant neural networks. We are currently conducting a clinical trial investigating the efficacy of TMS by assessing whether SLT paired with a 10-day course of (active) TMS confers greater outcomes when compared to SLT paired with sham (placebo) stimulation. Language performance is assessed immediately before and after treatment and 3 and 6 months post-therapy. Enrollment into the study is ongoing, and we will have collected a potentially informative set of pilot behavioral and neuroimaging data by the summer of 2020. We will evaluate these early data to determine whether there are immediate and persistent effects on language performance and brain activity related to TMS. Additional analysis will explore the behavioral, anatomic, and genetic factors that predict subjects' responses to TMS intervention. Students will evaluate and score neuropsychological test battery data, including a variety of language measures. Prior experience in cognitive neuroscience research is useful but not a prerequisite. Over time, students will be encouraged to propose independent analyses and to participate in scientific authorship. They will be mentored by the PI, post-docs, and graduate students. Finally, students will have the opportunity to assist with ongoing subject sessions, thus gaining experience working with an important clinical population.

Frances Jensen

Altered synaptic function in neurological disease *2nd year applicants only*

We study a variety of neurological disorders, using a combination of human tissue brain samples (from brain biopsy or postmortem) and in vitro and in vivo mouse models of neurological disease. We study alterations at the synapse in hippocampus and cortical areas that contribute to disease, and identify and test efficacy of new therapeutic targets to prevent or reverse these changes. Projects available for study include epilepsy, autism and dementia, with evaluation of alterations in synaptic signaling pathways that affect network excitability, gene expression as well as learning and memory. We use a combination of human tissue studies such as gene and protein expression related to synaptic and signaling transduction pathways in epilepsy biopsy material as well as postmortem tissue. In addition, we use mouse models to examine how neuronal hyperexcitability such as due to seizures alters synaptic plasticity. We study neuronal populations in brain slices using whole cell patch clamp electrophysiology to examine the effects of seizures on circuits and synapses. Such studies are used to determine new therapeutic targets for the prevention of epileptogenesis as well as learning and memory impairment in epilepsy. Furthermore, we study similar synaptic mechanisms across several disease states in both the animal and human tissue, to examine the interaction between epilepsy or hyperexcitability and other disorders such as autism and dementia, where seizures can occur.

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Dawn Mechanic-Hamilton

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

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

Adeline Vanderver

Hypomyelination and atrophy of basal ganglia and cerebellum (H-ABC)

Hypomyelination and atrophy of basal ganglia and cerebellum (H-ABC) is a rare leukodystrophy with spectrum of mutations in tubulin alpha 4A (TUBB4A); p.Asp249Asn (D249N) is a recurring variant occurring in the majority of affected individuals. H-ABC typically begins in early childhood characterized by dystonia, ataxia, altered gait and progressive motor dysfunction with loss of ambulation before the end of the first decade of life. To date, there is no therapeutic approach available. To understand how TUBB4A mutations cause H-ABC and to facilitate the pre-clinical therapeutic strategies, we developed a knock-in CRISPR-Cas9 mouse model harboring homozygous (Tubb4aD249N/D249N) Tubb4a mutation. Tubb4aD249N/D249N mice replicates hallmark pathology of H-ABC and is reliable platform for pre-clinical study. We also have a library of patient derived induced pluripotent stem cells (iPSC) with TUBB4A mutations and we show that deletion of TUBB4A in iPSC neurons can rescue H-ABC associated cell death. Thus, as pre-clinical approach, we intend to employ molecular therapies – anti-sense and adeno-associated viral - gene therapy approaches to downregulate overall Tubb4a. Simultaneously, we are working on iPSCs derived neurons and glia to understand the cellular and molecular mechanisms in H-ABC patients. Students will have the opportunity to learn basic science and translational competes involving mouse intracerebroventricular injections, cisterna magna route of injections, neurobehavioral tests, histopathology. In addition, students will benefit professionally, as they will interact with potential collaborators and will have opportunity to present their data in the lab meeting and Glia Journal Club 2020. The post-doc fellow Dr. Sase and Dr. Almad will be mentoring the students along with Dr. Vanderver.

NEUROSCIENCE

John Dani

Neural circuit mechanisms of memory associated with drug addiction

The goal of this project is to understand how hippocampal neural circuits interact with midbrain dopamine reward centers in bringing about drug (cocaine) addiction. The hippocampus is important for memory of the places where the rewarding effects of addictive drugs were experienced. To disrupt the pathologically strong association between place and drug-associated rewards, we are employing cutting-edge technologies, including optogenetics and in vivo electrophysiology, to interfere with the memory consolidation mechanisms. Toward this goal, we are excited to welcome talented and motivated undergraduates to join our ongoing efforts to manipulate the neural circuits of drug addiction.

The student will work closely with and be mentored on a daily basis by Dr. Mani Subramaniyan, a Senior Research Investigator in my lab. The student will learn and perform the following: handling mice and collecting behavioral data in drug addiction-related tasks (conditioned place preference); preparing materials for optogenetic experiments; preparing electrodes for in vivo electrophysiology; histology of mouse brains; immunohistochemistry and microscopy; and survival surgery for implanting optic fibers to control neural activity. Depending on the interest and experience of the student, the opportunity also exists for MATLAB coding for data analysis. Prior experience in the above tasks is a plus but not required. In addition to obtaining hands-on experience, the student will have the opportunity to frequently discuss with the mentor recent progress in neuroscience and will receive mentorship on the design of experiments and the analysis and interpretation of scientific data. Since the project is multi-disciplinary, students from diverse academic backgrounds (biology, mathematics, engineering, etc.) are encouraged to apply.

Marc Fuccillo

Probing neural circuits for motor control in health and disease

Students will work on parallel projects that explore (a) novel neural circuit contributions to goal-directed decision-making and (b) molecular contributions of Tourette Syndrome-associated mutations to abnormal control of motor output. Both analyses will specifically focus on connected neuronal populations between frontal cortex and striatum. In performing these projects, students will be introduced to highly quantitative approaches to record mouse behavior using statistical and machine-learning based methods. Furthermore, they will be exposed to acquisition and analysis of in vivo recordings of neuronal activity and cutting-edge viral methodologies to map higher-order neuronal connectivity. Students will be responsible for performing behavioral assays with mice, so they must be comfortable with handling small

animals. Students will be trained by: Kyuhyun Choi (postdoctoral fellow, project A) and Luigim Vargas (NGG graduate student, project B), in addition to the lab PI, Marc Fuccillo.

Joshua Gold

Relationship between arousal and cognition

Arousal can profoundly affect learning, attention, and other aspects of higher-brain function, but little is known about the underlying neural mechanisms. My laboratory has several ongoing projects that are testing the hypothesis that these effects arise, at least in part, from arousal-mediated changes in coordinated neural activity throughout the brain.

This project involves helping to collect and analyze 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, analysis must be done in stages. The goal of this project 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.

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

Michael Platt

The effectiveness and physiological mechanisms of interventions meant to increase interpersonal connectedness

Relationships are crucial in numerous areas of life, and individuals with good relationships live longer, happier lives. Good relationships at the workplace, for example, may produce numerous positive effects, including heightened intrinsic motivation, self-efficacy, vitality, growth, learning, and an organizational culture of compassion. Determining effective interventions to increase interpersonal connectedness is thus crucial.

In the Platt Labs, we are currently testing the effectiveness and mechanisms of short exercises meant to increase interpersonal connectedness (e.g., giving positive feedback to one another). Participants of our studies interact with each other while we measure psychological (behavioral tasks, questionnaires) and physiological effects, including heart rate, respiration, skin conductance and electroencephalogram (EEG). We are particularly interested in whether the physiology of interacting participants synchronizes when interpersonal connectedness increases (e.g., see Palumbo, 2017, Personality and Social Psychology Review), and whether the exercises increase interpersonal trust and social sensitivity.

This project is a unique opportunity for students to gain research experience in social neuroscience and psychology. Students will be actively involved and mentored with regards to all research stages, including literature research, study design, planning, data acquisition and analysis. They will be trained in various physiological data acquisition methods and gain ample experience in collecting data themselves. Moreover, they will be guided to develop their coding skills (e.g., Matlab, Python) in the context of running experiments and analyzing data. Aptitude and motivation in the domains of mathematical thinking, technology and programming are helpful, but pre-existing skills are not required. Direct supervisor will be Dr. Vera Ludwig (Vera.Ludwig@pennmedicine.upenn.edu).

Amita Sehgal

Monitoring Neuronal Activity in sleeping Drosophila

The Sehgal Lab studies sleep and circadian biology primarily using Drosophila melanogaster, the fruit fly, as a model system. The goal of this project is to use in-vivo imaging to characterize how different regions of the Drosophila melanogaster brain change their calcium activity as the fly falls asleep. We hypothesize that the neuronal circuits that respond to sleep need in a sleep-deprived state differ from those that respond to sleep need as a function of circadian rhythms. There are no prerequisites, just a passion for neuroscience and/or sleep research. The student will work closely with a post-doc, Cynthia Hsu, to learn all the necessary skills for this project These skills include maintaining genetically enhanced Drosophila lines, immobilizing flies and removing their head cuticle for imaging, and acquiring and analyzing neuronal activity data with a two photon microscope.

This project will provide a well-rounded introduction to Drosophila as a model for systems neuroscience, especially chronobiology and sleep. In addition to experience in Drosophila genetics and husbandry and two photon imaging, the student will receive mentorship in reading the literature and understanding how neuronal circuits, behavior, sleep, and circadian rhythms are studied in the Drosophila model. The student will also be exposed to PCR, immunohistochemistry, MATLAB programming, and image processing. The student will also participate in lab meetings and journal club during which the Principal Investigator, all postdocs, graduate students, and technicians will be present, which will give them exposure to the research of other members of the lab as well as experience discussing science with others.

Franz Weber

Dissecting the neural circuits controlling REM sleep

Rapid eye movement (REM) sleep is a distinct brain state characterized by an activated electroencephalogram (EEG) and vivid dreaming. In the lab, we combine various methods including electrophysiology, optogenetics, viral tracing and calcium imaging to study the neural circuits controlling REM sleep in mice and its function in health and disease.

Students will perform viral tracing experiments to unravel the wiring diagram of neurons involved in the control of REM sleep, will learn how to run and analyze electrophysiological sleep data and how to manipulate sleep behavior in mice using optogenetics. Over the course of the project, students will develop a thorough understanding of electrophysiology, viral tracing, and optogenetics and will learn about the anatomy and connectivity of sleep circuits in the mammalian brain.

NEUROSURGERY

Donald O'Rourke

Post-Immunotherapy Tumor Tissue Evaluation *1st year applicants only*

Our lab conducts translational research focused on glioblastoma, the most common, adult, malignant, primary brain tumor. We are currently treating patients in a clinical trial involving chimeric antigen receptor (CAR) T cells. Part of the correlative analyses to be done involves assessment of protein expression, in both the tumor cells and the immune cells. Quantification of markers, including CD3, CD4, CD8, CD68, PD-1, TIM3, IDO1, and EGFRvIII, will help our group gain a better understanding of the activity of our novel treatment.

For this position, we are looking for a motivated undergraduate student to do the data collection and analysis on the clinical trial specimens. Most of the required staining will be performed by core facilities on campus, but there will be opportunities to learn immunohistochemistry and immunofluorescence as well. Most of the work will focus on digital image analysis of the stained slides, making use of software packages such as inForm Advanced Image Analysis Software from PerkinElmer. Statistical analyses will be done on GraphPad. Experience in either software is not required, as the student will gain an understanding of the required approaches through the course of their research. In addition to staining, image quantification, and statistical analysis, the student will have the opportunity to participate in correlative research occurring alongside a current clinical trial.

OPHTHALMOLOGY

Jessica Morgan

Adaptive optics imaging applications to understand the structure and function of the human visual system

The Morgan laboratory in the Department of Ophthalmology studies the human visual system using adaptive optics, a technology which permits visualization of individual light-sensing

cells—rod and cone photoreceptors—in the living retina. Using the same technology, we can probe the limits of vision by presenting small light stimuli confined to single or small groups of cones and investigate visual system function both in normal sighted individuals and in patients with retinal disease. This summer project is part of an ongoing effort to apply these advanced imaging and visual function testing tools to study the human retina both in health and disease. Two overarching goals of this ongoing project are (1) to quantify cellular structure and correlate measurements with clinical phenotypes of disease, (2) to link cellular-scale structure and function in patients with inherited retinal degeneration, and (3) to better understand how the retina and brain convey information about the world by studying the percepts elicited by stimulating individual neurons in the retina.

Students will work with data collected from normal and diseased retinas to measure cone densities at several retinal eccentricities and quantify abnormalities in cone density in patients with known retinal pathology. Students will also have the opportunity to carry out experiments to assess cellular function, for example testing visual sensitivity at the cellular level. Throughout the project, students will participate in state-of-the-art ophthalmic research, interact with research subjects, and learn optics and retinal anatomy. In addition to lab work, students will attend weekly lab meetings. Motivated individuals with an interest in bioengineering, clinical research, psychology, biology, neuroscience, image processing or computer programming are encouraged to apply. Prior experience using Matlab is preferred but not required. Multiple students may work on different aspects of the larger project, and opportunities to continue in the lab beyond the summer may be available.

Kenneth Shindler

Evaluation of Neuroprotective Therapies for Optic Neuropathies

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

Current projects aim to examine whether intranasal delivery of resveratrol leads to significant accumulation of drug in the eye, and to determine optimal dosing to achieve similar levels as seen after oral drug administration. Ongoing gene therapy studies are targeting expression of SIRT1 and its downstream signaling molecules to RGCs to reduce neuronal damage during optic

neuritis and optic nerve trauma. Students working on these projects will learn all applicable methods, including how to work with laboratory mice, oral and intranasal drug administration, injection of gene therapy vectors, collection of tissue samples to measure drug levels, and data analysis. The student will work directly with the PI, Dr. Shindler, and will have assistance from a post-doctoral Research Associate, Dr. Reas Sulaimankutty, as well as a Research Associate, Ms. Kimberly Dine. Interested students must be willing to learn to work with mice, and take required University training courses (2-4 hours total) prior to starting these projects.

ORTHOPAEDIC SURGERY

Nathaniel Dyment

Defining the cellular heterogeneity within tendons and ligaments

Injuries to tendons and ligaments often do not heal on their own and can be difficult to repair surgically. Because of this, people with these injuries often cannot move their arm or leg without significant pain, leading to poorer quality of life. One of the main focuses of our research program is to define cells at different stages of the lineage within tendons and ligaments. Defining the cell lineage is crucial to improving repair to tendon and ligament injuries as mimicking the normal differentiation process is likely needed for successful outcomes. Currently, tendon cells are thought to be a relatively homogeneous population. However, utilizing novel fluorescent reporter mouse models, our lab has demonstrated cells at different stages of the tenogenic lineage exist (e.g., stem and progenitor cells). Additionally, we have discovered a resident macrophage population within the growing tendon and are currently investigating the crosstalk between these intrinsic immune cells and tenocytes. Students interested in stem cell biology and cell lineage tracing will likely enjoy this project. Students will learn novel cell culture, histological, and imaging techniques using fluorescent GFP mouse models. Current PhD students in the laboratory will serve as the students' mentors. Ideally, students will continue on with us after the PURM program has ended to continue their training and mentorship.

