Potential Research Track Mentors
MS Physiology Class of 2018-2019

Peter Arvan, MD, PhD

Lab focus: We are working on protein secretion, and particular protein trafficking through the secretory pathway. Immediately upon synthesis, secretory proteins must first fold in the endoplasmic reticulum (ER) before advancing through the secretory pathway. Failure to fold properly in the ER leads to a phenomenon known as ER stress. We are working on animal models of thyroid disease, in which the major secretory protein, known as thyroglobulin, is misfolded and trapped in the ER.

Experience required: Prior work in a research laboratory desirable. Ability to work with mice, and mouse tissues is desirable.

Project description: The project will analyze thyroid cell growth, thyroid cell death, and the cell biology of thyroglobulin protein transport in thyrocytes, using genetic models that may perturb thyroglobulin folding, trafficking or protein degradation.

Lab website: http://www.med.umich.edu/intmed/endocrinology/aranlab/research.html

Daniel Beard, PhD

Lab focus: Research interests include: (1) Cardiac energy metabolism (2) Oxidative metabolism and energetics in skeletal muscle (3) Regulation of coronary blood flow (4) Etiology and sequelae of hypertension.

Experience required: A background in physical sciences (chemistry, physics) engineering or applied mathematics would be useful.

Project description: Systems Engineering Approaches to Understanding the Biophysical and Biochemical Operation of Physiological Systems.

Lab website: http://virtualrat.org/

Jimo Borjigin, PhD

Lab focus: A new technology, termed Electrocardiomatrix (ECM) invented in Borjigin lab, was shown to markedly increase the sensitivity and specificity of detection of cardiac arrhythmias such as Atrial Fibrillation (AF) from past studies. Incoming students will participate a Phase II clinical trial in collaboration with Stroke neurologists and Cardiologists at the UM hospital to test the clinical utility of the ECM technology.

Experience required: Each student will be trained following their hiring. Dedication, responsibility, and attention to details are traits required for this project.

Project description: Discovery of atrial fibrillation in stroke inpatients.

Lab website: https://sites.google.com/a/umich.edu/borjiginlab/

Christian Burgess, PhD

Lab focus: Our lab focuses on the neural circuitry underlying learning and behavior. We are specifically interested in how motivation-, arousal-, and feeding-related circuits can modulate higher-order brain areas and their responses to salient, learned cues in the environment.

Experience required: none specified

Project description: We use a combination of techniques and approaches to map neural circuits in mice, including neuroanatomy, behavior, optogenetics, and in vivo calcium imaging. The goal is to identify specific neuronal projections, record their activity during motivated behaviors & learning, and manipulate their activity to demonstrate a functional role in behavior. We are currently interested in how specific hunger and sleep promoting circuits in the hypothalamus can facilitate learning of, and appropriate responses to, motivationally relevant sensory cues.

Lab website: http://www.mbnl.med.umich.edu/mbnl/faculty/Burgess/burgess.html

June 20, 2018
Patrice Fort, PhD, MS
Lab focus: A major focus in our lab is the development of strategies to treat retinal neurodegenerations, including diabetic retinopathy. One of our objectives is to investigate the function and regulation of crystallin proteins in the adaptive responses of retinal cells during chronic disease states such as diabetes.
Experience required: none specified
Project description: [One] of our projects uses proteomic and immunohistochemical analysis to evaluate the impact of diabetes on the expression of retinal crystallins in humans. Our goal in this project is to confirm the potential of crystallins for developing novel therapies to prevent neurodegeneration under stress conditions.
Lab website: https://sites.google.com/a/umich.edu/patrice-fort-lab/

Thomas Gardner, MD, MS
Lab focus: We study the pathophysiology of diabetic retinopathy involving human subjects (clinical testing of retinopathy by structure/ function relationships and vitreous proteomics) and animal models with the goal of developing treatments to preserve vision.
Experience required: None indicated.
Project description: If interested in lab research the student can investigate the role of mTOR signaling in normal and diabetic tissues and cells. If interested in clinical research the student can participate in testing patients. If interested in the lab research, then Dr. Steve Abcouwer could be a co-mentor. The clinical project could involve Dr. Thiran Jayasundera. Options will be discussed on a case-by-case basis.
Lab website: http://kellogg.umich.edu/bios/gardner.html

Lisa Larkin, PhD
Lab focus: The purpose of our research is to design, fabricate, and evaluate the structural and contractile characteristics of three-dimensional (3-D) engineered tissues containing myotendinous junctions (MTJ) and neuromuscular junctions (NMJ), two of the principal tissue interfaces required for a functional musculoskeletal construct.
Experience required: None, will train.
Project description: Musculoskeletal tissue engineering.
Lab website: http://www-personal.umich.edu/~llarkin/

