2019 Summer Research Symposium

Developing a Heterogeneous Model of the Arterial Vasculature in the Human Retina

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Glaucoma is a serious ocular disease characterized by damage to retinal ganglion cells that results in irreversible vision loss. While thought primarily to be a disease caused by high intraocular pressure, clinical evidence shows that almost one third of glaucoma patients do not exhibit elevated pressures. Impaired blood flow and oxygenation of retinal tissue have been identified as other important factors that may contribute to retinal ganglion cell death. Theoretical modeling provides a useful tool for predicting the impact of several hemodynamic factors on retinal oxygenation. In this study, a theoretical model of the human retina is adapted from a previously developed model of the mouse retina based on confocal microscopy images. Oximetry data from the human retina is used to convert the murine network to a human network. Oxygen distribution in the arteries is calculated using a Green's function approach. The model also predicts blood flow, pressure, and viscosity throughout the human retinal arterial network. This heterogeneous model of the retinal arterial network will be connected to a series of compartments (vascular resistances) representing the capillaries and veins to create a hybrid model description of the retinal microcirculation. The hybrid model will preserve important spatial information from the arteriolar network while accounting for realistic conducted metabolic responses generated downstream. Ultimately, this model provides an important approach for predicting retinal blood and tissue oxygenation within a realistic human retinal network.

Mentor: Julia Arciero, Department of Mathematical Science, IUPUI

Characteristics of Infusion Related Reactions of Monoclonal Antibody Therapy and the Effectiveness of Premedication

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Monoclonal antibodies are antibodies that have been developed to treat many types of diseases and disorders, including cancer and autoimmune diseases. They are engineered in a way to target specific antigens, making them selective and thus, more preferable to other forms of therapy. However, there are some side effects of the treatment, one of them being infusion-related reactions (IRRs). IRRs can be mild but also very intense and possibly life threatening. To avoid any complications when using the treatment, premedication is given to the patient. Giving premedication has become the norm when trying to prevent IRRs, but the effectiveness of premedication has not been well established despite its frequent usage. After synthesizing the information gathered from the chosen studies, it is then analyzed to determine whether premedication influences the risk of infusion-related reactions from intravenous monoclonal antibody therapy. We ran a meta-analysis to examine the articles chosen for this study. Results from the analyses conducted revealed premedication does not decrease the risk of infusion-related reactions. The information gained from this study may educate healthcare providers on giving medication to patients going through intravenous monoclonal antibody therapy.

Mentor: Paul A. Ardayfio, GPS Internal Medicine/Neuroscience, Eli Lilly and Company

Microstructural Analysis of Lithium Ion Battery Electrodes After Long Cycles

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Lithium ion batteries have been powering portable technologies for several decades. Advancements in this field will lead to more reliable batteries that have longer life cycles. The goal of this research is to

identify materials that have high specific capacities and are able to maintain a high and consistent charge-discharge efficiency. To do so, batteries with lithium cobalt oxide (LCO) cores and batteries with lithium nickel manganese cobalt oxide (NMC) cores were constructed and compared, since they have similar discharge potentials and specific capacities. Comparison tests consisted of battery efficiency assessment through up to 1000 charge-discharge cycles. Data was then processed to compare efficiency as well as capacitance-voltage profile.

Mentor: Likun Zhu, Department of Mechanical Engineering, Purdue School of Engineering, IUPUI

Contributing Factors of Heavy Metal Presence in Sediments

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There are many components that make up the environment. In abundant amounts, some of these components are harmful to human health. Metals like lead, zinc, copper, and manganese are elements that occur naturally in the environment and can be found in water or sediment due to different interferences. Combined Sewage Overflow from sewage systems brings untreated water into waterways like Pleasant Run. In order to detect how much metal is present, the sediment must be collected from sites then analyzed using an elemental analysis instrument. Since metals comprise the sediment in contaminated areas, it is crucial to look at the grains that make of these sediments to further analyze the samples. This includes measuring each sample's grain size. There were six different sites and three different samples collected from each site. Each of the three samples were from three different locations on the site that included the sediment from the river, the bank of the river, then further away. All the collection sites were marked on a map. Each sediment sample was composed of the following grains: sand, silt, and/or clay. Clay is <.002 mm, silt is .002 mm-0.5 mm, and sand is .05 mm-2 mm. The metal existence in the sediment can be determined by the location of the samples and the grain size. It is predicted that the sediment farthest from the water sample will have the greatest metal presence because it has more clay which can retain greater amounts of water due to its small size.

Mentors: Gabriel Filippelli, Department of Earth Sciences, IUPUI School of Science

Effect of Prologed Alcohol Exposure on Performance in an Odor Discrimination Task in Rats

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Alcohol use disorder (AUD) is a pattern of drinking that involves the abuse of alcohol. Chronic alcohol use in humans has been found to impact the executive functions of the prefrontal cortex (PFC). Some consequences of AUD include poor performance during work, signs of anxiety and depression, and in some cases addiction.In a previous study, We found that alcohol preferring P rats are impaired in different stages of this task, compared to their origin strain (Wistar rats), and that performance in these stages was predictive of future alcohol consumption. Interestingly, impairment was found on the very first stage of task (simple odor discrimination), where animals had to use a rule learned on the previous day to guide foraging. Devaluation of the reward prior to testing was able to rescue performance, suggesting that positive urgency interfered with the decision-making process.In the present study, we will test the hypothesis that previous alcohol consumption could also affect the performance in this particular stage of the test. Specifically, we will investigate the effects of prolonged alcohol exposure in a cohort of Wistar rats. The animals will first undergo 4 weeks of prolonged ethanol self-administration. During this drinking process, they will have continuous access to both ethanol (20%) and water all the days of the week. The rats will then be trained to dig to retrieve food reward and then to discriminate between two odors. The day following training animals will be tested in the one of the two conditions (Devalued or Non-Devalued reward). Findings from this study will help to understand the effect of alcohol exposure on positive urgency, and its interaction with the decision-making process.