Foteini Mourkioti

Novel specialized properties of stem cells in muscle disease

Muscle stem cells play a major role in muscle regeneration. Following muscle injury, muscle stem cells become active, proliferate, and fuse with the surrounding tissue, allowing for the full regeneration within a few days. Pax7 is a marker of muscle stem cells that is conserved across many species, including humans. To look at muscle stem cells in vivo in a live animal, a Pax7EGFP mouse model was generated by inserting an enhanced green fluorescent protein (EGFP) cassette in the Pax7 gene (Tichy et. al., Skeletal Muscle, 2018). This allowed for the expression of EGFP driven by endogenous promoter and regulatory elements. Using 2-photon

microscopy, we were able to visualize for the first time muscle stem cells in vivo and have identified unique and novel properties of these cells that have never been reported previously. We recently identified the molecular pathway that controls these properties and have generated knockout mice to study their function.

We are seeking a motivated individual to work closely with a talented graduate student in the lab (Nuoying Ma) in the characterization of these mice. Work will include several techniques, such as tissue handling, stem cell isolation, histology, immunochemistry and quantification using an imaging software. As a result of these efforts, the student is going to be a co-author in any publication, which will utilize these experimental efforts. Moreover, the study of muscle regeneration has primarily relied on retrospective analysis of static images from tissue section histology. Our experimental system allows for longitudinal studies of muscle regeneration in a substantial reduced number of experimental animals and gives us the opportunity to test therapeutic interventions to reveal how early pathological symptoms correlate with later disease outcomes.

Ling Qin

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

Osteoporosis and low bone mass are major public health problems with substantial economic burden. Bone, a dynamic tissue, constantly remodels and adapts. Bone marrow mesenchymal stem cells (MSCs) are critical to bone dynamic by constantly producing bone-forming osteoblasts and marrow adipocytes, all within a supportive vascular network. Osteoporosis is often accompanied by diminished bone formation, increased bone resorption, and impaired marrow vasculature. By carrying out large scale single cell transcriptome analysis, we recently computationally defined the hierarchy of bone marrow mesenchymal lineage cells and delineated the in vivo differentiation process of MSCs through multiple intermediate subpopulations. Interestingly, we identified a new subpopulation of cells situated after proliferative progenitors and before classic lipid-laden adipocytes along the adipogenic differentiation route of MSCs. Those cells, abundant in young mice, form a ubiquitous 3D network in the marrow cavity to support vasculature and to regulate bone remodeling. This project aims to characterize this newly identified adipose type of cells, which does not exist in other adipose tissues, and study their regulatory function in bone. Student researchers will be paired with a lead postdoctoral fellow and be included in all aspects of this project, including mouse handling, cell culture, histology, and advanced 3D imaging analysis. At the end of this mentoring period, students will gain sufficient knowledge in mouse genetics, molecular and cell biology, and advanced laboratory techniques. Students will participate in all aspects of the lab, including lab meetings, journal clubs, departmental seminars, and social outings.

Neil Sheth

Building an Orthopaedic Center of Excellence in Moshi, Tanzania - A Sustaianble Solution of Delivering Care

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 last year 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 last Summer, and has recently received a grant from the Vagelos program to be in Tanzania for the Summer of 2020 and 2021. He continues to be an integral member of our team and will serve to be a mentor for the next PURM student.

Eileen Shore

Heterotopic ossification – how does one tissue become another?

Rare genetic diseases, though directly impacting relatively small numbers of people, provide unique insight into fundamental cellular mechanisms. Our research program investigates the genetic regulation of cell development and differentiation through studies of two rare human genetic diseases of extra-skeletal (heterotopic) bone formation, progressive osseous heteroplasia (POH), caused by inactivating mutations in the GNAS gene, and fibrodysplasia ossificans progressiva (FOP), caused by activating mutations in the BMP type I receptor ACVR1. We investigate the cellular and molecular basis of dysregulated stem cell fates, bone tissue formation, and skeletal development, as well as the effects of these mutations on the tissues in which ectopic bone forms such as adipose tissue and skeletal muscle. We develop, characterize, and use in vitro and in vivo models to understand the consequences of the mutations and to test novel therapeutic strategies. Collaborators include Dr. Faye Mourkioti and Dr. Rob Mauck.

Work on several project areas are available and will be discussed on an individual basis. Experimental approaches include working with mouse models, pre-clinical drug testing, histology, microscopy, molecular biology techniques such as PCR, DNA sequencing, cell culture. You will also learn how to design experiments, read research papers, document and analyze data, and develop written and oral presentation skills.

Louis Soslowsky

Orthopaedic Bioengineering

The overall goals of our research program are to determine fundamental relationships and mechanisms of tendon and ligament injury, healing, repair, and regeneration and to use this information to develop and evaluate potential treatment modalities. Undergraduate researchers are important to our research program as we have mentored many over the years. Students can expect to work with graduate students and postdocs on mechanical testing, histology, animal surgery, and other experiments. Ideally, students will continue on with us following the PURM project to gain additional experience and mentorship.

OTORHINOLARYNGOLOGY

Richard Doty

Non-Invasive Cholinergic Markers of Brain Disease

Olfactory dysfunction is an early biomarker for Alzheimer's disease and Parkinson's disease. In some cases, such dysfunction precedes the classic symptoms by years. The physiologic cause(s) of the olfactory dysfunction are unknown, but may be harbingers of early brain pathology. Most

neurologic diseases with olfactory loss also exhibit cognitive decline and dementia. A key neurotransmitter related to both cognitive and olfactory processes is acetylcholine (ACh).

The goal of this project is to correlate measures of brain ACh function, as measured by pupillometry (i.e., quantitative changes in pupillary responses to flashes of light), with olfactory test scores of patients with chemosensory disorders. The student will be involved in a number of different activities, including administering visual, olfactory, and cognitive tests, organizing and analyzing the data, and performing other research activities under the mentorship of one of the world's preeminent experts on taste and smell, Richard L. Doty, PhD.

Dr. Doty is the Director of the Smell and Taste Center (the first clinical research center in the United States devoted to the study of the chemical senses and their disorders) and is a pioneer in developing and validating practical quantitative tests of olfaction, including the olfactory tests to be used in this study. He has published over 400 scientific articles and book chapters, and is the author or editor of over a dozen books. Some of the tests he has developed and helped to commercialize have led to significant advances in a number of fields, most notably neurology, psychiatry, otorhinolaryngology, and epidemiology.

Steven Eliades

Development of automated methods to detect and classify animal communication sounds

Vocal communication is a behavior shared by both humans and many animal species. Currently, research in animal communication is limited by its dependence upon time-consuming manual and semi-automated methods to detect and classify such communication sounds. This project aims to develop new computational approaches to better automate this task.

Interested students should ideally have some experience in computer programming and an interest in either signal processing, biology, or neuroscience. All programming will be done in MATLAB, so some prior experience a plus but can be learning during the project. Students will work one on one with Dr Eliades, gaining experience in the biomedical research environment as well as instruction in signal processing, animal communication, and the biological mechanisms of hearing.

At the completion of the summer, interested students may be invited to continue to work with the lab group on either computational of experimental projects, depending on student interests.

Elizabeth White

Human Papillomavirus-Host Cell Interactions

The White laboratory works at the intersection of virology and cancer biology. We are a collaborative team of students and staff working together to study the molecular biology of human papillomaviruses (HPV), which cause 5% of human cancers worldwide. The ability of

HPV to cause cancer depends on the activity of two of its proteins: E6 and E7. These proteins act together to cause changes in cells that lead to increased cellular proliferation and decreased cellular differentiation. Both increased proliferation and decreased differentiation are hallmarks of cancer.

We recently discovered that the host cellular protein PTPN14 is targeted by HPV E7 protein to restrict cellular differentiation. We are now working to determine the mechanism by which differentiation is impaired and to determine whether PTPN14 inactivation is required for the virus to cause cancer. The student selected for this project will work closely with a current Penn PhD student on experiments related to this question. The student will perform cell culture-based experiments and will learn to use cellular and molecular techniques to study cancer-related signaling pathways.

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

PATHOLOGY

Youhai Chen

Inflammation and cancer

The connection between cancer and inflammation is widely recognized, yet the underlying molecular mechanisms are poorly understood. By genomic profiling of inflamed tissues, Dr. Chen and colleagues discovered three members of the TIPE (TNF-alpha-induced protein 8-like) family. They have since crystallized two of them and generated mice deficient in all of them. They discovered that TIPE family plays crucial roles in both inflammation and cancer, and provides a molecular bridge between inflammation and cancer by targeting signaling molecules shared by them. In a paper published in Nature Immunology (Nat Immunol. 2017;18:1353), they discovered that TIPE proteins are professional transfer proteins of lipid second messengers that include phosphatidylinositol 4,5-bisphosphate and phosphatidylinositol 3,4,5-trisphosphate. By regulating the localization and function of these lipid second messengers, TIPE proteins control migration of both leukocytes and cancer cells. Thus, TIPE proteins represent potential new therapeutic targets for the treatment of cancer and inflammatory diseases. Through this summer internship program, the students will learn basic concepts and techniques related to inflammation and cancer. With help of senior researchers in the lab, the students will select projects of their interest, and carry out immunological, pathological, and molecular biological studies. The students will be asked to make formal oral presentations of their work at the end of the summer to all lab members.

Paula Oliver

Regulation of microbial sensing and allergic disease by Cul5

Our immune system is poised to respond to a myriad of pathogens and parasites that seek to invade and replicate within our tissues. A failure to mount an effective response during invasion results in severe tissue damage, a depletion of resources, or even death. However, immune armament must be held in check to prevent inflammation and the initiation of allergic or autoimmune disease. One means of keeping our immune system in check are enzymes called ubiquitin ligases. These enzymes can limit the activation of immune cells or turn immune cells off after invasion has been cleared. However, in many cases, the enzymes that regulate key aspects of immune regulation have not yet been identified. Using a novel screen to search for ubiquitin ligases that are highly activated in T cells (the cells that organize immune responses), we identified Cul5, a member of the cullin ring ligase family. We then generated mice that lack Cul5 in T cells, and our preliminary data support that Cul5 reduces susceptibility to allergic diseases such as asthma. Additionally, we have found that Cul5 functions in other immune cells to limit responses to pathogenic microbes such as bacteria. With new mouse models in hand, we are poised to define key mechanistic aspects of Cul5 function in vivo. The major questions these projects are positioned to answer are 1) how does Cul5 regulate allergy, and 2) do does Cul5 help cells to distinguish between pathogenic or commensal microbes or how vigorously these cells respond to pathogenic infection?

Daniel Powell

Immunotherapy for solid cancers

The Powell lab is developing multiple innovative strategies for the treatment of solid tumor types, with a special emphasis on ovarian cancer. These studies include the development of gene-engineered T cell therapy approaches for precision targeting of cancer cells and immunosuppressive cells in the the tumor microenvironment. In addition to this work, we are conducting in depth analysis of the cellular components of the tumor microenvironment to better understand the current limitation of immunotherpeutics in solid cancers, and to develop the next generation of effective treatments. Candidates with some level of experience or knowledge in the area of molecular biology and/or cell biology and cell culture are encouraged to apply. The student will have the opportunity to work with a group of more seasoned investigators, including postdocs and graduate level students; to attend and present at weekly lab meeting; to contribute to exciting ongoing projects; and to experience the realm of translational science which has the potential to directly impact patients.

Sydney Shaffer

Investigating mechanisms of drug resistance in melanoma at the single cell level

The major challenge in cancer treatment is creating therapies capable of killing all of the different cells that exist within a single patient's tumor. Cells within a tumor can be highly variable in sensitivity to therapy and metastatic potential. Our lab is interested in detecting rare cell states with unique phenotypic characteristics. We have recently identified a population of cells resistant to targeted therapy that make up less than 1% of melanoma cells. Thus far, we have identified protein markers that characterize these cells, but we have not yet identified a mechanism behind the drug resistance. We have performed transcriptomic and epigenetic studies to converge on a set of candidate genes that could be conferring resistance to treatment.

We are looking for a motivated undergraduate student to learn from and assist Dr. Sydney Shaffer and Bioengineering PhD student Dylan Schaff in screening the list of candidate genes behind drug resistance in melanoma. The student will learn how to culture cancer cells and perform RNA FISH, an imaging technique for measuring cellular gene expression. They will then learn how to use image processing tools to extract data from the images they collect. This is a unique opportunity to learn both experimental and computational skills. However, we would prefer that the student comes in with basic programming experience. Finally, the student will learn invaluable scientific communication skills as they participate in biweekly meetings with Dr. Shaffer and Dylan and work with Dylan to craft a presentation to be given at lab meeting.

Kai Wang

Deep learning approaches for information extraction from electronic health records

Electronic health record (EHR) is an electronic version of a patient's medical history. Since some EHR data are unstructured and non-standardized, natural language processing (NLP) techniques can be used to extract structured medical information so that computers can automatically understand the meanings of clinical notes to facilitate disease diagnosis. Modern deep learning (DL) techniques used in NLP have greatly improved performances in many NLP tasks such as named-entity detection, relation extraction, topic modeling, and document classification. Candidates who are involved in this project will have an excellent opportunity to learn the whole clinical NLP pipeline from information extraction to DL-based model optimization. Through this project, the candidates will learn the implementations of several state-of-art DL-based NLP algorithms, such as Word2Vec, GloVe, ELMo, BERT, and XLNet, on real-world clinical data and biomedical literature for disease diagnosis, such as Autism Spectrum Disorders. Since each patient had multiple visits mapping to multiple EHR notes at different time points, the candidates will also learn how to model temporal information in EHR data to predict disease procession trajectory and disease comorbidity early detection. The candidates will also learn how to handle big-data in high-performance cluster computing and cloud computing. Skills and experiences gained from this project will facilitate the candidates to pursue a career in data science, especially in the healthcare domain.

PEDIATRICS

Kristina Cole

Pediatric Cancer Tumor Cell Atlas

Background: Cancers are made up 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, 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 cutting edge 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.