Jun Hee Lee, PhD
Lab focus: We focus on diverse physiologies including growth, development and aging that are controlled by signal transduction networks. Recently, our research has revealed that Sestrin, a stress-inducible protein, is a physiological regulator of mTOR complex 1 (mTORC1) signaling, and that loss of Sestrin can cause various chronic mTORC1-associated pathologies, such as fat accumulation, insulin resistance, mitochondrial dysfunction, cardiac arrhythmia and muscle degeneration, in diverse model organisms including Drosophila and mice. These phenotypes are quite similar to those associated with obesity, aging and lack of exercise, which are currently some of the major public health issues facing our society. We expect that further research on mammalian Sestrin-family proteins may provide a novel way to attenuate aging and prevent or treat age-associated diseases in humans.
Experience required: Basic molecular biology and genetics background.
Project description: (1) Effect of Sestrins on exercise and mobile capacity. (2) Identification of new autophagy mediators in Drosophila system. (3) Molecular mechanisms underlying hepatoprotective function of Sestrins in mouse liver.
Lab website: https://sites.google.com/a/umich.edu/lee-lab/
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Scott Leiser, PhD
Lab focus: The Leiser lab studies the biology of aging, focusing specifically on how changes in stress response and metabolic pathways can be manipulated to affect the aging process. We utilize a translational approach, using large-scale assays in invertebrate nematodes to develop and test specific hypotheses in mammalian systems, and then using interesting findings in mammals to test hypotheses in worms.
Experience required: Basic molecular biology experience and basic knowledge of genetics.
Project description: One potential project is to develop a screen to identify novel genes involved with increasing resistance to toxic stress. Once identified, the gene would then be tested for a role in promoting health and longevity, and for where it fits in with known stress and longevity pathways.
Lab website: https://sites.google.com/a/umich.edu/leiser-lab/

Malcolm Low, MD, PhD
Lab focus: We study the molecular regulation of Proopiomelanocortin gene expression in the hypothalamus and its relationship to energy homeostasis. We are also studying the neurocircuitry of POMC neurons to characterize their specific neuronal inputs and efferent targets. Because the monogenic loss of POMC results in a severe, early onset state of obesity, we believe this neural circuitry is essential for normal body weight control.
Experience required: prefer someone with previous experience handling mice and a solid background in both neurobiology and molecular biology
Project description: Use pseudotyped rabies virus for the anterograde identification of monosynaptic neuronal afferents to POMC neurons. This work involves the precise stereotaxic microinjection of viruses into the brain of mice followed by immunochemical detection of the targeted neurons and colabeling for potential coexpressed peptides or receptors of interest.
Lab website: Not available.

Costas Lyssiotis, PhD
Lab focus: The growth of a tumor, just like the growth of a cell or an organism, requires nutrients and a means to convert nutrients into energy and the basic building blocks that support life. These metabolic processes are frequently deregulated in cancer cells to facilitate growth and enable survival. The Lyssiotis laboratory uses a multi-disciplinary approach encompassing methods in chemistry and biology to define how metabolism is rewired in cancer and then to employ this understanding in the design of targeted tumor metabolism-based therapies.
Experience required:
Project description: The main focus of the MIP Master’s Thesis project(s) will be to explore how the heterogeneous cancer, stromal and immune cell populations in a pancreatic tumor coordinate their metabolism to support the survival and growth of the tumor. This will involve techniques in biochemistry, analytical chemistry and mass spectrometry-based metabolomics using human and murine models of pancreatic cancer.
Members of the Lyssiotis laboratory work in a highly collaborative research environment with leading experts in immunology, pancreatic cancer biology and oncology. Our goal is to motivate and train fellows across disciples to address new and challenging problems in cancer and metabolism.
For more information: @LyssiotisLab (Twitter)
Lab website: http://lyssiotislab.com

Ormond MacDougald, PhD
Lab focus: We investigate how adipocytes throughout the body develop, function, and interact with other cell types near and afar.
Experience required: Lab experience and a desire to create new information.
Project description: We are interested in the role of adipocyte genes in adipogenesis and metabolism. We use a range of approaches including cell culture and genetically-modified mice to evaluate functional roles for genes.
Lab website: http://macdougald.lab.medicine.umich.edu

June 20, 2018
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Tristan Maerz, PhD
Lab focus: Our primary research area is the pathogenesis of post-traumatic osteoarthritis following joint injury, with a specific focus on the trafficking of stem and progenitor cells following injury and how these cells modulate the onset of joint degeneration.
Experience required: none specified
Lab website: https://medicine.umich.edu/dept/orthopaedic-surgery/tristan-maerz-phd