Mentor: Christopher Lapish, Department of Psychology, Purdue School of Science, IUPUI

Prenatal counseling for fetal anomalies--qualitative analysis of observational data

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Congenital anomalies occur in approximately 3% of live births and are the leading cause of perinatal death. Developments in prenatal diagnostic technology have improved the ability of providers to predict the possibility of fetal abnormalities, including life-limiting diagnosis, throughout pregnancy. Diagnosis of a fetal anomaly with low possibility for a cure or survival creates a spiritual crisis in the lives of many parents. Parents experience the unexpected trauma and grief of learning that their fetus will require many invasive interventions and may not survive, accompanied by the loss of long-anticipated parenting roles and frequent high stakes prenatal or postnatal decision-making, often on the basis of complex or incomplete information. Fetal centers are formed to provide counseling to parents carrying a fetus with congenital anomalies. Many times, this counseling happens with large interprofessional and interdisciplinary teams. To provide effective care and support for parents living with a potentially life-limiting fetal diagnosis, it is important to have a deep understanding of parents' needs, including informational, spiritual and emotional responses and how the care teams interact with these parents during these care conferences. The purpose of this project is to observe parents' informational, emotional, and spiritual needs along with how the care team responds to those needs during these sessions at the Fetal Center at Riley Hospital for Children at IU Health. The results of this study will eventually inform developing programs to improve holistic perinatal care at the Fetal Center at Riley Hospital for Children at IU Health.

Mentor: Zeynep Salih, M.D., M.A., Department of Pediatrics-Neonatal Perinatal Medicine, Indiana University School of Medicine

Gastroschisis: Prenatal Imaging and the Current State of Care

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Gastroschisis is a congenital abdominal wall defect estimated to occur in 1 of every 2000 births, where intestines are located outside the abdominal wall without a membrane covering at birth. A retrospective chart review of gastroschisis patients treated at Riley Hospital for Children from 2010-2018 was completed to examine prenatal and postnatal markers. Prenatally, comparisons of exposed bowel and bowel edema from first to last ultrasound were shown to be ineffective predictors for type of gastroschisis and postnatal outcomes. However, subjects with uncomplicated gastroschisis were more likely to display increased bowel dilation (46.4% vs. 33.3%; $p=.015$). Postnatally, subjects who received delayed (85.8%) or primary closure (14.2%) displayed a similar prevalence of complications, including bowel obstructions and dysmotility, as well as post-operative infections. Subjects with complicated gastroschisis (15.7%) displayed significantly higher median day of abdominal closure (7 vs. 5; $p=.04$), days intubated in first 30 days of life (9 vs. 5; $p=.01$), days until feeding initiation (46 vs. 10; $p<.001$), days until full enteral feeding (78 vs. 23; $p<.001$), and length of hospital stay (83 vs. 33; $p<.001$), as well as a higher prevalence of sepsis in the first 30 days after closure (42.9% vs. 5.6%; $p<.001$) and requirement for total parenteral nutrition at discharge (23.8% vs. 8.0%; $p=.03$). Further research examining continuous ultrasound factors, such as amniotic fluid index percentile for estimated gestational age and abdominal circumference, is needed to determine predictors for type of gastroschisis and give expecting parents more realistic expectations about their child's postnatal care.

Mentor: Brian Gray, MD

Optimizing osteoprogenitor cell culture systems for studying the impact of Nmp4 on PTH-induced osteogenesis

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Osteoporosis is a disease often seen in postmenopausal women. Parathyroid hormone (PTH), a profound molecule for skeletal homeostasis, is one of the primary drugs for anabolic bone remodeling when administered intermittently. FORTEO® (human PTH[1-34]), is an FDA-approved osteoanabolic treatment for people suffering from severe osteoporosis[1]. This drug adds new bone to existing skeleton yet loses effectiveness after about 1.5 years. Disabling *Nuclear Matrix Protein 4* (*Nmp4*), a transcription factor present at over 15,000 sites throughout all tissues, suggests a pathway for modifying the skeletal response to PTH through combinational therapy[2]. Our goal is to explore how *Nmp4*$^{-/-}$ mice show an enhanced PTH-induced bone formation compared to their wild type (WT) littermates. Interestingly, these mice maintain an unremarkable baseline phenotype before treatment[4,6]. We hypothesize that PTH increases osteoprogenitor collagen secretion that leads to the formation of more bone matrix. The experiment compared collagen secretion using the Sircol assay to measure collagen deposited in the culture dish of mesenchymal stem progenitor cells (MSPC) lacking *Nmp4* and their WT in response to either PTH or vehicle. The *Nmp4*$^{-/-}$ osteoprogenitors secreted more collagen/cell than WT cells under both PTH and vehicle-control conditions. Additionally, *Nmp4*$^{-/-}$ cells showed increased secretion in response to PTH while WT cells did not show a PTH-induced increase in collagen. Therefore, we conclude that loss of *Nmp4*$^{-/-}$ enhances both collagen secretion and PTH-responsiveness in osteoprogenitors.