Joel Fein

Complete Eats: Free Summer Meals for Kids to Address Food Insecurity

21.5 million low-income children nationwide receive free or reduced-price meals during the school year, including nearly 660,000 in Pennsylvania. During the summer, many of these children go hungry. In Pennsylvania, only one in ten eligible children continue to get free or reduced-price meals through the USDA Summer Food Service Program. Complete Eats is a partnership between CHOP and the Nutritional Development Services of the Archdiocese of Philadelphia to provide free summer meals in clinical settings at the point-of-care, and to connect families with food resources in their community. Summer 2020 will be the program's 4th year of

operation and we anticipate continued rapid growth of the program; in the summer of 2019 CHOP served nearly 16,000 meals across 4 clinical sites.

This summer we will be studying the feasibility, acceptability, and reach of the program, as well as the impact of the program on child health and food security. We are looking for students to assist with program operation at the clinical sites, and data collection from program participants. Students will work primarily with Complete Eats founder and director, Dr. Danielle Cullen. Responsibilities will include communication with CHOP and community partners, participant recruitment, survey administration via iPad, phone interviews with participants, and data collection. Students will be welcome to attend meetings with community leaders and hospital partners, city public health officials, and governmental officials, as they arise throughout the summer. Students can expect to gain valuable experience in public health program design and implementation, qualitative and quantitative research methods, community based participatory interventions, and an in-depth understanding of the social determinants of health.

Applicants for this position should have an interest in public health/community health and excellent interpersonal communication skills. We look forward to meeting you!

Riccardo Gottardi

Cartilage Tissue Engineering for Laryngotracheal (Windpipe) Reconstruction

There is a lot of engineered cartilage developed in labs around the world, but very little finds its way to the patients. We have adopted a fast translation approach to reach the clinic in the next 3 years. Our priority target is engineering cartilage for laryngotracheal reconstruction to enable infants and children with subglottic stenosis to breath again without a tracheostomy. For rapid translation, we design scaffolds based on FDA approved materials: starting from the simplest building blocks we build the complexity that drives stem cell differentiation. Moreover, the engineered tissues we develop are based on new stem cell sources that can be harvested with minimally invasive outpatient procedures.

In this project, the students will have the opportunity to learn about 3D printing/bioprinting, cell culture, and materials fabrication. Students will not be directly involved in animal work, but they will have the opportunity to study engineered tissues grown in the lab before they are implanted in animals, and to work with graduate students and postdocs to study how the engineered tissues perform after they are implanted.

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

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

We offer:

- A collaborative and open environment that fosters learning and scientific growth
- An exciting environment where trainee can learn and grow to develop new research directions working with incredible collaborators
- Individual mentoring to enhance your professional profile and tailored opportunities to support specific professional goals
- A highly translational focus to address patient-centered medical problems and to push research from bench to bedside

Brian Jenssen

An innovative approach to public health through human factors engineering *2nd year applicants only*

The field of public health has relied upon traditional methods of education and training to protect the health of people and their communities. While that is an important tool, we know that training and education only has limited sustainable impact. What would happen if we took a novel approach to influence positive human behavior towards public health by using a human factors engineering paradigm? This project will research current public health trends and vulnerabilities, and apply the human factors framework to these problem areas to examine and inform potential, innovative solutions. Partnering with Dr. James Won, adjunct assistant professor, human factors engineering principles mentorship will also be provided to the student.

Sriram Krishnaswamy

Molecular Mechanisms of Blood Coagulation *2nd year applicants only*

Several projects exist related to the mechanisms of thrombin formation and its regulation. This focus of the laboratory employs a range of approaches including protein chemistry, recombinant protein expression, biochemistry, biophysics and structural biology. There are a range of approaches that undergraduate trainees can participate in with the goal of advancing the mechanistic bases for the reactions of blood coagulation.

Elizabeth Lowenthal

Pediatric Global Health Research

This research team is focused on issues of importance to the health of children living in resource-limited settings. Penn students and other U.S.-based members of the research team primarily support ongoing projects in Botswana and the Dominican Republic. Ongoing projects include a study of neurocognitive assessments for children affected by HIV in Botswana and a study related to anemia in the Dominican Republic. Students selected to work with this team have a

passion for issues related to pediatric global health and should be organized, energetic, and respectful of cultural differences. No specific academic or professional skills or experiences are necessary. Student roles can be tailored according to the interests of the students. Students on this research team commonly gain a basic understanding of clinical epidemiology and experience using REDCap databases, organizing and analyzing data using Stata, coding qualitative data using NVivo software, and assisting with the development of educational materials for local stakeholders and manuscripts for professional audiences. Former students from this research group have gone on to complete Fulbright Fellowships abroad, to volunteer for the Peace Corps, to attend medical school, and to conduct child health research in a variety of settings.

Stephanie Mayne

Neighborhood Environments and Health Behaviors among Urban Families

My research focuses on identifying social and environmental determinants of health behaviors and outcomes among children and adolescents. Currently, my research group is examining the relationship of neighborhood-level factors such as crime, social cohesion, physical disorder, and green space with diet and sleep among families in CHOP's primary care network. We study these factors using epidemiologic methods, survey data collection, and geographic information systems (GIS) analysis. The overall goal of this work is to determine the key contextual factors needed to promote health and well-being beginning in childhood.

This summer research project will involve participating in up to two research projects with pediatric primary care populations. One study uses surveys to collect data from low income mothers of preschool-aged children on neighborhood environments and dietary patterns, in order to understand how neighborhood social factors (safety, social cohesion) relate to diet in parents and children. The second study uses mobile health methods to understand how the neighborhood physical and social environments teens encounter throughout their day influences their sleep. Opportunities may also be available to participate in additional projects focused on primary care innovation.

The participating student will learn key techniques for clinical and social/behavioral research, including 1) critical literature review, 2) participant recruitment for research studies, 3) survey data collection, 4) data entry, 5) basic data analysis skills, and 6) GIS methods. They will interact with a diverse team including pediatricians, epidemiologists, and clinical research staff. They will participate in weekly meetings on study progress and will receive individual mentorship on their research project and career development.

Shaon Sengupta

Circadian Clock and Lung injury: Paving the path for new connections

My lab is focused on circadian regulation of lung injury. Circadian rhythms are anticipatory mechanisms for organisms to adapt to their environment. This is evolutionarily conserved from Cyanobacteria to humans and is vital for health. Disruption of the clock (most commonly due to social, work or travel related jet lag) is associated with various disease conditions. While historically, the suprachiasmatic nucleus (in the hypothalamus) was considered to be the master circadian pacemaker, it is now known that almost all cells in the body have their own clock. Many biological processes are the impacted by these cell autonomous clocks. At the molecular level the clock comprises of core "clock" genes, which can be altered genetically to provide a genetic model for clock disruption to test its function in different organs. We have recently published our work on lung inflammation caused by influenza virus. We show that mice infected in the evening had three time higher mortality than mice infected in the morning. Further this difference was lost in animals where the clock was genetically disrupted. In my lab our projects involved mechanistic studies uncovering how the clock regulates lung injury and repair. Another set of projects are directed towards further our understanding of what early live exposure can do to the developing clock. We are looking for passionate students who want to learn about this field and about these scientific process at large. Our group will provide a helpful and nurturing environment--Questions are encouraged, creativity is valued and having fun while working is important! Those who are commited to the projects and make significant contributions should expect opportunities for authorship and other scholarly activities.

Rebecca Simmons

Exosomes in Preterm Birth *2nd year applicants only*

Extracellular vesicles (EVs), including exosomes and larger microvesicles, may function as vectors to transport signals between fetal and maternal tissues, where they deposit their cargo into target cells to produce a functional effect. Several cells/tissues have been reported to release EVs, including both fetal (placenta, umbilical cord, and fetal membranes) and maternal (decidua, myometrium, and cervix) reproductive tissues. Cargo in EVs includes proteins, fatty acids, micro RNA (miRNA), mitochondrial DNA (mtDNA), and mitochondrial components. We hypothesize that early spontaneous preterm birth (SPTB) is initiated by signaling mechanisms mediated by EVs. In previous studies we demonstrated that: 1) circulating total exosomes from term pregnant women at the time of delivery contain high levels of mtDNA; and 2) relative levels of placental exosomes (syncytin-1 labeled) were significantly lower in early SPTB cases compared to term delivery controls. Here, we propose to characterize maternal plasma levels of EVs – total EVs, placenta-specific (syncytin-1 labeled) EVs, exosomes (EVs in size range 30-200 nm), and larger EVs (200-1,000 nm) – and cargo within EVs in SPTB cases compared to controls, study the effects of EV cargo on reproductive cells of interest (e.g., trophoblast, cervical, and myometrial cells), and determine the usefulness of measuring maternal plasma EV levels and EV cargo early

in pregnancy as potential biomarkers and therapeutic targets for SPTB. The proposed specific aims are: 1) test the hypothesis that the size, distribution, numbers, and cargo content of circulating EVs are altered in SPTB cases compared to term delivery controls, and that the profile of EV cargo will predict women who will deliver SPTB.; 2) test the hypothesis that the cargo (mtDNA, miRNA) of circulating EVs from SPTB cases is sufficient to activate inflammation and alter placental/cervical/myometrial function.

Ignacio Tapia

Pediatric Sleep

The Sleep Center at CHOP has a vast research portfolio funded by the National Institutes of Health. The Sleep Center performs basic physiologic studies of airway neural control, and cerebral blood flow and oxygenation responses to hypercarbia; normal infant sleep parameters and the effects of micrognathia; efficacy and effectiveness of behavioral interventions and cross-cultural considerations of sleep in infants and toddlers; primary care-based sleep and behavioral interventions for socio-economically disadvantaged children; multi-center studies of the effects of adenotonsillectomy on the neurodevelopmental outcomes of obstructive sleep apnea. In addition, we have a strong adherence to positive airway pressure research portfolio.

Details of our portfolio can be found here: https://www.research.chop.edu/sleep-center

Students will learn from clinical researchers the basics of clinical research. Students will be expected to have completed the CITI Human Subjects module https://about.citiprogram.org/en/series/human-subjects-research-hsr/, attend weekly research meetings, observe the operations of the sleep laboratory, observe a sleep study set-up, and scoring and interpretation of sleep studies. Students will be able to participate in data collection and analyses. Based on interest selected, students could also propose and conduct a project with already existing data under the mentorship of members of our team, which could lead to an abstract and/or publication.

Students will be able to interact with an established team of researchers including the following (but not limited to): Ignacio Tapia, MD, MS; Christopher Cielo, DO, MS; Ariel Williamson, PhD; Melissa Xanthopoulos, PhD

PHARMACOLOGY

Elizabeth Heller

Regulation of bivalent chromatin across drug abstinence *1st year applicants only*

The Heller Lab of Neuroepigenetics studies brain reward regions of rodents exposed to chronic drug and stress paradigms. Epigenetic changes, such as histone post-translational modifications (HPTMs), regulate gene expression in all cells, including neurons in the brain. These changes can occur after drug exposure and persist through drug abstinence periods.

Bivalent domains are regions of chromatin that contain hPTMs that both activate and repress gene expression. While bivalency domains are known to influence gene expression, the regulation of bivalent chromatin has not been examined with respect to cocaine exposure. This PURM project will allow an undergraduate student to work directly with Dr. Heller, the PI, and Delaney Fischer, a graduate student, on work addressing the hypothesis that bivalent chromatin plays a underlies persistent gene expression across drug abstinence.

The undergraduate will be trained in laboratory safety and animal handling through KnowledgeLink and ULAR, assist in running mouse self-administration, and learn methods of transcriptional and epigenetic profiling of specific neuronal cell types in mouse brain. The student will work with Dr. Heller and Delaney in planning and executing experiments, data analysis and interpretation, and written and oral presentations. Students will participate in all aspects of the lab, including lab meetings and social outings.

Aalim Weljie

Metabolism of sleep and circadian rhythms using mass spectrometry and NMR

We are interested in the fundamental question of how metabolism changes through the course of the day (circadian function) and also as a function of sleep and sleep loss. Together, the areas of circadian and sleep biology are considered chronobiology, and within this our lab uses analytical tools such as mass spectrometry and nuclear magnetic resonance spectroscopy to study samples from cells, flies, animals samples, and human subjects.

This work sits at the interface of chemistry, biology, and statistical approaches using 'systems biology' approaches to further our understanding of metabolic constraints of sleep and circadian rhythms. Recent work from our lab and others has demonstrated a strong rhythm in endogenous metabolites through the course of the 24 h day (i.e. circadian rhythm). Perturbation of these rhythms leads to desynchrony between various biological processes with potential consequences in disease processes such as cancer and/or diabetes and obesity. An important cyclic process is sleep, and we are also interested in the impact of sleep loss and sleep disorders on the metabolome.

There are three general areas in which we work toward furthering our understanding of the connection between the circadian clock, sleep and metabolism and each is a possible area for a student project:

1)   Molecular approaches to understanding chronometabolism in model systems using analytical tools such as mass spectrometry and nuclear magnetic resonance spectroscopy. We are seeking to understand dynamic aspects of metabolism through isotope labeled studies, as well as factors regulating rhythmic metabolism using high-throughput assays.

2)   Human Biomarkers with an emphasis on sleep disorders such as insomnia and sleep apnea in human populations using metabolomics tools. We also have an active project examining lung cancer biomarkers.

3)   Environment, disease the and chronometabolome. We are trying to understand the contribution and perturbation of the chronometabolome via external factors such as environmental contaminants (endocrine disrupting compounds) and disease (e.g. cancer, metabolic disease).

PHYSICAL MEDICINE AND REHABILITATION

Michelle Johnson

fMRI compatible device to Assess Changes in Motor Regions After HIV and Stroke *2nd year applicants only*

Roughly 1.2 million people live with HIV in the United States. Due to successful antiretroviral therapies, the life span of people living with HIV has approached that of the general population, but challenges in HIV management remain (such as HIV-associated non-communicable diseases and neurocognitive disorders, specifically stroke). The Rehabilitation Robotics Lab is exploring ways to develop more effective neurorehabilitation strategies for these populations. We are interested in studying the impact of HIV on stroke recovery using various neuroimaging techniques in conjunction with our robot-based methods. The student on this project will continue the development of an MRI-compatible device that will be used to collect data during test sessions in an 3T MRI scanner. Our goal is to validate the device for safe task-based data collection in the scanner, finalize the motor tasks to be completed in the scanner and complete a small case study. Highly motivated students with an interest in or experience with mechatronics, programming, mechanical design, robotics, and/or bioengineering are encouraged to apply. They will receive direct mentorship from a Ph.D. student and Dr. Johnson and gain valuable experience in robotic applications to human health and working in a clinical setting.