Daniel Michele, PhD
Lab focus: The Michele laboratory is focused on the molecular mechanisms of human diseases of skeletal and cardiac muscle. By understanding molecular mechanisms of relatively rare genetic disorders, such as human muscular dystrophies, we hope to identify important disease mechanisms and therapeutic targets, and use these findings to understand the pathogenesis of more common idiopathic or acquired forms of skeletal muscle and cardiovascular disease.
Experience required: Previous wet bench experience in a basic research laboratory as an undergraduate student is helpful.
Project description: Project 1 is focused on understanding how mechanosignalling in muscle cells activates nitric oxide synthesis and regulates blood flow during muscle activity, and how this pathway is disrupted in dystrophic muscle cells from mice and human patients, as well as whole animal studies in animal models with mutations in the dystrophin glycoprotein complex. The focus is to develop therapies for the extreme muscle fatigue observed in patients
Project 2 is focused on elucidating the mechanisms of plasma membrane repair in muscle cells using muscles from novel transgenic GFP reporter mice, cellular models expressing novel GFP biosensors of membrane repair. In many forms of muscular dystrophy, membrane repair is highly activated due to mutations that alter sarcolemma stability, and efficient membrane repair required for maintenance of sarcolemma integrity and preventing muscle degeneration.
May work in collaboration with Susan Brooks-Herzog's laboratory.
Lab website: https://sites.google.com/a/umich.edu/michelelab/

Bishr Omary, MD, PhD
Lab focus: "We are actively working on the following areas:
1. Drug discovery to identify compounds that may have a therapeutic benefit for keratin-associated diseases.
2. Understanding the pathogenesis and developing potential therapies for the rare porphyria disorders.
3. Understanding the regulation and function of the keratin and lamin intermediate filament proteins.
4. Biomarkers of liver injury."
Experience required: Some prior lab experience is preferred.
Project description: Specific projects will depend on when the student would start but the general themes are highlighted in the research area. In general, I encourage my trainees to work on more than one project in order to maximize the chance that they will end up with positive results. This usually means they will need to work a bit harder.
Lab website: Not available.

William Rainey, PhD
Lab focus: Researching Adrenal Physiology and Disease
Experience required: Interested applicants must have at least some research experience.
Project description: Translational research focused on defining the molecular causes of human adrenal diseases.
Lab website: https://sites.google.com/a/umich.edu/raineylab/
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Michael Roberts, PhD  
**Lab focus:** Our lab aims to determine the cellular, synaptic, and network mechanisms used by neural circuits in the auditory midbrain and thalamus to extract and encode important features of sounds.  
**Experience required:** none specified  
**Project description:** Our approach combines patch clamp electrophysiology, optogenetics, genetically engineered mice, and viral transduction. Through this work, we seek to identify methods for restoring the function of auditory circuits for individuals with hearing disorders or hearing loss.  
**Lab website:** [https://medicine.umich.edu/dept/khri/faculty-labs/labs/roberts-laboratory](https://medicine.umich.edu/dept/khri/faculty-labs/labs/roberts-laboratory)

Santiago Schnell, DPhil (Oxon), FRSC  
**Lab focus:** The Schnell lab investigates complex biomedical systems comprising many interacting components, where modeling and theory may aid in the identification of the key mechanisms underlying the behavior of the system as a whole.  
**Experience required:** Students familiar with calculus, dynamical systems theory, and computer programming will be preferred.  
**Project description:** Our primary research interest is to use mathematical, computational and statistical methods to design or select optimal procedures and experiments, and to provide maximum information by analyzing biochemical data. Much of our work focuses on protein aggregation and fibrillation, which is the underlying cause of protein folding diseases, such as diabetes, cystic fibrosis, Alzheimer's, Parkinson's and Huntington's disease and cataract. Protein folding diseases are triggered by the inability of the cells to cope with inherited misfolding-prone proteins, aging, metabolic or environmental stress. For potential projects, please visit the Schnell lab research page.  
**Lab website:** [http://www.med.umich.edu/schnell-lab/research.html](http://www.med.umich.edu/schnell-lab/research.html)