Mentors: Joseph P. Bidwell

***Ex vivo* Brain Stimulation via Antibody Conjugated Magneto-Electric Nanoparticles (MENs)**

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Within recent decades, noninvasive brain stimulation has risen to the prevailing method of treatment for neuropathic pain, epilepsy, etc. Current, clinically used, stimulations are TMS and tDCS. While these techniques are known for their non-invasiveness, they however lack spatial and temporal precision. Here we propose a new non-invasive brain stimulation technique utilizing magneto-electric nanoparticles (MENs). Our MENs compose of a cobalt ferrite ($CoFe_2O_4$) piezomagnetic core and barium titanate ($BaTiO_3$) piezoelectric shell. In the presence of an external magnetic field, the core vibration induces surface charge redistributions of the shell, thus generate an electric field. We hypothesize that this generated field is capable of stimulating neuronal activity. Here, by conjugating AMPA receptor specific antibody (i.e. GluR2A subunits) to the MENs, we enhance the localization of MENs towards excitatory neurons. *Ex vivo* fresh cortical slice were prepared from juvenile GCaMP6 transgenic mice. We performed calcium imaging on these slices, along with pharmacological testing. We found that antibody-conjugated MENs (GluR2A-MENs) localized mainly around cell body areas. Through ex vivo slice calcium imaging, we found GluR2A-MENs enhanced excitatory neuronal activity. Furthermore, calcium transients were still observed with particle stimulation under the presence of tetrodotoxin (TTX) and attenuated after DNQX/AP5 were added. Our results provide preliminary evidence that MENs can be wirelessly control with magnetic field, thus in turn enhance neuronal activity. Taken together, MENs has the potential to be a future approach in brain stimulation.

Mentors: Xiaoming Jin, Stark Neuroscience Research Institute

Type 2 Diabetes-Driven Alterations in Bone Healing and Angiogenesis

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Type 2 diabetes mellitus (T2D) is prevalent in the United States. Those with T2D are at risk for impaired fracture healing due to decreases angiogenesis, which is required for successful bone regeneration. Bone morphogenetic proteins (BMPs) are often used to help orthopedic surgeons with bone healing in difficult cases. Here we begin characterizing the mechanism by which T2D alters fracture healing with or without BMP-2 treatment. We hypothesize that T2D impairs fracture healing by decreasing angiogenesis and endothelial cell function, but that BMP-2 improves angiogenesis and bone healing. We created a high fat diet (HFD)-induced T2D mouse model to compare with control low fat diet (LFD)-fed mice. Mice underwent testing to confirm the T2D-like metabolic phenotype, underwent a critical-sized defect surgery of the femur, which was treated with either saline or BMP-2, and then were assessed biweekly by x-ray imaging over the course of 12 weeks. Finally, bone marrow-derived endothelial cells (BMECs) were collected from these mice to further assess endothelial colony and tube formation in vitro. Results indicate that the HFD mice acquired the T2D metabolic phenotype. X-rays revealed impaired fracture healing in the HFD mice even with BMP-2 treatment. In vitro tube formation and proliferation assays indicated that HFD impaired angiogenic and proliferative capabilities of BMECs, supporting our hypothesis. Finally, our group has previously shown that the main megakaryocyte growth factor, thrombopoietin, can improve both fracture healing and angiogenesis. Therefore, future investigations will examine whether thrombopoietin can more effectively improve bone healing in HFD mice than BMP-2.

Mentors: Melissa A. Kacena, Department of Orthopedic Surgery, IU School of Medicine, IUPUI; Fazal Ur Rehman Bhatti, Department of Orthopedic Surgery, IU School of Medicine, IUPUI; Ushashi Dadwal, Department of Orthopaedic Surgery, IU School of Medicine, IUPUI

Extracellular matrix (ECM) Stiffness-Driven Breast Cancer Cell Metabolic Signaling and Migration

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Cancer cells sense and respond to mechanical changes in their microenvironment such as elevated extracellular matrix stiffness and cell -cell tension via a process called mechanotransduction. The noncellular extracellular matrix (ECM) component of the tumor microenvironment and the metabolic signaling events (AMPK signaling) produced depending on the subcellular location play a critical role in promoting invasion and metastasis. We aimed to study the effects of subcellular specific AMPK signaling, specifically inhibition of AMPK activity at cellular organelles such as mitochondria and golgi apparatus, on breast cancer cell migration. Breast cancer cells (MDA-MB-231) were grown and transfected to inhibit AMPK activity in the mitochondria and golgi bodies. Cell migration activity was assessed using a scratch assay and the migration index for each treatment group was measured. We observed specific AMPK inhibition in the mitochondria reduced cell migration. Further testing and examination will be conducted to verify these results. Also, breast cancer cells will be grown in polyacrylamide gel substrates with varying mechanical stiffness to mimic primary tumor and metastatic sites to study extracellular matrix (ECM) stiffness-driven breast cancer cell metabolic signaling and migration. This project will ultimately contribute to a deeper understanding of the role of metabolic signaling and its therapeutic potential in breast cancer.

Mentor: Sungsoo Na, Department of Biomedical Engineering, IUPUI

Travel Motivations and Decisions Correlates to Fear of Missing Out: An Exploration of the Generation Z

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Social media not only has gained increasing popularity among the new generation, but also have affected their decisions, attitude, and behavior. Social media is also becoming more and more popular within tourism and travel, where the young generation relies on social media for trip ideas and informed travel decisions. The rise of social media has also resulted in the phenomena of Fear of Missing Out—normally referred to as FoMO. FoMo is defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent." The appeal of FoMO affects the young generations' daily activities as well as travel-related behaviors and decisions. This study tries to assess the impact of social media on Generation Z's travel decisions and behaviors through exploring the phenomena of FoMO. Particularly, this research tries to answer the following research questions: Do FoMo appeals affect college students' travel decisions through social media? If so, how? To address the research questions, this study plans to adopt an inductive approach and interview 50 individuals. To be qualified for the study, the participants need to be 18-23 years old, which fits in the criteria of Generation Z, and have taken at least one trip in the past 3 months. They will be asked questions about their usage of social media, their perception of FoMO, and how these factors affect their travel decisions and plans. The content of the interview will be analyzed and major themes will be identified. A thematic framework will also be developed and presented. The findings will provide theoretical insights into how Generation Z perceives FoMo and how FoMO appeals affect their travel decisions through social media. Practical implications regarding how to better market tourism and travel within the young generation will also be discussed.