Flavia Vitale

High-resolution, gel-free epidermal bioelectronics leveraging Ti3C2 MXene

Advances in soft, flexible electronics have led to an explosion of wearable sensor technologies which have been transforming the healthcare monitoring and consumer electronics industries in recent years. In the medical realm, epidermal sensors enable critical diagnostics such as: scalp electroencephalography (EEG) for diagnosing epilepsy and sleep disorders; electromyography (EMG) for diagnosing and targeting treatment for muscle spasticity and pain; and electrocardiography (ECG) for monitoring heart function. There remain critical shortcomings in the epidermal electrodes which are currently used for these diagnostics, however. Many are bulky and do not offer high spatial resolution, and nearly all require sticky conductive gels to achieve good electrical coupling with the skin. The conductive gels are particularly problematic, as they can irritate the skin and they dry out over time, significantly limiting long term monitoring capabilities and requiring continual replacement. Our lab has been pioneering the use of a recently discovered 2D nanomaterial, Ti3C2 MXene (pronounced "MAX-ene"), to improve the performance of epidermal sensing electrodes. We have developed a new platform technology which enables high-resolution recording of EEG, EMG, and ECG signals without the need for any conductive gels. In this project, the student will learn basic fabrication skills and will be involved in optimizing new electrode array geometries for different medical applications. This project is intended for a student interested in learning more about neuroengineering and materials science and potentially looking for a longer-term research experience to extend into the academic year. Some prior wet lab or fabrication experience is preferable.

PHYSIOLOGY

Joe Baur

NAD metabolism in mammalian tissues

Nicotinamide adenine dinucleotide (NAD) is a critical cofactor for many enzymes that is derived from vitamin B3. Recently, novel NAD precursors such as nicotinamide riboside (NR) have been shown to protect rodents from a range of diseases and conditions. We are currently exploring the consequences of NAD depletion or supplementation in several conditions with clinical significance, including heart failure and liver regeneration. It is now established that NAD depletion occurs in human heart failure and several mouse models have suggested a protective effect of NAD precursors. 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, with a focus on mitochondrial function. Another condition in which NAD is thought to be limiting is liver regeneration, as it has been proposed that the same precursors are needed for synthesis of both NAD and DNA. Accordingly, we have shown that supplementing the NAD pool by supplying nicotinamide riboside is sufficient to accelerate liver regeneration. We are

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currently using a combination of metabolomics and genetic models to determine which pathways account for the beneficial effect of NAD in the regenerating liver. Together, these studies will reveal fundamental details of how NAD metabolism influences physiology, and will help guide efforts to develop novel therapeutic approaches for the treatment or prevention of diseases associated with obesity and aging.

Toshinori Hoshi

Electrical excitability of cells studied using electrophysiological and computational methods

Opportunities exist to study cellular electrical excitability using electrophysiological methods and/or molecular dynamics computational methods. Our research areas include opening and closing of large-conductance calcium- and voltage-gated potassium channels, studied using the patch-clamp method and molecular dynamics simulations, calcium-dependent anion channels, and pancreatic beta cells.

PSYCHIATRY

Rinad Beidas

Fidelity Accuracy: Comparing Three Strategies (FACTS)

What do therapists in community mental health agencies do in sessions with their youth clients? How can we measure the extent to which therapists deliver cognitive behavioral therapy (CBT), an evidence-based practice, as it is intended to be delivered – in other words, how do we measure fidelity? Project FACTS looks to answer these questions by studying three different methods used to measure therapist fidelity to CBT and assessing which is the most accurate and cost effective. Successful completion of this project will identify accurate fidelity measurement methods as well as factors that can increase their uptake in community mental health settings. This multifaceted study provides those working on it opportunities to learn about a number of topics with cross-cutting relevance, like implementation science, cost effectiveness, community-academic partnerships, and approaching complex topics like therapist-client interaction with both sensitivity and scientific rigor.

In supporting this project, the PURM student would help to prepare for agency visits and process data. They may also have the opportunity to accompany researchers on visits to community mental health centers—a rare and valuable experience for undergraduate students.

Keith Bredemeier

Working memory, repetitive negative thinking, and medication adherence in adults who are HIV+

Disruptions in working memory (the capacity to temporarily store and manipulate information) are well documented in adults who are HIV-positive, but the emotional and functional consequences of these difficulties remain unclear. Based on emerging findings in other clinical studies/samples, we propose that working memory difficulties contribute to repetitive negative thinking (RNT) in HIV-positive adults, and thus may help account the prevalence of anxiety and depressive symptoms (which are elevated) in this population. We also hypothesize that working memory difficulties contribute to difficulties with HIV medication adherence (a salient concern), both directly and indirectly (via anxiety and depression) – a link between working memory and medication adherence has been documented, but the nature and mechanisms involved in this relationship are not clear.

In this study, we plan to recruit a sample of 20 adults (18-65) who are HIV-positive and prescribed antiretroviral medication(s). Participants will complete laboratory assessments at three times points, which will consist of well-validated performance measures of working memory and other domains of neurocognitive functioning, as well as self-report measures of different types of RNT and psychiatric symptoms. Participants will also provide weekly reports of medication adherence. The pilot study will help launch a new line of (HIV/AIDS) research for the PI, building directly on his previous work. Undergraduate volunteers who assist with this project will provide support with preparation of study materials, participant recruitment, and data management. Participation will provide students an opportunity to learn about clinical research, as well as the assessment of anxiety, depression, and neurocognitive functioning.

Mariella De Biasi

The effect of juvenile sugar consumption on the risk of adolescent nicotine abuse

People who initiate nicotine use as adolescents are significantly more likely to develop nicotine dependence than those who begin as adults, thus it is of paramount importance to identify ways to prevent adolescent nicotine use. Like nicotine, sugar activates the mesolimbic dopamine system, a pathway that undergoes extensive remodeling over the course of childhood and adolescence. We propose that consumption of sugary foods during childhood increases the subsequent risk of heavy nicotine consumption in adolescence, and that the effect of highly-palatable substances on cholinergic and dopaminergic signaling in the nucleus accumbens warrants further investigation. We will use a mouse model of nicotine addiction to measure the effect of juvenile sugar exposure on nicotine intake and symptoms of withdrawal. Trainees will work with Dr. Mariella De Biasi and Dr. Jessica Shaw, a postdoctoral researcher, to learn basic laboratory skills (including animal handling, solution preparation, brain dissection, and data collection and analysis) as well as the conceptual underpinnings of their work (neurochemistry of addiction, animal behavior, and adolescent neurodevelopment) and generation of testable

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hypotheses. They will attend weekly De Biasi Lab meetings and receive guidance in reading and evaluating scientific papers, writing protocols, and clearly presenting their results. The trainee may also pursue other skills available in the lab based on interest. All members of the De Biasi lab are committed to education and mentorship, thus the trainee will have the opportunity to engage with scientists with a range of interests and experience. Trainees should be willing to work hands-on with mice.

Philip Gehrman

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

Major Depressive Disorder (MDD) is the most prevalent mental illness. However, standard treatments for MDD typically take at least 2-3 weeks to take effect. An emerging literature suggests that an underlying mechanism of MDD involves impaired neuroplasticity and that increasing synaptic potentiation can produce rapid antidepressant effects, observed with Ketamine and during sleep deprivation. The overall goal of this project is to test the hypothesis that disrupting slow-wave sleep can enhance synaptic potentiation, thereby increasing plasticity, and improving 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. Undergraduates will receive training in several areas of sleep research including but not limited to, how to administer a hearing test, how to administer study surveys using the online resource, RedCap, how to administer the neuroplasticity task battery and waking EEG task, thereby becoming familiar with using the E-prime software suite. Students will be responsible for administering and explaining the use of sleep diaries and actigraphs to all participants, and for determining adherence using these methods. Undergraduates will also be involved with the facilitation of the project by performing operational tasks including orienting all participants to HUP and the sleep lab, testing study equipment to ensure appropriate operation during the protocol, and the removal and cleaning of EEG electrodes following the study overnight. At the end of the undergraduate's time in the lab, they will have a keen understanding of the essential components of conducting sleep research, and working with clinical populations.

There will also be several opportunities for optional training. For example, although sleep techs in the sleep lab will be responsible for applying EEG electrodes for overnight sleep recording, there will be an opportunity for undergraduates to learn how to apply EEG using the international 10-20 system for electrode placement. Undergraduates will also be able to observe the administration of transcranial magnetic stimulation (TMS). We will also have several opportunities for students who are highly motivated to be involved in the more advanced stages of research including data analysis and dissemination. We can provide mentorship opportunities where students can learn to develop their own independent research question, and perform data analysis using study data.

Jennifer Goldschmied, PhD, junior faculty in our lab, will provide day-to-day mentorship of all undergraduates.

Melanie Pellecchia

Parent Empowerment and Coaching in Early Intervention (PEACE)

The PEACE project uses community-partnered participatory research methods focused on developing a toolkit of implementation strategies designed to improve the use of parent coaching for families of young children with autism spectrum disorder served within the Philadelphia early intervention system. The PEACE project includes direct field observations of usual practice during early intervention sessions within families homes, qualitative interviews with early intervention providers, and families, and collection of survey data to gather information about barriers and facilitators to using parent coaching within early intervention.

Undergraduate student primary duties include behavioral coding of observational videos, qualitative coding of interview transcripts, and data entry. Opportunities to participate in field observations and to assist in qualitative interviews may also be available. Students will gain experience in using mixed-methods research and community-partnered participatory research design.

Candidates should be working toward a bachelor's degree in health and societies, psychology, sociology, or a related field. Candidates should have proficiency in computer skills, including Microsoft Office programs. Interest in children's mental or developmental health, autism, Nvivo or other similar qualitative coding software, and a desire to work in research is preferred. The student should be organized, professional, and hard-working.

PULMONARY, ALLERGY, AND CRITICAL CARE MEDICINE

Brian Anderson

Factors associated with neurologic impairment following sepsis in the Medical Intensive Care Unit

This project is a great opportunity for students who wish to experience clinical research. Students will gain experience in both clinical and translational ("bedside to bench") research and obtain a basic understanding of sepsis (a severe form of infection) in the Medical Intensive Care Unit (ICU). Working alongside members of the Molecular Epidemiology of SepsiS in the ICU (MESSI) cohort study (see below), students will experience clinical cohort operations and testing associations in an observational setting.

The focus of this project is to determine clinical and molecular risk factors for sepsis outcomes, with a specific focus on delirium and long-term cognitive impairment. Delirium is an acute disturbance in neurologic function, sometimes referred to as acute brain dysfunction, and is associated with an increased risk of mortality. About 1 in 4 sepsis survivors will suffer from longer tem cognitive impairment that is similar to dementia. Assessing delirium at the bedside involves interacting with critically ill patients to gauge their attentiveness and their cognition with a simple set of commands and questions called the Confusion Assessment Module adapted for the ICU (CAM-ICU). A second cognitive scale termed the MOCA – Montreal Cognitive Assessment test – is administered close to hospital discharge to understand patient's cognition after they recover from the acute infection.

Students will be taught to extract key information related to the patient's infection, medical history, physiologic state, and response to treatment while in the ICU from the medical record and to record this information in a computerized database. If students show interest and ability, they will be trained to administer the CAM-ICU and MOCA for direct patient interaction. Students will also assist with chest X-ray reading and attend lab meetings to discuss ongoing projects, analyses, and manuscripts in progress. Prerequisites: Students should be enthusiastic about working with critically ill patients and their families; professional and adherent to patient privacy standards, and interested in clinical/translational research.

If a more molecular project is desired, our lab also has opportunities to accommodate testing plasma proteins, RNA expression patterns (from circulating white blood cells), or genetic variants (DNA) for association with sepsis outcomes, including delirium/cognitive impairment, respiratory failure/acute respiratory distress syndrome, acute kidney injury, or survival. The skills obtained from this experience will include: RNA extraction from whole blood; ELISA, Multiplex (MSD) protein quantification, and Bradford technique protein quantification, and potentially Western blotting for qualitative protein identification. As the project progresses, there may be additional opportunities to learn techniques like real time PCR for mRNA quantification or for immunohistochemistry. Prerequisites: Students should be interested in translational research and should have completed college-level chemistry. Prior laboratory experience is

preferred but not required. Students will need to adhere to standards for handling of biologic fluids and for maintenance of patient privacy.

Molecular Epidemiology of SepsiS in the ICU Cohort Members involved in student mentorship:

Brian Anderson, MD, MSCE
- Assistant Professor and Associate DIrector of the HUP MICU
- Research Focus: Molecular mechanisms of delirium and long-term cognitive impairment in sepsis
- https://www.pennmedicine.org/providers/profile/brian-anderson

Nuala Meyer, MD, MTR
- Associate Professor and Director of the Center for Translational Lung Biology
- Research Focus: Molecular mechanisms of the Acute Respiratrory Distress Syndrome (ARDS), Clinical Trials in Sepsis and ARDS
- https://www.pennmedicine.org/providers/profile/nuala-meyer

Michael Shashaty, MD, MSCE
- Associate Professor and Director of the HUP Rapid Response Team
- Research Focus: Molecular mechanisms of Acute Kidney Injury in sepsis, severe trauma and lung transplantation
- https://www.pennmedicine.org/providers/profile/michael-shashaty
-
John Reilly, MD, MSCE
- Assistant Professor
- Research Focus: Molecular mechanisms of ARDS, Pollution and Lung Injury, Clinical Trials in Sepsis and ARDS
- https://www.pennmedicine.org/providers/profile/john-reilly

Joanna Hart

Reducing disparities in family-centered critical care

This project addresses health disparities in the delivery of critical care (inpatient intensive care) specifically focused on prior traumatic experiences. This would be particularly relevant for students interested in a career in medicine, psychology, health policy, education, the social sciences, and other related fields. The research student can expect mentoring and hands-on skill development in research methods including but not limited to literature review, study design, enrollment of research participants, and analysis of qualitative and quantitative data. This is a project that would involve direct communication with clinicians (e.g., doctors and nurses) and patients' family members. The student can expect authorship and presentation opportunities with appropriate contribution to the project.

Trauma can take many forms, including but not limited to physical or sexual abuse, neglect, living in a home with others suffering from mental illness or substance abuse, experiencing

parental separation or incarceration, and witnessing the violent treatment of others. Although traumatic events occur in all racial, geographic, and sociodemographic groups, such experiences are most prevalent in low-income communities that have high rates of violence, substance abuse, and loss. Traumatic exposures have been particularly described in urban Black communities and the prevalence of trauma may be under-recognized in rural communities, leading to a disparate burden of trauma among vulnerable populations. We hypothesize that a lack of recognition of and response to the challenges traumatized individuals face perpetuates disparities in critical care delivery and outcomes. Given the tremendous potential for critical illness to cause primary and relived trauma, we aim to further investigate the role of trauma in critical care communication and decision making, including as a potential mechanism for well-described racial disparities in critical care outcomes.

We will estimate the prevalence of prior trauma among family members of critically ill patients. We will also conduct and analyze semi-structured interviews among critically ill patients' family members and clinicians focused on the decisions to restrict family-centered critical care practices to specific family members.

The Palliative and Advanced Illness Research Center's mission is to generate high-quality evidence to advance health care policies and practices that improve the lives of all people affected by serious illness. We have a dedicated educational director who coordinates and supports students working with our faculty members, enhancing the summer research experience and helping them access our broader intellectual community.