Yatrik Shah, PhD  
**Lab focus:** The major goal of our research program is to determine the molecular mechanisms by which oxygen sensing transcription factors regulate gastrointestinal homeostasis, inflammation and cancer. Cellular oxygen level is an important systemic signal that modulates metabolic activities and disease in the liver and intestine. Low cellular oxygen also referred to as hypoxia is observed in several gastrointestinal diseases such as non-alcoholic and alcoholic fatty liver disease, inflammatory bowel disease and liver and colon cancers. Regulation of hypoxia-mediated genes is dependent on the nuclear transcription factor, hypoxia inducible factor (HIF). HIF signaling is critical in the adaptive response to low oxygen levels by activating genes involved in metabolism, angiogenesis, cell survival and iron metabolism. Using the latest in mouse transgenic technology we have developed novel animal models to study accurately the role of oxygen sensitive transcription factors in the liver and intestine. These studies have revealed new pathways that have not previously been associated with hypoxia.  
**Experience required:** Will train. Must be willing to work with animals.  
**Project description:** Exploring the role of oxygen signaling in intestinal cancer. With a focus on one of these three projects – (i) The role of hypoxia inducible factor (HIF) in iron metabolism, (ii) The role of intestinal epithelial-elicited inflammation in cancer progression, or (iii) The role of HIF in regulating systemic glucose and lipid metabolism  
**Lab website:** [https://sites.google.com/a/umich.edu/yatrik-shah-lab/home](https://sites.google.com/a/umich.edu/yatrik-shah-lab/home)
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Susan Shore, PhD
Lab focus: The Shore lab studies processing of multisensory information in the brains of animals that have received noise damage. Compared to normal animals, these animals show aberrant neural plasticity that changes how multisensory circuits function, and can lead to disorders such as tinnitus "phantom sound perception" or difficulties perceiving signals in noise. We use single cell physiology, optogenetics and anatomical tracing to study these systems.
Experience required: Lab experience is desirable but not essential.
Project description:
Examining brains from animals that have been exposed to noise using immunocytochemistry and fluorescent microscopy.
Data analysis of single unit recordings to look for pathological circuit changes.
Lab website: https://medicine.umich.edu/dept/khri/susan-e-shore-phd

Michael Wang, MD, PhD
Lab focus: We are investigating the molecular basis of disease of small blood vessels of the brain. This process is thought to cause stroke and dementia in a substantial population and does not yet have effective treatments. One focus is to characterize abnormal forms of the NOTCH3 protein that cause the genetic disorder CADASIL. Our experiments utilize a range of techniques including molecular biology, biochemistry, cell biology, and animal modeling.
Experience required: A strong desire to learn and flexibility of thinking are the major requirements.
Project description:
A. To identify amino acid residues in NOTCH3 that result in pathological protein transformation. This will utilize molecular and cellular techniques.
B. To characterize behavioral, brain structural, and physiological changes in mice that produce altered NOTCH3 protein. This will utilize molecular analysis and animal neurological assessments.
Lab website: https://sites.google.com/a/umich.edu/michiganwanglab/home

Brendon Watson, MD, PhD
Lab focus: Neocortical network dynamics; Basic function in normal brain and role in psychiatric disease
Experience required: none specified
Project description: Exploring neocortical structure-function; cortical networks during sleep and wake cycles; or antidepressant action in mammalian systems.
Lab website: https://sites.google.com/view/watsonlab/

Jun Wu, PhD
Lab focus: Obesity is essentially a disorder of energy balance, in which intake exceeds expenditure. The profound health consequences associated with obesity emphasize the importance of developing effective therapeutic interventions. My work focuses on a recently identified form of fat cells, so-called “beige cells.” Genetic manipulations that create more of these fat cells in mice have strong anti-obesity and anti-diabetic effects.
Experience required: Some prior lab experience is preferred.
Project description: Further understanding of beige fat biology is required to determine the role of human beige fat in energy expenditure and its value as a potential target for intervention. The isolation of beige adipocyte opened up a brand new field, we aim to elucidate 1) the molecular regulation of beige fat function, 2) the therapeutic potential of human beige fat and 3) the developmental origin of beige precursors. These ambitious aims will bring together leading laboratories to investigate the function and regulation of this new type of fat cells
Lab website: http://wwwlsi.umich.edu/labs/jun-wu-lab

June 20, 2018
Lei Yin, PhD

Lab focus: The Yin lab is interested in the physiology and pathology of liver metabolism and liver metabolic diseases, such as Alcoholic liver disease and diabetes. Both genetic mouse models and in vitro hepatocyte culture are currently used in the lab to address the impact of dys-regulation of molecular circadian clock on the susceptibility of alcohol feeding on liver injury and liver lipid metabolism. Yin lab is currently developing a protocol to use CRISP-CAS9 system to generate liver-specific knockout and knockin mouse models for specific clock gene.

Experience required: Experience working in the lab during college will be desirable.

Project description: The project will examine the cross-regulation between E4BP4 and PPARalpha pathway during hepatic ER stress. E4BP4 is the circadian output transcription factor. Our previously studies showed that E4BP4 potently suppresses hepatic hormone Fgf21 during feeding state. Our further analysis suggests that E4BP4 could be an important suppression of hepatic fatty acid oxidation pathway by inhibiting PPARalpha, which is the major regulator of hepatic fatty acid oxidation. The project will address the following questions: (1) At the molecular level how does E4BP4 suppresses PPARalpha transcription activity; (2) Is E4BP4 required for PPARalpha suppression during hepatic ER stress, including alcohol feeding and sepsis.

Lab website: https://sites.google.com/a/umich.edu/yinlab/home