Mentor: Becky Liu-Lastres, Department of Tourism, Event, and Sport Management,School of Health and Human Science, Indiana University-Purdue University Indianapolis

Group Link Predictions

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Group link predictions is a newer research topic that shares similarities with link prediction which is used in suggesting people you may know in social networks. However, instead of looking at the connections between two individuals, group link predictions look at the links between a group and an individual. We are trying to find a method that will predict who will fit best within a group of people. There are several different embedding programs that we are using as well as different ways that we are looking at the distance between points in order to maximize our prediction accuracy.

Mentors: Mohammad Al Hasan, Department of Computer & Information Science, IUPUI; George Mohler, Department of Computer & Information Science, IUPUI

Key Phrase Extraction Using NMT and BERT

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Key phrase extraction is an important task in natural language processing. However, traditional methods may not fulfill this task efficiently. Therefore, deep learning techniques are applied to speed up the process. For example, neural machine translation (NMT) models are used to efficiently work with sequential data like text. However, there has been little work exploring the use of sequential models like NMT for key phrase extraction. One part of this paper examines the usefulness of neural machine translation, a sequence to sequence model, for key phrase extraction. First, we created an automated sequential labeling system to extract keywords from tweet sequences, and we examine possible

methods to sequentially analyze the key phrases of each tweet to create an overall sentiment polarity for each tweet. Another language representation model we used was BERT: Bidirectional Encoder Representations from Transformer. When using BERT for sentiment analysis, we added a layer to capture the attention of words in determining the polarity of a sentence. By examining these attention values, we could find the important phrases in each sentence. In order to analyze these methods, we worked with a dataset of 600 tweets about the HPV vaccine. In this paper, we hope to explore both methods as a means to extract important phrases from the text.

Mentor: Xiao Luo, Department of CIT, Purdue School of Engineering and Technology, Indiana University-Purdue University Indianapolis

Perceptions of Options for Mode of Delivery in Periviable Decision-Making

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This study sought to qualitatively evaluate women's perspectives on shared decision-making for mode of delivery (MOD) in the setting of periviable delivery (22-25 weeks), including their understanding of alternatives, risks/benefits, and provider recommendations. Interviews were conducted with women hospitalized for a threatened periviable delivery. We explored decision-making prompts related to MOD. Participants were also prompted to discuss their understanding of MOD risks/benefits and provider recommendations. Interviews were coded and analyzed using NVivo 12. Two-thirds of participants explicitly acknowledged having the option of cesarean section (CS) or vaginal delivery (VD). Maternal comorbidities limited some to one option. Many expressed a particular MOD preference, but most ultimately wanted "whatever's best for baby." Conceptually, MOD preference and decision-making were distinct, but typically aligned. However, occasionally, women recognized a MOD choice, but did not perceive the decision to be theirs, and vice versa. Likewise, consent was a separate concept, as some gave consent but did not feel they made a/the MOD decision. Understanding of MOD risks was mostly limited to bleeding, infection or fetal harm. Nine participants did not discuss any risks/benefits. Most women did not describe classical cesarean or risk to future pregnancies as risks. Patients felt that physicians recommended CS for fetal distress and to avoid risk of VD, though both CS and VD were equally recommended overall. Findings revealed a need for providers to clarify options and decision-making roles; review risks more comprehensively; refine recommendations; and create shared MOD plans in periviable counseling to aid women in informed, shared MOD decision-making.

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Increasing Transparency within Intelligent Virtual Assistants

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The significant increase and prevalence of intelligent virtual assistants (IVA) such as Amazon Alexa or Google Home provides an array of benefits to the daily life of older adult consumers; however, increased consumption has also given rise to fears concerning privacy and security. Little research exists on providing transparency within IVAs; transparency referring specifically to how a device or application works in storage, utilization, and management of data. Most IVAs indicate that information is only recorded by an IVA when a wake word is uttered, and at any other moment the device is in sleep mode waiting for a user to interact. At the same time, privacy use and data management are generally kept in long document style pages on websites, which may hinder users' efforts in understanding how their information is being processed and used. Our investigation explores ways to improve transparency within

IVAs to reduce uncertainty and provide knowledge on how data is being collected and used. We conducted semi-structured interviews with older adult consumers to identify their understanding of IVAs and to test design ideas for improving transparency. Knowledge of IVA privacy, data use and data management of user data are key concerns that older adults have expressed when considering whether to adopt IVAs. Therefore, we explored approaches such as instructional videos and condensed pages of information to better clarify how a device works. We present our initial design ideas and preliminary findings of older adults' thoughts on IVA transparency and the design ideas.

Mentor: Aqueasha Martin-Hammond

Modeling and Preparation of Materials for 3D Bioprinting

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Bioprinting as a method of tissue engineering is an interdisciplinary activity, which needs optimization of its main components, namely the cells and the supporting materials ('bioinks'). Methods and Results. In this continuation MURI project, we learned, adapted and used the open-platform software CompuCell3D (CC3D), to model the behavior of cell aggregates, as dependent on glucose as available nutrient in the medium. Using it, we monitored the composition of the constructs generated by spheroids fusion, and confirmed that available glucose impacts this process via the combined effect of cell aggregation, mixing, survival and proliferation. We also compared the rates of spheroids' primary formation from hepatoma and smooth muscle cell lines. Lastly, we prepared from an alginate hydrogel, microbeads of comparable dimensions to the cell spheroids (500 microns and smaller). Conclusion. We further advanced with modeling, preparation and characterization of the 'building blocks' necessary for bioprinting.