Nilam Mangalmurti

How do red blood cells contribute to host defense during sepsis?

At over 30 trillion cells in circulation, RBCS are the most abundant circulating cell. While RBCs are in continuous contact with circulating pathogens and inflammatory mediators, their role in regulating the innate immune response is unknown. My lab studies how RBCs regulate immune responses during inflammatory states. Sepsis, the dysgregulated host response to infection, is the leading cause of death in US hospitals. Currently, besides antibiotics, there are no other therapies for sepsis. We have recently found that RBCs express a receptor (TLR9) that may be important in regulating the inflammatory response during infection. The goal of this project is to understand how TLR9 on RBCs alters the immune response during sepsis. We will use in vivo mouse models of sepsis, human red cell specimens and cultured erythroid progenitor cells to better understand how TLR9 on red blood cells may give red cells immune function.

Undergraduates interested in working on this project will learn basic lab tasks such as cell counting, cell isolation from human and murine whole blood, PCR and ELISA. Undergraduates interested in bench based disease oriented research and a career in medicine are encouraged to apply.

RADIOLOGY

Abass Alavi

Evolving Role of Molecular and Structural Imaging in Modern Medicine

I conduct research in almost in all disciplines in medicine by utilizing the most advanced imaging techniques such as MRI, PET and CT. My lab is particularly interested in quantifying disease activity by very advanced segmentation techniques. By adopting structural imaging techniques like MRI and CT along with molecular imaging methodologies (PET), we are able to assess and characterize many serious diseases that we face in medicine at the molecular and cellular levels. Such diseases include cardiovascular disorders, cancer, brain dysfunction including dementias, infection, inflammatory disorders, and age-related abnormalities.

Currently, our discipline is judged as being the most exciting domain for research for the foreseeable future. We are able to use some hard core sciences such as physics, math, chemistry and biology to detect disease at its earliest stage and also discover the most effective therapeutic interventions for future management of patients.

Ongoing and potential projects include:

1. PET-Based Assessment of Radiation Therapy Induced Pulmonary inflammation and Vasculitis
2. Detection of Cognitive Impairment Due to Cerebrovascular Disorders by Advanced PET Imaging techniques
3. Advanced PET-CT imaging Methodologies to Examine Musculoskeletal Injuries
4. Evolving Applications of PET/CT-Based novel imaging techniques to assess and quantify atherosclerosis in Major and Coronary arteries
5. Novel imaging Schemes for Accurate Quantification of Disease Activity in Hematological Malignancies
6. Detection and Characterization of Atherosclerosis in Patients with Cancer
7. Detection and Characterization of Atherosclerosis in Patients with Inflammatory disorders psoriasis and Rheumatoid Arthritis
8. Critical Role of PET in quantitative measurement of Bone and Muscle metabolism in Health and Disease

Requirements: I prefer students with backgrounds in biology, chemistry, physics and computer sciences. The students take the primary responsibility for conducting these projects but work very closely with the faculty assigned to her/him while working in the lab.

Peter Noel

Advancements in Biomedical X-ray Imaging

Phase-contrast and darkfield x-ray imaging are novel contrast mechanisms that have the potential to significantly improve lung diagnostics. Based on our recent developments (https://doi.org/10.1038/s41598-017-05101-w / https://doi.org/10.1038/s41598-017-06729-4), we are currently building a next-generation x-ray interferometer. Our tasks for setting up the bench-top focus on hardware and/or software development in the following ways:

1. Hardware. Design, fabricate, and assemble a component for an imaging prototype. Work with CAD models and 3D printing facilities.

2. Software. Develop, implement, test, and integrate an algorithm for system control or image post-processing.

The focus of the project can be adjusted toward tasks 1 or 2 depending on student interest. Students will be mentored by the PI as well as senior researchers. Students with little or no background in biomedical imaging, but with interest in learning, are highly encouraged to apply. Students will gain experience in basic research in biomedical imaging while experiencing the workings of an interdisciplinary research team with close industrial collaborations.

 Dr. Noël is committed to developing next-generation x-ray and computed tomography solutions to provide clinicians with information that exceeds present clinical standards. His primary research interests include spectral imaging with photon-counting detectors, advanced x-ray tube concepts, phase-contrast and darkfield imaging, reconstruction approaches, and the clinical translation of advanced technologies. His work has found application in oncology, pulmonary disease, cardiovascular disease, and osteoporosis screening.

Chamith Rajapakse

Radiology Applications in Orthopaedics, Surgical Planning, and Artificial Intelligence

Multiple projects involving medical imaging (MRI, CT, and PET) in the following technical areas are available: personalized medicine, surgical planning, image analysis, artificial intelligence, 3D printing, biofabrication, and cell culturing. Disease specific projects involve: osteoporosis, osteoarthritis, atherosclerosis, HIV, HCV, kidney disease, oral disease. No experience is needed and training will be provided. Preference will be given to students intending to apply for medical school and/or academic careers and who are interested in continuing the research beyond summer.

Hersh Sagreiya

Hepatic Fat Quantification Using Machine Learning

Chronic liver disease related to nonalcoholic fatty liver disease (NAFLD) is a crucial global health problem, affecting over one billion people worldwide. While radiologists use ultrasound to assess for fatty liver, or hepatic steatosis, the current approach is neither reliable nor quantitative. While MRI is more accurate than ultrasound, it is far more expensive. Traditional ultrasound is inexpensive, portable, and real-time. Deep learning has recently gained prominence as a tool to discover subtle features for image recognition and classification, sometimes exceeding human performance. This project will use traditional ultrasound images as inputs to a convolutional neural network to predict MRI-based fat quantification. In addition, the Penn Medicine Biobank has significant genomic data available. Imaging features could potentially be linked to genetic and clinical data through genome-wide association studies and phenome-wide association studies. This could offer greater insights into disease development and potentially identify drug targets. Especially with the development of portable ultrasound probes, physicians in the future could quantitatively monitor hepatic fat content with the simple sweep of an ultrasound probe, revolutionizing disease management.

In working on this project, you will have the opportunity to develop skills with machine learning and deep learning, powerful skillsets for both academic work and job opportunities in the coming decades. You will also have the opportunity to learn more about medicine if that is a career interest. Computer science skills are a plus (i.e. at the level of introductory computer science/AP Computer Science), although students of all backgrounds are welcome to apply.

Ronnie Sebro

Evaluating the role and impact of artificial intelligence on the practice of medicine

Artificial intelligence (AI) promises to revolutionize the way medicine is practiced. The goal of this short project is to evaluate how AI has affected different fields in medicine, and based on these changes, predict how AI may affect medicine in the future. The student is expected to know very little about artificial intelligence, but will learn about AI (not programming) and engage in primarily a literature review. This will be a good project for someone considering a career in medicine.

SLEEP MEDICINE

Sigrid Veasey

Lasting effects of sleep disruption on peripheral systems health

Our lab has demonstrated that chronic short sleep and sleep fragmentation can result in lasting injury including degeneration in select groups of neurons. We are now turning our attention to address the effects of sleep disruption on peripheral organ health and metabolics. We propose that sleep loss induces lasting alterations in peripheral clocks and these changes result in injury patterns consistent with the health risk of shift workers: obesity, hypertension, atherosclerosis, fatty liver disease and insulin resistance.

We will use mice with luciferase driven by the clock gene, Period 2, to examine the effects of sleep loss on peripheral circadian rhythms, and we will model these rhythm changes in normal mice to determine whether disturbed peripheral clocks induce injury consistent with shift work injury. Finally, we will use several feeding and gut microbiota strategies to improve peripheral rhythms and then determine whether we can reverse pathophysiology.

SURGERY

Pavan Atluri

Spatio-temporal pattern of RV and LV t-tubule dysregulation in a model of ischemic heart failure

Heart failure therapies have undergone massive changes in recent times, one of the most significant of which is the use of mechanical circulatory support (artificial heart pumps) as a means of inducing cardiac recovery. Left ventricular assist devices take blood from the left ventricle and transmit it to the ascending aorta, relieving the workload of the left heart and supporting the circulation. It was discovered that in selected patients, these devices can be used to recover cardiac function. The mechanisms of how this happens could lead to new therapeutic targets. We have an animal model of heart failure and cardiac recovery and are examining protein expression of key calcium handling proteins and proteins which regulate cell structure, to correlate with physiological changes at the organ level. Specifically, the student would be involved in a project examining protein expression changes related to calcium handling in a model of heart failure and recovery. We hope that by determining which proteins change and when, we can open the door to new experimental models of targeting heart recovery. Ideally, the applicant will have some experience with basic lab techniques. Techniques involved in this project include microscopy, western blots and echocardiography. We will support the student in developing critical scientific skills including critical reading of the literature, experimental

technique, data analysis and scientific writing. Dr. Michael Ibrahim will be the primary scientific director and mentor.

David Lee

MRI analysis of pelvic anatomy to predict outcomes after robot prostatectomy

The project that we propose for undergraduate research work on this summer under the scholarship would be attempting to establish 'normal' pelvic anatomy in relation to the individual pelvic floor muscle layers, prostate anatomy and bladder anatomy by computer learning via MRI pelvis anatomic data. This work requires initial manual segmentation of pelvic anatomy. We propose that the selected student would be primarily responsible for this segmentation. This work would be done in conjunction with Dr. Drew Torigian who is an expert in the field of MRI and development of models that distinguish between normal and variant anatomy and Dr. David Lee who is a high-volume robot prostatectomy surgeon.

We would query the existing robot prostatectomy database at Penn to capture 50 patients who had a preoperative MRI, postoperative MRI and well captured quality of life data. These images would then be downloaded from the MRI servers and anonymized. After conversion into the applicable form, these scans would be segmented by the selected student thereby helping to establish the 'normal' anatomy parameters in regard to relationships, thicknesses, and tissue characteristics. An established method will be applied by Dr. Torigian to extract a few features that are most potent in distinguishing good outcomes from bad outcomes by a computer learning method.

We would then use this training set in order to use predictive testing models to validate these findings.

This work has the potential to aid in patient outcomes and counseling of patients preoperatively. We would train the students on the process of MRI segmenting and construction of the database to correlate the MRI findings and the quality of life outcomes data. The student would also be involved in the data analysis and preparation of abstracts for presentation and manuscripts for publication.

Mark Seamon

Long Term Outcomes after Severe Injury: What Happens to Our Survivors?

Millions of Americans survive injuries each year. In 2015, 2.8 million injured patients were hospitalized and another 27.6 million were treated in emergency departments. By impacting large numbers of young people, trauma is a leading cause of disability that results in more disability-adjusted life years lost than any other disease process. The economic burden of injury is equally overwhelming. Of $671 billion in estimated injury costs accrued in 2013, $457 billion were attributed to injury survivors. Despite these survival, disability and economic statistics,

remarkably little is known about how injuries such as gunshot wounds or car crashes impact patient lives after leaving the hospital. This knowledge and patient care gap must be addressed to improve the recovery and lives of millions of Americans.

In this project, we will assess how injury affects physical, mental and social health recovery one year after injury. We will evaluate patient reported outcome measures in injured adults requiring hospital admission prior to hospital discharge as a baseline, then by phone 6 and 12 months after hospital discharge. We will use validated survey tools to assess recovery including physical function (how well can our patients walk, perform activities of daily living, etc.), mental health (PTSD, depression, sleep, etc.) and social health (drug and alcohol use, employment, spending time with others, etc.). Learning how patients' lives are impacted after injury will provide the best opportunity for the initiation of long-term preventative, longitudinal, patient centered care to improve physical, mental and social health recovery after injury.

Interested students will have some patient contact through the administration of long term outcome survey tools. Students will be directly supervised by myself and will have regular contact with other study personnel including Joy Steele (Trauma Research Coordinator) and Elinore Kaufman (Trauma Fellow). We will assure that students involved in all aspects of the project including data collection, data analysis, and data reporting through scientific presentation. Students will also have contact with Trauma and Surgical Critical Care fellows, surgical residents, medical students and nurses during data collection. Opportunities to shadow or scrub in the OR will be available to those interested.

Arun Srinivasan

Disparities in the incidence of End Stage Renal Disease in children with congenital urological anomalies

We are seeking a highly motivated student to assist with research involving children and youth affected by complex urological conditions and its relationship to kidney failure. We would aim to look at health care quality and quantity metrics and disparities of care within such metrics. Goal is to improve access of health care and identify specific quality metrics to improve and follow.

The student will have an opportunity to participate in a number of different types of research projects including systematic reviews of the literature, assisting with data collection, management and analysis and preparing abstract submissions and helping with manuscripts.

 The student will develop skills with literature searches and review; IRB, manuscript, or presentation preparation; patient tracking; and data collection, entry, management, analyses, and interpretation. The clinical research assistant may have the opportunity to submit and present their work at conferences and to participate in preparation of publications.

This student will have the opportunity to attend professional development workshops available to all CHOP research personnel like advanced Excel, R software and REDCap training. They will

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be able to attends all pediatric and surgical grand rounds presentations. There is also ample opportunity to immerse oneself in the field of pediatric urology by attending weekly radiology conferences where attending physicians discuss complex patients with various teams in the hospital as well as observe in the operating room and clinic. This position may be a particularly good fit for students seeking additional clinical research experience in preparation for future graduate study in clinical psychology, pediatric psychology, public health, or medicine. Research assistants must be extremely detail oriented, organized, and able to uphold ethical standards for the conduct of clinical research.

Hansell Stedman

Towards a Cure for Muscular Dystrophy

2019 was an exciting year in this field with three companies reporting early results of first-in-man gene therapy trials for the common and severe disease Duchenne muscular dystrophy (DMD). However, the reports revealed evidence for potentially severe immune responses to the gene therapy vectors, with some patients developing acute illnesses requiring intensive care uint admissions. My lab has focussed on methods to improve the safety profile of potentially curative biological therapies for DMD by minimizing or altogether eliminating the immune response. The student projects offer an opportunity to contribute to rapid progress in the field through immersion in a lab environment with ongoing basic and translational studies using a variety of model systems (see e.g. Song, Y, Malik, A, Morales, L, et al, Stedman HH. (2019) Non-immunogenic utrophin gene therapy for the treatment of muscular dystrophy animal models. Nature Medicine, 25: 1505-1511. Featured in News and Views editorial by Kay Davies and Jeffrey Chamberlain, Nature Medicine 25: 1473-1474). The materials and methods in this paper provide an overview of the many technologies we routinely use in the lab. We are looking to engage two students. If you have any questions I would be delighted to provide more information in response to emails to hstedman@pennmedicine.upenn.edu

TRANSLATIONAL NEUROSCIENCE

Gregory Corder

Uncovering the brain neural circuits of pain perception and emotion

The Corder Lab (Department of Psychiatry and Department of Neuroscience) is looking to work with highly motivated students that are interested in gaining lab experience and assisting with a cutting-edge neuroscience project to use a combination of genetically engineered mice and fluorescent viruses to discover the brain cells that encode our perception of pain and negative emotions.