Mentors: Horia Petrache, Department of Physics, IUPUI; Nicanor I. Moldovan, Department of Physics, IUPUI and 3D Tissue Bioprinting Core, Richard L. Roudebush VA Medical Center, Indianapolis, IN

Patient-specific and Non-invasive Quantification of Trans-stenotic Pressure Gradient in 3D-printed Replicas of Human Arteries

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Arterial stenosis is an abnormal narrowing of a blood vessel that may lead to life-threatening consequences, such as heart attack and stroke. Although computer tomography angiograms (CTAs) allow for the detection of a stenosis, the ischemic severity is determined by the pressure gradient across the stenosis, as well as the invasive measurement which is a risky, expensive, and uncomfortable procedure. This research project developed a mechanical model which mimics the pulsatile blood flow in a 3D-printed phantom that has been anatomically extracted from patient-specific CTAs. The flow rates at the inlets and outlets of the phantom are controlled based on Doppler ultrasound imaging data of the same patient. A signal processing pathway was designed to gather data from pressure transducers and a digital acquisition program was developed using LabVIEW. The mechanical system was also refined using concepts from the Windkessel model to more accurately mimic human blood pressure waveform characteristics. Both flexible and rigid 3D arterial phantoms of the renal artery were tested to observe hemodynamic differences. As the project progresses, it is intended that other arteries, both healthy and diseased, will also be tested and compared to patient data. The continued improvement of the mechanical system will provide a low-cost and risk-free methodology to help determine the severity of a stenosis, in addition to invasive measurements and image-based computational hemodynamics. The

ultimate goal of this research is to eliminate the need for invasive measurements to determine stenosis severity.

Advisors: Dr. Huidan (Whitney) Yu, Department of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI; Dr. Alan Sawchuk, Department of Surgery, Indiana University School of Medicine
Mentor: John Talamantes, Department of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI

3D Bioprinting of Vascular Channels in Hydrogels

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Bioprinting is a promising method for tissue engineering, for it combines computer aided designs with cells, hydrogels, and other biological materials to create tissue constructs. To mimic biological vascularization, channels of various complexities can be created by bioprinting either with the use of a sacrificial material, or by embedding in another supporting hydrogel. Methods and Results. In this project, linear tubes de novo generated, or extracted from microvascular images were designed in the BioCAD software of regenHU instrument and printed with Pluronic as sacrificial hydrogel. Alternatively, 3D models of anatomically realistic abdominal aortic bifurcations and of their aneurysms were also prepared in BioCAD, and directly printed in a supporting hydrogel bath with an alginate bioink containing mouse aortic smooth muscle cells. Conclusions. Bioprinting technology can be adapted to generation of anatomically realistic models of large vessels and of microvascular patterns.

Mentor: Nicanor I. Moldovan, Department of Biomedical Engineering, IUPUI and 3D Tissue Bioprinting Core, Richard L. Roudebush VA Medical Center, Indianapolis, IN

Optogenetic Activation of the mPFC During Delay Discounting

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Delay discounting can be used as a framework to measure an animal's impulsivity and consistency. The form of impulsivity we are focusing on deals with maladaptive decision making during this delay discounting process. Consistency, in this sense, is measured by whether or not the animal initiates and chooses with the same lever during the delay discounting process. Optogenetic manipulation of this brain region can result in different cognitive and behavioral effects, while also helping us better understand the decision-making process. Previous studies done by our lab have shown that optogenetic inactivation of the mPFC decreases an animal's consistency and increases their impulsivity. The goal of this study is to evaluate the pro-cognitive effects of optogenetic stimulation of the medial prefrontal cortex in Wistar rats during delay discounting. It is hypothesized that an animal's consistency will increase during optogenetic activation of the mPFC.

Mentor: Christopher Lapish

In Vitro Modeling of the Glaucoma Risk Factor, POU6F2, using Human Pluripotent Stem Cell-Derived Retinal Organoids

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Retinal ganglion cells (RGCs) are the projection of the retina, located within the most interior layer. RGCs send signals between the eye and the brain, allowing for the ability to see. RGCs mature over time *in vivo*, and this phenomenon can be recapitulated *in vitro* using human pluripotent stem cells (hPSCs).

hPSCs can be differentiated and organized into retinal organoids, which is advantageous for modelling. Damage to RGCs, leading to degeneration of these cells is seen in glaucoma and other neurogenerative diseases. POU6F2 has recently been identified as a risk factor for glaucoma, however, the mechanism in which it works remains unknown. Therefore, the aim was to characterize POU6F2 expression at various time points in retinal organoids. Using immunocytochemistry (ICC) and cyrosectioning, retinal organoids were stained for POU6F2 and imaged at multiple time points. Based on the data, POU6F2 emerges around week 4 and steadily increases until week 6. Then, begins to decrease at later time points. The link between RGCs and POU6F2 and its shown predisposition for retinal ganglion cell death in glaucomatous models is important for future studies in showing whether POU6F2 is detrimental to the cells or if it plays a role in neuroprotection.

Mentor: Dr. Jason Meyer, Sailee Lavekar

Data Exploration in Dark Web Markets

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The Dark Web is an area of the internet that exists on an encrypted network where anonymity of users is preserved through the use of the Tor-Browser. This feature makes it a popular ground for users to engage in illicit activities, most notably, involvement in the online drug market. In this study, we analyzed data collected from 2018-2019 to understand contemporary darknet markets. We take a closer look at the goods and services being sold, behaviors in the buyer-seller network, and the economy of Dark Web marketing. Techniques in statistical analysis and data mining will be used via tools that enhance data augmentation, visualization, and comprehension (i.e. Beautiful Soup, Python, MySQL, Plotly, and Jupyter). We also explore the possibility of linking sales on dark web markets to bitcoin transactions. By investigating illicit activities on these markets, we aim to provide the necessary comprehensive analysis to further promote law enforcement intervention and established policies in the cryptocurrency ecosystem.