The mission of the Corder Lab is to decipher the neural basis of how the brain generates the experience of pain, and how pathological changes within these brain networks promotes the transition to chronic pain and drug abuse. Using advanced in vivo imaging of neural activity, neuroanatomical tracing, and optical neuromanipulation techniques, in rodent model systems, our group continues to deconstruct the brain circuits and molecular mechanisms involved in pain and pleasure. From our lab's investigations, we aim to identify translational targets for developing novel treatments that reduce the mental health disorders associated with chronic pain and addiction to opioid drugs.

Students will have an opportunity to be a part of a young and dynamic lab, and to gain experience in advanced neuroscience techniques, including viral-assisted neural circuit mapping, stereotaxic brain surgery, tissue histology and immunohistochemistry to visualize fluorescent proteins in neurons, and laser-confocal microscopy. Students pursuing, or intending to pursue, degrees in biology, neuroscience, psychology, or other medically related fields are encouraged to consider these projects. We also encourage students with electrical engineering or computer science backgrounds who are interested in the crossroads of neuroscience and engineering to uncover how brain circuits excel at extracting information from our senses to come work with us. Experience in MatLab / Python / R / TensorFlow or other deep learning platforms is desired for some projects. A willingness and/or comfort working with mice is required.

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

Matthew Hayes

Brainstem endocannabinoids: Modulation of Feeding and Anxiety-Related Behaviors

My lab is a behavioral neuroscience lab studying obesity, food intake and body weight control. We utilize a rodent model to investigate the novel neural pathways in the control of appetite. In particular, this project focuses on the endocannabinoid system. We will investigate whether the brainstem is involved in the ability of cannabinoids to increase food intake and whether it is dependent on the type of diet (i.e. highly palatable, high fat, high sugar diet) or weight status (obese vs. lean). Importantly, stress and anxiety are often associated with changes in food intake, often binge-like behavior. Therefore, we will investigate whether manipulation of the cannabinoid system can prevent stress-induced over-eating. Students will get involved in numerous aspects of research including behavioral, physiologic, endocrine and molecular analyses, data entry and analysis, etc., and will have the opportunity to gain exposure to rodent surgical techniques. Students on this project will work closely with a post-doctoral fellow in my lab, Dr. Lauren Stein. This project has the potential to apply machine learning technology to develop predictive models for the interrelationship between anxiety-like behaviors of obesity. Students will gain some introductory experience with R, MATLAB, and Python programming language.

WEIGHT AND EATING DISORDERS

Rebecca Pearl

Behavioral Weight Loss and Stigma *2nd year applicants only*

The Center for Weight and Eating Disorders is seeking summer students to work on studies relating to psychosocial aspects of obesity and weight loss. The students will primarily work on a weight loss clinical trial testing a psychological intervention to help patients with obesity cope with weight bias and stigma.

The students' duties may include: data entry and verification; data management; coding of qualitative data; organization of study materials and documents; attending treatment group meetings; interacting with patients; and other tasks as assigned. This position will provide an excellent introduction to clinical research if students are interested in pursuing careers in medicine, psychology, public health, nursing, social work, or related fields.

Experience in clinical or social science research is preferred. Coursework in psychology, social work, public health, medicine, nursing, or similar fields is a bonus. Experience with Redcap and/or data management is also helpful but not required. Most importantly, the ideal candidate is self-motivated, able to work and problem-solve independently, flexible, and professional.

Jena Tronieri

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

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

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

The students' training activities may include: conducting phone screening interviews with potential study participants (including collection of medical and psychiatric history); assisting with patient assessments (behavioral and biological testing) and appointment check-ins;

attending weekly study team meetings to learn about the workings of clinical research; gaining exposure to study measures, assessment procedures, and data management; and opportunities for direct observation of medical assessments and behavioral treatment visits. The students will receive direct mentorship from Dr. Tronieri in clinical research, obesity medicine, and cognitive and behavioral treatments. Students also are invited to attend and participate in center-wide lectures and research presentations. Previous coursework in research methods, psychology, public health, medicine, nursing, social work, epidemiology, or similar fields is preferred but not required.

Nursing

BIOBEHAVIORAL HEALTH SCIENCES

Ariana Chao

Food for Thought: A Randomized Controlled Trial Examining the Neurocognitive Benefits of Weight Loss

The purpose of the present study is to conduct a randomized controlled trial (RCT) to assess the effects of a commercially available weight loss program (WW; formerly Weight Watchers) on neural response to food cues and memory tasks, as well as on structural brain morphology. Participants with obesity will be randomized to either 16 weeks of an in-person, group-based WW program (n=30) or a wait-list control (WLC; n=30). Both groups will have structural and blood oxygen level-dependent (BOLD) functional magnetic resonance imaging (fMRI) scans at baseline and after the 16-week intervention. Participants will complete the following fMRI tasks: 1) structural scan; 2) food cue task to measure reactivity to high and low-calorie food images; and 3) N-back task to measure working memory (i.e., the ability to temporarily hold information available for processing). In addition, participants will complete self-report and behavioral measures of eating behaviors, appetite, physical activity, mood, quality of life, attention and memory at baseline, and weeks 8 and 16.

Responsibilities would include: assisting with fMRI visits and cognitive assessments; conducting phone screens; assisting with study visits; completing data entry; observing obesity treatment sessions; helping with participant recruitment; drafting manuscripts and presentations.

Mary Ersek

Palliative Care Consultations for Older Adults in the Medicare Skilled Nursing Facility (SNF) Setting

Palliative care is goal-directed, patient and family-centered care that focuses on a wide range of physical, psychosocial, and spiritual needs for persons with serious, life-limiting illnesses. Despite its association with improved quality of care, higher satisfaction, and better symptom management at the end of life, palliative care is not widely available to Medicare patients in the Skilled Nursing Facility (SNF) setting. This NIH funded clinical trial will test an evidence-based palliative care intervention derived from existing standards for older adult SNF patients in nursing homes.

Student duties and responsibilities: (1) attend weekly research team meeting (review participant screening and enrollment, data collection, study progress), (2) assist research assistant in tracking

data and identify missing data in RedCap, (3) actively carry out scholarly activities (update literature search, manage references, outline trial protocol manuscript under direction of PI)

Academic and professional skills, experiences, and benefits a student would derive from working on the project: training in clinical trials, refining research procedures, testing a clinical intervention in community settings, and opportunities to work on manuscript development and possibility for publication.

Student Prerequisites: Biomedical CITI training, Good Clinical Practices Training, word processing and computer skills.

The project principal investigator, Joan Carpenter, PhD, CRNP, also will be involved in mentoring the student. Dr. Carpenter is a nurse scientist and maintains as active clinical practice in geriatric palliative care. She will meet with the student each week to guide the student's study activities, oversee progress, and provide education and mentorship in nursing science.

Nancy Hodgson

The Role of Palliative Care Interventions to Reduce Circadian Rhythm Disorders in Persons with Dementia

This project has three aims:

1. The immediate (at 1 month) and sustained (at 4 months) effect of the Healthy Patterns activity intervention on Persons with Dementia (PWD) quality of life and Circadian Rhythm Disorder (CRD) symptoms.

> Hypothesis 1a. Compared to control group participants, PWD receiving the intervention will demonstrate quality of life, total sleep time, nocturnal wake after sleep onset, day/night sleep ratio, and neuropsychiatric symptoms at 1 month.

> Hypothesis 1b. Compared to control group participants, PWD subjects receiving the intervention will demonstrate quality of life, total sleep time, and neuropsychiatric symptoms at 4 months.

2. The immediate (1 month) and sustained (4 months) effect of the Health Patterns activity intervention on caregiver outcomes.

> Hypothesis 2a. Compared to control group participants, caregivers who have received the intervention training will demonstrate quality of life, burden, confidence in using activities, and sleep disruption at 1 month.

> Hypothesis 2b. Compared to control group participants, caregivers who have received the intervention training will demonstrate quality of life, burden, confidence in using activities, and sleep disruption at 4 months.

3. The mediating effect of neuroendocrine activity on changes in CRD symptoms.

Hypothesis 3. CRD symptoms will be mediated by changes in diurnal cortisol from baseline to 1 month.

The mentee will learn the following skills: 1) complete training in human subjects research; 2) learn principles of clinical research; 3) learn to use data capture software (REDCap); 4) develop interpersonal skills with older adults suffering from dementia; 5) conduct literature reviews and contribute to grants and publications.

Other individuals involved in mentoring: Laurel Caffeé and Sonia Talwar (Project Managers)

Lea Ann Matura

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

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

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

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will find the treatments easy to use and helpful. We expect that Cognitive Behavioral Therapy and Bright Light Therapy will improve insomnia, fatigue and physical activity levels compared to the usual pulmonary arterial hypertension care.

The student will need to complete the CITI human subjects training.

Student duties include assisting with subject enrollment. Assisting with preparing study materials for enrollment (actigraphs, questionnaires). Assisting with data entry.

The student should have good communication skills and an interest in clinical research.

This project will introduce the student to clinical research including aspects of a clinical trial.

Heath Schmidt

Neuroscience of Drug Addiction

The overarching goal of this project is to elucidate the role of novel neuropeptides in animal models of drug addiction. Our research program aims to understand how chronic drug exposure (i.e., cocaine, opioids, and nicotine) changes the brain to produce compulsive drug taking and relapse. To this end, we use a multi-disciplinary approach that incorporates behavioral pharmacology, molecular biology, neuroanatomical tracing, immunohistochemical and epigenetic methods to identify molecular substrates that could be targeted to prevent craving-induced relapse in humans with substance use disorders. The ideal candidate/student should have a background in biology with an introduction to neuroscience. The student will be working in a collaborative environment and, therefore, will be expected to act in a professional and respectful manner. A willingness to work with rodents (primarily rats) is a must. Responsibilities include assisting with intravenous drug self-administration experiments, jugular and intra-cranial surgeries, immunohistochemistry, histology, microscopy and animal husbandry. In addition to these technical skills, the student will also build a foundation of intellectual knowledge by learning how to critically evaluate the literature, formulate hypotheses and analyze data. The student will present papers and their original research at weekly lab meetings and in doing so gain confidence in their oral presentation skills. Successfully completing this project may result in an invitation to join the lab on a more permanent basis.

FAMILY & COMMUNITY HEALTH

Dalmacio Flores

The G.I.S.T (Gender Identity and Sex Talks) Program

This study will collect qualitative data from dyads of parents and their transgender adolescents to inform the development of much-needed HIV/STI prevention interventions for transgender

youth. Parents are underutilized HIV/STI prevention agents for sexual and gender minority adolescents. With transgender adolescents living at home, parents are optimal HIV/STI prevention educators because they are able to reach youth early to provide sequential and time-sensitive information that is responsive to the child's questions and anticipated needs. Unlike their cisgender peers who are socialized into their gender and sexual roles during adolescence, dominant hetero- and cis-normative structures do not encourage the sexual socialization of transgender adolescents. Thus, negative health outcomes, such as HIV and STI infections, continue to disproportionately impact this population despite targeted public health efforts. Because more children are disclosing to their parents of being transgender at younger ages and there is growing parental acceptance of transgender children, it is important to explore the potential of transgender-focused parent-child sex communication, defined as the bi-directional discussions between parents and their children about sex and health-related topics, as a home-based HIV/STI prevention intervention. This study will inform the development of a dyadic, family-based, transgender-focused parent-child sex communication intervention. Through one on one interviews, focus groups, card sorts, and theater testing, key barriers and facilitators to inclusive parent-child sex communication will be identified.

Undergraduate researchers assisting with the G.I.S.T Program will receive training in data clean-up and qualitative data analysis using the software NVIVO. Students will work closely with the research team develop the following skills:

- to code interview transcripts and generate categories, study thematic patterns in participants' responses
- to become familiar with data management and conducting a literature review
- to prepare conference presentations and publish with the research team
- to assist/facilitate in focus groups involving parents and transgender 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.

Melanie Kornides

Teens' views of HPV vaccine found in social media

In this project, you will work with Dr. Kornides to evaluate posts from adolescents found in different social media sources (for example, Youtube and Instagram) for the content about HPV vaccine. You will evaluate each post and enter information about the post into a data extraction tool we will develop together. You will work with Dr. Kornides to analysis the findings, including compiling a list of common themes found across posts, and enter them into tables for publication. You will be included as a co-author on the paper produced and have the option to submit the findings as an abstract at a conference. Academic and professional skills you will gain include experience with qualitative data coding, data extraction, preparation of results for publication, and content expertise in HPV vaccination. The project is an exciting opportunity for a student interested in any of the following: adolescent health, vaccination, anti-vaxxers, public

health research using social media, reproductive health, and cancer prevention. No prior research experience is needed!

Jianghong Liu

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

My overarching research aims to understand how early health risk and protective factors impact sleep health, emotional, and behavioral development in children and adolescents, why this occurs, and what measures we can take to enhance development. Factors include prenatal/postnatal risk factors, early nutrition, and environmental exposure and sleep behavior.

Currently our team has several ongoing projects. The student will conduct extensive literature searches, read, analyze published literature, and make a synthesis on the following relevant topic. The student should have good organization ability and effective communication skills. They are comfortable working independently and in a group setting. Training will be provided.

Project 1: Nutrition and sleep

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

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

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

Project 3: Early health factors on adolescents' positive psychology

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

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

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

Social Policy and Practice

NONPROFIT MANAGEMENTAND LEADERSHIP

Femida Handy

Labour Force Participation and Volunteering Trends *2nd year applicants only*

There is considerable interest in the decline in labor force participation in the US especially among less educated prime-age adults. We examine if there is also a decline in the supply of social capital, more specifically volunteering, amongst the population and more generally different groups in the with differing employment status across the demographic and socio-economic characteristics

The primary data being used comes from The American Time Use Survey (2003-2019) which collects its data using surveys. It is a robust survey because it takes into account the fact that there exists a decline in response rates according to volunteer rates, which may bias trends. The survey is taken by asking participants what they were doing during the 24 hours range before the survey was taken and categorizing these activities accordingly.

The student's role in this research project is cleaning and analyzing this dataset using R. By creating time series, this dataset sheds light into the trends over the past two decades in the change of volunteer rates amongst different demographic and socio-economic groups. These trends help us investigate how volunteering time in the ATUS responds to the business cycle and other macroeconomics factors. By also creating different regressive models, the same dataset also shows which factors, such as education or immigration status, could impact the volunteer rates amongst these groups.