Mentors: Mohammad Al Hasan, Department of Computer and Information Science, Purdue School of Science, IUPUI; George Mohler, Department of Computer and Information Science, Purdue School of Science, IUPUI

Dual Classifiers Assisted Unsupervised Domain Adaptation

Alex Chen, Javier Campos

Domain adaptation has attracted great attentions to facilitate the sparsely labeled or unlabeled target learning by leveraging previously well-established source domain through knowledge transfer. Recent activities on domain adaptation attempt to build deep architectures to decrease cross-domain divergences by extracting more effective features. However, its generalizability would decrease significantly due to the domain mismatch that enlarges particularly at the top layers. In this work, we develop a novel Dual Classifiers assisted Domain Adaptation framework (DCDA) to solve the domain mismatch across source and target domains. Specifically, we explore the maximize mean discrepancy (MMD) by incorporating the pseudo labels of target samples to measure the domain difference better. Hence, we can bridge the domain gap in a semi-supervised fashion such that the marginal and conditional disparities across different domains will be better alleviated. Moreover, dual different types of classifiers are jointly trained to optimize the prediction on the target samples to maximally enhance the prediction ability of both classifiers. Experimental results on visual domain adaptation benchmarks verify the effectiveness of our proposed approach on boosting the recognition performance for the target domain, by comparing it with other state-of-the-art deep domain adaptation algorithms.

Mentor: Dr. Zhengming Ding, Purdue School of Engineering, IUPUI

Molecular changes in bone in the absence of complement molecule C3

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The bone is capable of healing itself with the aid of the immune system and endocrine action that occurs within the bone cells; osteoblast, osteocytes, and osteoclasts. The complement system is part of the innate immune response and plays an important role in bone healing by being the activator and amplifier of local and inherent inflammation. Complement activation occurs via three important pathways (classic, alternative, and lectin pathways) in which different proteases get activated in a chain reaction with the goal to generate active C3. The complement molecule C3 will then bind to its receptor and prompt significant functions of immune cells. To demonstrate the connection between the role of complement and bone healing, this study focused on the absence of complement molecule C3 in mice with global deletion of the C3 gene, and comparing it with wild type mice to determine if absence of C3 leads to changes in the expression of intracellular signaling molecules or enzymes in bone cells. This was mainly investigated by isolating RNA with trizol reagent and RNA purification; also using a DNA polymerase and reverse transcriptase machine and a quantitative polymerase chain reaction. We are currently analyzing the levels of expression of bone-specific genes using real time quantitative PCR (qPCR). Also, we are testing the effect of C3 gene in different model systems to see if there is a relation between C3-Panx1, FMR1 and miR-21.

Mentors: Lilian Plotkin, Department of Anatomy, IU School of Medicine, IUPUI; Padmini Deosthale, Research Analyst, IU School of Medicine, IUPUI.

Optimization of Assay Protocols for the Analysis of Salivary Cortisol in Clinical Trial Participants Receiving a Music Therapy Intervention

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[3] Indiana University School of Nursing, Indianapolis, Indiana

Active Music Engagement (AME) is a music therapy intervention conducted to help patients acquire behavioral skills that will help them cope with stressful situations such as hospitalization for cancer treatment. The Translational Research Core (TRC) is aiding Dr. Sheri Robb's team in evaluating the effect of AME in pediatric patients undergoing stem cell transplant as part of their treatment as well as their parent. In order to determine whether salivary cortisol is a valid biomarker to assess the effects of AME in these patients, saliva was collected at three different time points from both parent and patient. The sample was collected before AME, after AME, and 1-3 hours after the prior collection. Saliva was collected on control days at the same time corresponding to the AME sessions. After the collection, the samples were stored at -80until analysis. A subset of samples were analyzed via cortisol immunoassay to optimize the assay before running the remaining samples. Analysis utilized a UV-VIS spectrophotometer. A 4-parameter logistic curve was plotted from the standards to obtain the unknown concentrations. The samples revealed that a 5-fold dilution is required to accurately assess the concentration of the unknown samples. These results were essential for establishing a protocol by which all samples will be analyzed. This study will be among the first to assess the use of salivary cortisol as a biomarker for stress in pediatric patients undergoing HSCT and receiving a music therapy intervention.

Mentor: Dr. Kristen Russ, Director, Translational Research Core, Indiana University Melvin and Bren Simon Cancer Center

Emerging Graphene/Josephson Junction Devices Into High Speed Communication

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Josephson Junctions are ultra-fast devices that consist of two superconducting plates separated by a nanoscale layer of nonconducting material which exhibits quantum tunneling phenomenon and many resulting side effects which have potential applications in physics and engineering. While Josephson Junctions-based devices have existed since nearly 1962, when the devices were discovered by B. D. Josephson, interfacing or otherwise interacting with them using standard electrical systems has been an issue and a challenge for several reasons, including operating temperature, switching speed, low-signal sensitivity, and the superconducting-conducting junction. Here we investigate how the Josephson Junctions so-called AC-effect – an effect where when a constant voltage is applied across a junction it outputs a sinusoidal current whose frequency directly scales with voltage – can be controlled and how to interface it with standard electronics using graphene nanoribbon field-effect transistors (GNRFETs). The purpose of this setup is to provide a foundation on top of which further developments can be made, especially in the areas of communications, medical devices, instrumentation and measurement devices, high-speed imaging, sub-infrared antenna arrays, and computer architecture and hardware, by providing a system which can respond to speeds on the order of fifty to one hundred times faster than current commercial computer equipment or signal generation/processing, and between a seventh and a fourteenth the size of the best transistor technology currently on the market.