So far, the data indicates that there is a statistically significantly greater count of those who volunteer who a have bachelor's degree or above in comparison to those who do not. However, the average hours that they dedicate to volunteering is significantly less than those whose educational level is less than a bachelor's degree. The same data indicate similar trends for those who are in employed versus those who are not. Our initial hypotheses suggests that those with higher educational qualifications (such as college or university degrees) and who are employed, are more actively engaged in volunteering as they are equipped with more resources and have greater incentives to do so. However, because they have limited hours available to volunteer and the marginal benefit to volunteering decreases quickly, the number of hours they volunteer is small.

SOCIAL WORK

Amy Hillier

Gender Identity and Commute to High School

This pilot study will put qualitative methods and geospatial technologies into dialog through an investigation of the daily commute to public high schools of students across gender identity and race/ethnicity. Our previous qualitative research with transgender students in Philadelphia highlighted their experiences with mis-gendering, homophobic and transphobic language, invasive questions, intimidation, and violence as they crossed neighborhood boundaries and traveled by public transportation to school. This pilot study will enroll 40 high school students across gender identity (cisgender male and female, transgender male and female, non-binary) and race/ethnicity (Black, Latinx, Asian and White) in a mixed-methods study utilizing photo and map-elicitation interviews in conjunction with GPS, accelerometers, heart-rate and skin temperature monitors, and eye-tracking glasses. The results of this pilot study will serve as preliminary studies data for external grant proposals as well as gender action plans for public transit systems such as that being developed by the Los Angeles County Metropolitan Transportation Authority.

The undergraduate research assistant will work directly with the PI and a post-doctoral scholar to develop the IRB protocol, test the various devices we will use, develop the qualitative interview guide, and conduct practice interviews and data collection with the devices. Summer work may also involve helping prepare a grant proposal for outside funding and recruiting study participants. This research requires a student with some background in gender/women's/LGBTQ studies who has an interest in qualitative and quantitative research.

Veterinary Medicine

BIOMEDICAL STUDIES

Montserrat Anguera

Investigating epigenetic mechanisms of X-chromosome Inactivation in immune cells

Some autoimmune diseases, such as lupus, exhibit a strong female bias, and the genetics have a important role. Our lab investigates X-chromosome Inactivation (XCI), which regulates the expression of genes on the X chromosome in female mammals. XCI is a hallmark example of epigenetic gene regulation, involving long noncoding RNAs, histone modifications, and DNA methylation. We have various research projects in the lab to investigate the epigenetic features of XCI in different immune cells. The student will work with a graduate student or postdoc in the lab to learn cell isolation and cell culture, and also how to image epigenetic features of the inactive X chromosome.

CLINICAL STUDIES NEW BOLTON

Andrew van Eps

Heart rate variability and ambulatory activity monitored using wearable sensors in horses with painful orthopedic conditions

Existing literature indicates that 10-27% of horses with a severely painful condition in one limb (e.g. fracture, synovial sepsis) will develop laminitis in the contralateral limb or "supporting limb". It has long been suspected that support limb laminitis (SLL) is a result of decreased lamellar perfusion caused by preferential weight bearing on a limb. Recent studies, as well as unpublished data collected by our research group, have provided more evidence to support the idea that increased load and lack of cyclic offloading leads to ischemia in lamellar tissue. Tracking changes in motion patterns of horses with painful limb conditions may therefore be important in order to assess a horse's risk for the development of SLL.

Increased frequency of stationary weight shifting and reluctance to ambulate normally have historically been associated with laminitis pain. Preliminary data collected by our lab shows that subtle offloading events (in the static horse), as well as walking steps and time spent recumbent, can be accurately tracked using tri-axial accelerometers placed on the dorsal hoof wall. Using this information as an objective measure of discomfort is desirable because current composite pain scoring systems have some element of subjectivity and rely on user experience or skill at recognizing specific behaviors. Another remote, sensor-based method that has been used to asses pain is heart rate variability (HRV). Limited information is available on the use of HRV to assess

pain in horses, but it has been suggested that HRV measurements may provide useful complementary information for pain assessments.

We hypothesize that limb motion patterns and indices of HRV in horses with painful orthopedic conditions will differ from non-painful hospitalized control horses and that these parameters will correlate with traditional measures (published pain scoring systems and video behavioral analysis) used to assess discomfort in horses. Our goal is to test and refine sensor-based means of assessing pain, ambulation and limb motion in horses with orthopedic conditions in order to help prevent SLL and provide objective means of monitoring pain in clinical patients.

The student will participate in experimental trial equipment setup and instrumentation of horses for data collection. They will also be involved in subsequent data analysis including video analysis of horse behavior and motion data analysis. This is a great opportunity for a student to work with veterinary specialists in a clinical large animal hospital environment. Students interested in musculoskeletal research and/or pursuing a career in veterinary medicine are encouraged to apply. The student would be responsible for their own transportation to and from New Bolton Center.

CLINICAL STUDIES PHILADELPHIA

Margret Casal

Genetic Diseases of the Irish Wolfhound

This overarching goal of this project is to create the largest and best maintained DNA bank for the Irish Wolfhound breed. Every sample that is submitted is accompanied by a medical record, a pedigree, and demographic information. Several hundred samples have already been processed. The student is responsible for putting together the pedigrees of all samples submitted to create an ancestry tree; cataloguing the incoming samples; making high quality DNA from the blood samples; and tracing inherited diseases through the lines of the different dogs. In addition, the student will have the opportunity to learn about these diseases and how genome wide association studies are performed from faculty and staff. This position is of particular interest to the student, who desires insight into genetics of dogs, the work up of genetic diseases, and the research aspects of veterinary medicine. There are no prerequisites. The faculty and staff both teach genetics, have 29 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.

Elizabeth Lennon

Anti-Inflammatory Mechanisms of Mast Cells in Inflammatory Bowel Disease

Inflammatory bowel disease is a debilitating condition that affects humans, dogs and cats. The goal of our laboratory is to investigate the anti-inflammatory mechanisms that mast cells use to control IBD with the ultimate goal of designing better treatments for humans and pets with IBD. We use in vitro and mouse models, as well as samples from dogs and humans with naturally-occurring IBD that come to our clinic. We believe that because pets share our environment so closely, and because their lifespans are shorter than humans, that we can more effectively find treatments for people and pets with IBD by studying the similarities between species.

We have discovered that mast cells, a type of immune cell usually associated with allergy and inflammatory responses, have anti-inflammatory roles in chronic intestinal inflammation, such as occurs in IBD and that mast cells regulate concentrations of bone morphogenetic proteins (BMPs), anti-inflammatory and anti-fibrotic mediators in the intestine. This project will characterize mechanisms by which mast cells regulate BMPs.

Description:

Projects in the lab will use in vitro culture of bone marrow-derived mast cells and mast cell lines to examine mechanisms by which mast cells promote an anti-inflammatory environment. Projects in the lab will involve cell culture, PCR, Western blotting, and flow cytometry.

Requirements:

Research techniques will be taught to students. Requirements are enthusiasm, motivation, strong organizational skills, and the ability to work independently in a collaborative environment.

It is expected that students will be mentored closely for the necessary skills, but will have the opportunity to work independently and learn skills including study design, data collection and statistical analysis, and interpretation of results. Optimistically, students will have an opportunity to author a poster abstract and coauthor a research manuscript.

Cynthia Otto

Canine Sports Medicine - Defining Physical Fitness

Dogs are athletes, but we don't have a good way to tell how fit they are. In this project, we are are working to determine measures of physical fitness in dogs. We are applying principles of sports medicine, engineering and statistics to develop a test to help determine the level of fitness and then the impact of a physical training program.

PATHOBIOLOGY

Jorge Alvarez

Dissecting how immune dysregulation at Brain-Gut axis barriers impacts mental health

Although schizophrenia is a devastating neuropsychiatric condition, the underlying biological mechanisms of the disease are unknown. As many environmental and genetic risk factors associated with schizophrenia are immune-related, and because a subset of patients present with peripheral inflammation, it has been hypothesized that the immune system plays an important role the disease. In healthy patients, such peripheral inflammation is restricted from affecting brain function due to the protective role of the blood brain barrier (BBB), the specialized vascular system of the brain. However, studies have found BBB damage and resulting brain inflammation in schizophrenia. This suggests that peripheral inflammation and BBB disruption may contribute to neuroinflammation and neuronal dysfunction in schizophrenia.

Recent reports on the increased rate of inflammatory gastrointestinal disturbances in schizophrenic patients have implicated the gut as the potential source of this peripheral inflammation. Despite the clinical evidence linking gut-driven peripheral inflammation to schizophrenia, few animal models exist to study gut-brain interactions in the context of neuropsychiatric disease. For this reason, our lab studies schizophrenia in the context of 22q11.2 deletion syndrome (22qDS), a human genetic condition that confers a 30-fold increased risk of the disease. Notably, this deleted region includes genes that may be critical for proper cellular barrier function, including mitochondrial genes and the tight junction protein claudin-5. Our lab studies a mouse model of 22qDS, which has a nearly identical deletion as human patients and has behavioral deficits linked to schizophrenia. Previous research in the lab has found peripheral inflammation, BBB disruption, and neuroinflammation in these 22qDS mice. Currently, our lab is interested in identifying the gut as the source of peripheral inflammation and assessing the efficacy of blocking peripheral inflammation to reduce neuroinflammation and behavioral deficits.

Alexis Crockett, a Neuroscience PhD student in the lab, will mentor students. The main duties of students working on this project would include: studying the barrier and immune status of the brain and gut of 22qDS mice by performing immunofluorescent stainings of immune markers, junctional proteins, and barrier molecules in these tissues. This includes learning how to operate a cryostat, calculate dilutions, perform antibody titrations, and determine staining success via microscopy. Students will also have the opportunity to learn additional techniques, present at and participate in lab meeting discussions and how to read and critique papers. Students will receive support in designing and presenting a poster for the CURF Research Expo, and will be encouraged to secure funding for and present at additional conferences. Further, students will learn how to think about science and design solid experiments; students will learn how to interpret their data and understand how their experiments fit into the larger project. Due to the interdisciplinary nature of this research, there are no major or course prerequisites, although previous experience in lab-based coursework is preferred.

Michael Povelones

Identification of mosquito immune proteins required for killing of malaria parasites

The PoveLab at PennVet has two opportunities:

Project 1:

Malaria is a devastating disease responsible for greater than 500,000 deaths per year. There is no vaccine and evidence for resistance to currently used anti-malarial drugs highlighting the urgent need for new strategies to block disease transmission. Mosquitoes are required for the life cycle of malaria parasites. The Povelones laboratory at PennVet is interested in studying the molecular interactions between the mosquito and malaria parasites to identify novel ways to block their development and prevent parasite transmission. Work by our lab and others has identified the mosquito innate immune system as being a key point of interaction. Using mass spectrometry, we have recently identified a large number of candidate mosquito immune proteins that need to be tested in functional assays. This project will be to use a newly developed screen in the lab to test candidate proteins for function. Ultimately, strong candidates will be moved forward to for additional analysis to determine whether altering them in mosquitoes changes the outcome of infection by malaria parasites.

This project will standard molecular biology techniques of PCR and nucleic acid purification to generate probes to screen candidate immune proteins. It will also require the ability to work under a stereo microscope to micro inject mosquitoes! This sounds challenging, but it is pretty straightforward with practice, and if you can master this, you will have the skills and confidence to take on other difficult dissections as well as having a fun conversation starter at parties! In the later stages of the project, you will learn mosquito infection with malaria parasites and microscopy to check the infection level.

Students interested in public health, infectious diseases and immunity studies who are thinking about med or grad school would all benefit from participation. This project has possibilities for long-term involvement.

Project 2:

Dr. Povelones is involved in the Parasitology course for vet students. He has an interest in developing new interactive course materials with a particular focus on the laboratory portion of the class. This project would be to work with Dr. Povelones to develop a new interactive laboratory guide. This is a great opportunity for a student who is thinking about vet school as they will get very familiar with course content and get a head start. This project is a great opportunity for a developing scientist with strong creative and artistic inclinations. The project will make use of typical desktop publishing (Office, InDesign) and illustration tools (like Photoshop and Illustrator). Familiarity with these basic tools and strong organizational skills preferred.

Thinking about vet school and love parasites? This is a great opportunity for you. The lab has an active research program in canine heartworm disease, and there are long-term possibilities to get involved with the wet lab.

Jennifer Punt

Cancer, Immunity and Education: The significance of IL-8 receptor expression by immunosuppressive monocytes

As companions that share both our environment and many of our diseases, dogs are valuable partners in our quest to improve animal and human health. Our research team of undergraduate and veterinary students has been working to characterize the phenotype and function of a type of canine blood cell that inhibits rather than activates the immune response. These cells, the myeloid derived suppressor cells (MDSCs), help to resolve successful immune responses in healthy animals; however, they can also inhibit the immune response to tumors and contribute to cancer progression.

Our PURM student will join a second year Penn Vet student and a Haverford College undergraduate to pursue a novel observation made this fall by two undergraduate Penn students. Carmen Li and Jeffrey Xue (Penn '20) devised a unique approach to examine differences in the ability of myeloid cells to respond to a chemoattractant, IL-8, which recruits cells to sites of inflammation. They made the intriguing discovery that the highest proportion of cells capable of binding to IL-8 were found in the suppressor population of monocytes (the "non-classical" monocytes) rather than the pro-inflammatory population.

Together we will address the hypothesis that monocytes that bind IL-8 are uniquely capable of generating immunosuppressive activity.   All students will be part of a team that works together not just to master techniques, but to engage in the literature and to share ideas that will allow them to become part of a discovery process that should advance our understanding of immune systems and of disease processes.

Shelley Rankin

PETS TOO: Carbapenem Resistant Enterobacteriaceae Colonization in Pet Animals

Carbapenem resistant Enterobacteriaceae (CRE) are "superbugs" that are resistant to ALL antibiotics. The emergence of CRE in companion animal veterinary medicine was inevitable. To date there have been a few sporadic reports in the United States, Europe, the UK and China. In July 2018, the Ryan Veterinary Hospital identified CR-E. coli in dogs and cats for the very first time in the United States. The lab is working with the FDA Veterinary Laboratory Information and Response Network (VetLIRN) to characterize the isolates by whole genome sequencing (WGS). The emergence of CRE in companion animals is cause for great concern given the few therapeutic options for infections due to these organisms. The prevalence of CRE has risen

significantly in human healthcare settings over the past few years but we have no data on the population prevalence of CRE colonization among pet animals. In addition, there is no standard method for the direct or selective enrichment culture of CRE from the feces of dogs and cats.

In recent years, numerous reports have been published which suggest the occurrence of transmission of antimicrobial-resistant bacteria from pet animals to humans (and vice versa). The determination of an estimate of prevalence of CRE in pets is critical to inform the veterinary community and to prevent the spread of these organisms to human caregivers and owners. We must do research to determine if dogs (and cats) in the community are colonized by this "superbug" because if they are they could transmit it to humans.