Mentor: Dr. Maher Rizkalla, Department of Electrical and Computer Engineering, IUPUI School of Engineering

Synthesis of hydroxylated seed oil with improved function

Damon Cookerly
Purdue School of Science, Department of Chemistry & Chemical Biology

The idea of synthesizing 'unusual' fatty acids is one that has been around for decades. It is necessary, now, that humans develop methods for synthesizing these 'unusual' fatty acids so that they can be readily available without the need of extracting them from plants. The recent discovery of the seed oil of Orychophragmus violaceus (a flower native to China) has led to new attempts to modify the oil of the plant, such that the altered oil will have enhanced physical properties.

Mentor: Dr. Robert Minto

Fabrication and Characterization of UV-Initiated Dynamic Hydrogels for Biomimetics

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Department of Biomedical Engineering, Purdue School of Engineering and Technology, IUPUI

Hydrogels are networks of polymeric chains filled with water which can be customized in composition, fabrication method, and post-fabrication treatment to alter gel properties such as stiffness, size, and bioactivity. The purpose of our work was to tune dynamic hydrogels to create platforms for tissue engineering and cell studies. Norbornene-functionalized natural gelatin or synthetic PEG-tetra-norbornene was combined with thiol-containing molecules like dithiothreitol (DTT), PBS, and lithium arylphosphinate (LAP) in a precursor solution where LAP would trigger free radical formation under UV exposure and promote the cross-linking polymerization of the gel. Loading the precursor into a glass sleeve and polymerizing produced bulk gels while the use of a T-junction flow-focusing microfluidic system with orthogonally flowing oil and polymer phases produced microgels. After fabrication some gels were also given post-treatment of heparin, an anti-coagulant, as well as heparin-tetrazine in order to test for the effects of biologically relevant modifications on gel properties. The bulk gels were characterized using a rheometer while the microgels were imaged using Lionheart microscopy, allowing for the characterization of a specific gel composition through bulk rheometry as well as microgel image analysis. We found through rheometry on bulk gels that increasing the weight percentage of PEG_{NB}+DTT in

precursor solution results in a more than twofold increase in stiffness per weight percent. Additionally, increasing PEG_{NB}+DTT weight percentage in microgels resulted in significantly smaller gels in 3%, 4%, 5% weight. Increasing oil phase flow rate in microgel fabrication also caused a significant decrease in gel size. When treated with heparin and heparin-tetrazine, bulk heparin-tetrazine gels were tenfold stiffer than heparin gels and heparin-tetrazine microgels stained purple as opposed to no staining in heparin microgels. The tunability of these microgels introduces a dynamic biomimetic platform that permits for further application in drug delivery and tissue engineering.

Mentor: Chien-Chi Lin, Department of Biomedical Engineering, Purdue School of Engineering and Technology, IUPUI

Elucidating the role of IL-17 in macrophage polarization in recovery following Acute Kidney Injury

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Acute Kidney Injury (AKI) impedes the body's ability to filter toxins from the blood and is known to have negative health effects on patients, including an increased risk for developing chronic kidney disease (CKD) and high mortality. Immune infiltration in AKI includes the presence of T cells and macrophages, which the latter of which can take on two polarizable phenotypes, referred to as M1 and M2. Previous studies have suggested that the dynamic between these two phenotypes influences the progression of multiple disease models, including AKI. Previous work in our lab suggests that Th17 cells, which produce the cytokine IL-17, play a role in the progression from AKI to CKD, and may influence macrophage polarization. The goal of this project was to better elucidate the role of IL-17 in macrophage polarization in recovery following AKI. In order to test this hypothesis, we utilized a model of Th17 depleted rats (ROR gamma C mutant rats) and compared inflammatory response wild-type (WT) control rats. Wt and KO were subjected to renal ischemia reperfusion. After sacrifice, macrophages were isolated and cultured. Following ischemia, KO rats showed decreased ability to recover following injury and elevation in renal macrophage infiltration. Further studies of macrophage phenotype polarization are still in progress. These results suggest that IL-17 participates in recovery following AKI although a more complete analysis of macrophage polarization requires flow cytometry studies. These results will us a more complete understanding of the mechanisms governing macrophage polarization as well as a pathway which could target macrophage repair and response.

Mentor: David P. Basile, Department of Cellular and Integrative Physiology, IU School of Medicine.

Crystallization of APE1

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Protein Crystallization is the procedure of transforming a protein into crystals. These crystals are beneficial in determining the protein's structure using X-ray Crystallography. The protein that was studied was Human Apurinic Endonuclease 1 (APE1) because of its role in the base excision repair pathway (BER). Its function as a DNA repair protein in BER made it a primary target in developing cancer-therapeutic drugs (drugs that can bind directly to APE1). Four inhibitors were used in the studying the crystallization of APE1: a well-documented APE1 inhibitor called E3330 and fragments; CAS [121-48-2], B3, and C2. The method used for crystallization was the hanging drop vapor diffusion method. In the hanging drop vapor diffusion technique, a 2uL drop on a glass slip containing 1uL of APE1 and 1uL of the inhibitor (both having same concentration) is suspended as a drop hanging over a % PEG reservoir solution and sealed. When incubated at 20°C, the drop undergoes a change in concentration through loss of water vapor until the drop's concentration is that of the reservoir. The purpose is to grow crystals of APE1 that are suitable for X-ray diffraction analysis providing a structural basis for the interaction of the inhibitor/fragment with APE1.
Mentor: Millie M. Georgiadis, Department of Biochemistry and Molecular Biology, IU School of Medicine