The primary aims of this study are to:

1)   Optimize a method for direct and enrichment culture of CRE in dogs and cats

2)   Determine the prevalence of CRE colonization in 1000 pet animals that visit the Ryan Veterinary Hospital.

The hypotheses for these primary aims are that 1) the use of CHROMID CARBA agar plates (bioMerieux) and direct selective enrichment in Trypticase Soy Broth with the addition of a 10ug meropenem disk to screen fecal and rectal samples from dogs and cats will be an effective method for the detection of colonized animals 2) the prevalence of CRE colonization among pet animals can be precisely calculated.

This study will offer novel insights into the epidemiology of these important pathogens and provide critical information regarding potential reservoirs that will guide intervention strategies to limit the spread of CRE in the community.

The student(s) will be responsible, with oversight, for microbiology lab culture testing primarily. There is a parallel project validating a multiple PCR assay for screening animal fecal samples and there is an opportunity for cross training. Isolates from culture will be submitted to the FDA VetLIRN for whole genome sequencing so there may be an opportunity for molecular epidemiology/bioinformatics training. There is a data collection part to this study and student(s) interested in epidemiology would have the opportunity to work with veterinary and human epidemiologist, and a veterinary student, on data collection (from the hospital medical record and a biosecurity survey that will be administered to the owner of all pets in the study) to perform a risk analysis.

Phillip Scott

Immune responses to the protozoan parasite leishmania that promote pathology

Cutaneous leishmaniasis is a major neglected tropical disease caused by parasites transmitted by sand fly bite. The disease ranges from a single benign lesion to chronic, ulcerated disease. The disease affects 1 million people per year, with an estimated 12 million at risk of contracting disease. There are currently no vaccines available, and although standard Leishmania-directed

treatments can lead to control of the parasites, complete elimination of the parasites does not occur and many patients fail treatment due to an exaggerated immune response to infection. Our laboratory studies this infection in mice and focuses on understanding the mechanisms involved in protection and pathology. We recently demonstrated by transcriptional analysis of leishmanial lesions that a cytolytic gene signature and high transcript levels of IL-1β promotes increased disease.

The goal of a summer project by an undergraduate student would be to evaluate the cells that are producing IL-1β. The student would learn a variety of techniques, some of which include sterile tissue culture, immunohistochemistry, qRT-PCR, and experimental animal handling. The student would be involved in two lab meetings, one the Scott lab meeting and another that includes several investigators at Penn Vet. In addition, the student would participate in a journal club in the Scott Lab. Thus, the student will receive both a hand-on lab experience, and advance their understanding of immune responses to pathogens.

Wharton

BUSINESS ECONOMICS & PUBLIC POLICY

Jose Miguel Abito

The Legal Cannabis Industry

As of today, forty-seven U.S. states have legalized the use of medical cannabis and of these, eleven states allow for recreational adult use. According to a recent industry report by New Frontier Data, annual sales of medical cannabis is projected to have a compound annual growth rate of 17% through 2025, while adult-use sales are projected to grow by 16%.

The goal of the project is to understand the legal cannabis industry in the U.S. The project involves collecting publicly available data from state regulators and suppliers of seed-to-sale tracking systems, exploring the possibility of accessing confidential administrative data, reading through industry reports, and performing various descriptive and statistical analyses of the industry. An important part of the project involves learning how to handle and analyze large datasets, and how to use this data to build an economic model of the industry. The main prerequisites are a strong interest in the industry and on economics research, and a desire to pursue a career in data analytics or academic research.

Judd Kessler

Fair Fares and Discounted Transit Research

Access to affordable transit is essential for low-income individuals in urban areas. A number of cities and municipalities are experimenting with, or have implemented, subsidized fare programs to help expand transit access. This research project will work to evaluate the effect of providing discounted and free metro cards to low-income residents of Washington DC as part of a randomized controlled trial I am working on with the Lab@DC. In addition, the project may also involve a research partnership with New York City's Fair Fares program, which already provides nearly 100,000 low-income New Yorkers with half-priced MetroCards. Depending on partner interest, we may be in a position to evaluate how to encourage eligible individuals in NYC to register for Fair Fares or be in a position to research the effect of the program on the labor market, health, and educational outcomes of low-income New Yorkers.

LEGAL STUDIES AND BUSINESS ETHICS

Peter Conti-Brown

The History of the Federal Reserve

The US Federal Reserve System, the US central bank, is the most important institution in public life. It is also among the least understood. Prof. Conti-Brown is writing a comprehensive history of the Fed that will look at the intersection of politics, finance, law, and history. Students will write research memos, travel to archives, find historical documents, and otherwise help with this research. Familiarity with statistics is a plus.

MANAGEMENT

Mary-Hunter McDonnell

Punishment of Workplace Harassment

This study will explore trends in the legal punishment of workplace harassment in the United States. The ultimate goal of the project is better understand how the #metoo movement has affected the severity of punitive responses to harassment in different jurisdictions. The project will primarily involve collecting and coding civil cases brought against firms accused of being the sites of workplace harassment, as well as some preliminary data analysis. Students involved in this research will have the opportunity to learn about civil litigation, corporate liability, and basic statistical analysis. This project should be a great fit for students interested in corporate social responsibility, social movements, and/or employment law and litigation.

Paul Nary

Private equity and its ever-increasing prominence in every corner of the M&A markets
2nd year applicants only

Over the last couple of decades, private equity (PE) firms have transitioned from their humble beginnings as smaller, opportunistic leveraged buyout shops to sophisticated players with significant interests in just about every part of the global economy. In my research, I look at the role and behavior of private equity firms in a variety of settings, with primary focus on their M&A activity. More specifically, I investigate topics such as evolution of PE business models and strategies, PE's interactions with and their effect on other actors (such as public corporations and their investors), as well the the overall effect of PE activity on specific market segments and industries.

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This position is ideal for students considering a career in consulting, finance, management, or corporate law. The bulk of the work for the research assistant(s) will consist of collecting, cleaning, synthesizing, and analyzing data. Experience with using research databases, facility with MS Excel, and basic familiarity with advanced data analysis tools such as R or Python are critical. Rising junior Wharton undergraduates or economics majors are preferred. Attention to detail, strong written and oral communication skills, and ability to work independently are also prerequisite skills.

Samir Nurmohamed

Foisting versus Corralling: When Managers' Recommendations Help or Hurt Their Employees' Prospects

Employee referrals are a driver of how vacant positions get filled. Although we often assume that individuals have prosocial motives when referring or recommending coworkers or team members to others, there are times in which it may be done for more self-interested reasons. The purpose of this project is to understand when and why do others provide more positive recommendations for individuals who are less talented and less positive recommendations for people who are more talented.

The students who work on this project will aid in providing a literature review, designing and deploying the studies online or in-person (e.g., in the Wharton Behavioral Lab) and depending on their qualifications, could assist in performing the analyses. They will also work with my larger research team and attend lab meetings together, providing them an opportunity to learn from others involved in research.

As a side note, I had an excellent experience with PURM in the past. I would love to have another opportunity to hire multiple people as my prior experience had a meaningful impact on my work (I learned a lot from PURM students in the past and hope they benefited from working from me).

Natalya Vinokurova

Are central research laboratories the engine of innovation in large firms?

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 (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. An ideal research assistant

is organized, detail-oriented, and self-motivated. Experience with Microsoft Excel and/or Python would be a plus.

OPERATIONS, INFORMATION & DECISIONS

Gad Allon

Investigating the gig economy and economies of scale

Project 1: Multihoming in the Gig Economy

We will study the impact of competition in the gig economy on three stakeholders: the firms, the customers, but more importantly, the drivers (or the workers). In particular, we will study how the ease of multi-homing impacts the overall viability of the market, as well as their working conditions.

Project 2: Scaling Operations: the impact of economies of scale

We will study how the presence of economies of scale changed over time. Specificlaly, we will try to build a model to predict the scalability of firms, by better understanding their operational model and economies of scale.

Eric K Clemons

Big Tech and Social Welfare — The Good, The Bad, and the Ugly *2nd year applicants only*

Big Tech companies have gotten enormous faster than any company, in any industry, at any time in American history. Seven of the top ten public companies in the US are tech companies, and of those only Microsoft and Apple were founded before 1994. Clearly, these digital disruptors create enormous value or their products would not have been so widely adopted, they would not have achieved such enormous market valuation, and they would not have enjoy so much power.

There is an off-setting set of negative impacts that are harder to measure, and by now may be very difficult to control.

•   Facebook thrives on engagement and excitement, and fake news provides both. Various sources, including co-founder Chris Hughes believe that Facebook interfered with both the Brexit Referendum and the 2016 US Presidential Elections, and that it represents an existential threat to Western Democracy. And yet, much of its activity is protected by freedom of speech in Europe and the First Amendment in the US. Breaking up Facebook would produce numerous smaller social media companies, each of which would have the same incentives towards profit maximization. How do you regulate activities when traditional antimonopoly remedies are in appropriate, and activities may be protected by tradition and law?

• Android creates super-additive value each time it adds an app to the platform, making it enormously attractive to its users. And, as the sole owner of Android, Google can decide which apps a hardware manufacturer can preinstall on an Android device, which must be preinstalled, which must be preinstalled on the home page, and, importantly, which cannot be preinstalled. Manufacturers who violate any of the rules have all of their devices blocked from Google play, rendering them bricks instead of smart phones. The EU has found that this is anticompetitive behavior and fined Google several billion dollars, but there is limited case-law and limited explicit policy governing platform envelopment strategies.

• Online Gateways like Google and Amazon have unprecedented power over what we see and what we don't see when we shop. Walmart has enormous market power, but it does not get to "spy" on our activities outside its stores. In contrast, Amazon observes every transaction we make when we purchase from a vendor on the Amazon Marketplace, and can use small vendors to do its market research. Whenever a product sells well, Amazon can (and frequently does) re-internalize it, making it an Amazon offering and crushing its online partners.

• Sharing Economy Platforms may harm communities. Cities as diverse as Barcelona and San Francisco are wrestling with the problems created by Airbnb. These problems are externalities; use of the platforms may harm residents, but the platforms are wonderful for out of town renters who want a true center-city experience when they travel.

There are numerous other examples and they are all wicked problems. That doesn't mean that anyone is evil; a wicked problem exhibits a high degree of entanglement, with numerous interacting parts and numerous players, often with conflicting values and conflicting needs.

Our objectives when tackling these problems are consistent with the stated regulatory objectives of the current Chair of the FCC:

1.   Intervene when there is demonstrable harm — competition is limited, consumer choice is limited, products are more expensive, or lower quality, than would be available in the presence of greater competition. For example, consumers have expressed willingness to adopt a clean Facebook, not no clean social networking products have significant market share, and none can compete with existing giants.

2.   Intervene when there is demonstrable need — market forces will not remedy the problem. The harm from privacy violations is not always visible; markets don't solve problems that consumers cannot detect. Market forces do not correct externalities because both parties to an Airbnb transaction are often delighted, and the harm affects only other residents.

3.   Intervene when it is within the law — Do not violate First Amendment rights, for example.

4.   Intervene when it does no harm — Do not stifle innovation.

However, it is not clear how to address these wicked problems and achieve an ideal outcome, improving social welfare.

I can advise one or two students, in the following areas:

1.	Simulation modeling — I have modeled the distribution of fake news and competition in search, but there are many other areas in platform evolution that have not been studied.

2.	Understanding current problems in the context of privacy law, consumer law, and antimonopoly law. What are the problems? What complaints have been lodged, by individuals, by consumer groups, or by governments? What are the relevant statutes? What are the novel complexities, that make in difficult to apply existing statutes?

Serguei Netessine

Empirical study of ecommerce retail development

Project 1: Impact of Amazon.com on retail sales and labor conditions

It is believed that Amazon.com negatively impacts brick and mortar retail stores, especially when it starts delivering same day or next day to the geographical location. Moreover, Amazon.com is also blamed for poor labor conditions and reduction in retail employment. The goal of this project is to study these questions using empirical data. We will first collect data on warehouse openings by Amazon as well as satellite imaging for the number of cars driving up to retail locations in the close vicinity. Using ML tools, we will process images to count cars and note any reduction in demand. We will also collect from public sources data on employment and wages. We will then use statistical tools to relate warehouse openings to retail demand, unemployment levels and average wages.

Project participant will need to possess strong programming skills (probably using Python) to be able to collect data from public and private sources, including through APIs. Ability to work with large amounts of data is a must. Background in ML is expected, with experience in using image processing tools. Moreover, knowledge of multivariate regressions using R or Python is a must.

Project 2: E-commerce technology adoption by internet retailers

Digital revolution has opened up multiple ways for firms to adopt new tools and platforms to strengthen relationships with their customers and increase sales and profits. Consequently, managers are often forced by various stakeholders into adopting the latest "state-of-the-art" digital technologies, driven by fears of being "left behind". Does it always pay to be the early adopter, though? To answer this question, we have obtained a comprehensive longitudinal data on the top e-commerce firms over the past decade. The dataset includes information about adoption of various technologies (such as mobile and social media), solutions used (including vendor information if outside suppliers were used), and multiple outcome variables, including both engagement (likes and tweets, web and mobile traffic) and monetary (sales and profits) metrics.

We are looking for a student with experience in data analysis and statistics to help us with empirical investigation focused on identifying differences in the effects of marketing (front-end)

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vs. operational (back-end) technology adoptions, as well as examining potential interactions with the product type and competitive environment.

Maurice Schweitzer

Gaming the System: How Experience Influences Unethical Behavior

Is more experience always better? Do organizations benefit when employees become acclimated to company culture? Prior research has found that well-socialized employees demonstrate increased organizational commitment, loyalty, and job performance. In this project, we extend our understanding of organizational socialization by investigating how experience with organizational norms affects ethical behavior. Fellows will contribute to this project in several ways: (1) running laboratory studies, (2) analyzing data, (3) presenting and participating in weekly lab group meetings, and (4) reading relevant research.

STATISTICS

Anderson Ye Zhang

Variational Auto-encoder for Unsupervised Learning

Deep learning has gained increasing attention from researchers and has achieved many remarkable successes in the recent years. Variational auto-encoder (VAE) is one of the most popular methods in deep learning, especially for generating realistic images. However, VAE can also be used for unsupervised learning (i.e., clustering). For example, VAE can be applied to the MNIST dataset (https://en.wikipedia.org/wiki/MNIST_database) to group handwritten digit images by their shapes, and consequently reveal their underlying labels (0-9).

The goal of this project is to develop VAE-based methodologies for unsupervised learning. The project consists the following steps: 1) Implement the VAE by Python. 2) Use the vanilla VAE and its variants on the MNIST dataset for clustering. 3) Explore different directions to modify VAE to see improve the clustering accuracy.

A student working on the project will gain knowledge and experience in deep learning and statistical methods for data analysis. Ideally, the student should have had some exposure to statistics or data science, and can program in Python.