Encapsulation of the Magnetic Nano-powder/Nanoparticles in Silica

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In the last few years, iron oxide nanoparticles have been widely used in imaging, biomedical application and technology due to their unique magnetic properties. However, in order to make them useful in biomedical applications, such as transporting medicine they must be encapsulated with either a hydrophilic or hydrophobic coating substance. The purpose of this research is to encapsulate Fe_3O_4 nanoparticles with silica in order to decrease its toxicity when injected in the eye to treat detached retinas. Silica coated iron oxide nanoparticles usually are stable and can be easily dispersed in an aqueous or organic solution, even without surfactants. The magnetic nanoparticles/Nano powder can be encapsulated within silica through the modified Stober method and reverse microemulsion. This study proceeded with the Stober method, as it offers higher chemical and colloidal stability. The thickness of the SiO_2 shell can be tuned by controlling the concentration of the chemicals, temperature, and stirring technique. As the iron oxide surface has a strong affinity to silica, the coating of silica can be achieved without intermediate steps to promote the adhesion of silica to the iron oxide surface. Coated nanoparticles were further characterized using images from an inverted microscope to verify the change in size of the coated nano-powder. The outcome of the project is to coat single nanoparticles with silica and suspend them in silicone oil, in order to localize them in the eye to treat retinal detachment.

Mentors; Rasoul Akbari, Purdue School of Engineering and Technology, Indianapolis, IN; Dr. Afshin Izadian, Purdue School of Engineering and Technology, Indianapolis, IN; Dr. Amir Reza Hajrasouliha, Department of Ophthalmology, Indiana University School of Medicine, Indianapolis, IN

Computational and Experimental Assessment for Ischemic Severity of Arterial Stenosis based on Patient's Radiological Images

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We focus on the uses of different software approaches to analyze the medical data for arterial stenosis from IU Methodist Hospital and the computational results from *InVascular* (an in-house computational modeling platform for noninvasive and patient-specific assessment of The four important aspects to this research project include a statistical analysis of medical data, stenosis shape extraction , 4D blood blow visualization and animation, and graphical user interface (GUI) design of *InVascular*. Statistical analysis of medical data serves as an indicator, which helps doctors to understand the trends over time thus making predictive analytics to the individual patient. Along with statistical data analysis, software simulation is used as an aid in determining stenosis severity. In this project, stenosis severity is estimated by calculating the cross-sectional areas of a certain artery and visualized by constructing animation of arterial blood flow in four dimensions. A web application, called *InVascular*, is being developed to function as a patient-specific, non-invasive computational platform to support the diagnosis of cardiovascular diseases. This tool helps both physicians and patients to have a better understanding of patients' arterial stenosis condition by providing information such as 4D blood flow visualization and animation, stenosis severity and other statistical analysis based on the radiological images (CT or MRI) uploaded. The visualization software tool, called Para View is used to help show the blood flow in 4 – dimensions, so that both the doctors and the patients can see the blood velocity at every location and time step of the data. Blood flow rates allow the users to have a better understanding of the patient's condition and their severity. Users would be able to see the results through various data filters, where they can be used both manually and through python code.

Mentors: Dr. Whitney Yu and her MS and PhD students Xin Jin, Arya Abootorabi, Xiaoyu Zhang, Rou Chen, Monsurul Khan, Department of Mechanical Engineering, Purdue School of Engineering;

The Effects of Cannabidiol on the Human Gingival Fibroblasts

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Cannabidiol (CBD) is the second most prevalent chemical in the *Cannabis sativa* plant, commonly known as marijuana. Cannabidiol is extracted and used to reduce inflammation, seizures, pain, anxiety, and psychotic symptoms. The use of CBD has become more prevalent due to its antipsychotic effects and that it does not produce a euphoric high or psychoactive effect. The primary goal of this research was to evaluate the effects of CBD on the Human Gingival Fibroblasts (HGFs) in regards to cell proliferation and toxicity. These assays are essential to defining a concentration of CBD to be use when examining the levels of cytokines and growth factors involved in inflammation that may be altered by CBD. The first step was to grow HGFs in order to do WST and LDH assay to determine cell proliferation and cytotoxicity. respectively. However, this step encountered numerous challenges. Initially, the CO_2 incubator did not function properly. Secondly, the alternate incubator resulted in the bacteria contamination of the cell cultures; An alternate CO_2 incubator was then utilized, which solved problems for CO_2 levels and contamination. However, cell culture problems continued. Because of time limitations, studies were performed to show the direct effects of CBD on matrix metalloproteinase activity, which is involved in inflammation. Zymmography was utilized to examine CBD. CBD at 10 mg/ml inhibited MMP-2. Preliminary data conducted in the lab has shown that CBD can be toxic and affect cell proliferation. In conclusion, CBD can affect the activity of MMPs and that research is a challenge.

Effects of Chronic Alcohol Exposure on NMDA Receptors in the Rat Brain

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Excessive NMDA receptor activation can lead to cell injury and death through excitotoxicity. Prior studies have shown that the serial exposure to a model of chronic voluntary alcohol drinking and a binge model of methamphetamine (Meth)-use induces a loss of dopamine cell bodies in the substantia nigra with these effects being blocked by the antagonism of cyclooxygenase-2 during alcohol exposure. In addition, studies have shown that chronic alcohol administration increases NMDA glutamate receptor expression in the hippocampus and cortex whereas Meth exposure alone increases glutamate transmission. Therefore, we hypothesized that chronic alcohol drinking increases NMDA receptor expression not only in the frontal cortex and hippocampus but also in the substantia nigra, the latter leading to an excitotoxic dopamine cell loss after exposure to Meth in a manner that is dependent on COX-2 activation during alcohol drinking. Using a model of chronic alcohol exposure, rats were allowed 28 days of intermittent access to 10% alcohol. We report on the effects of alcohol drinking on NMDA receptor levels, specifically at the substantia nigra pars compacta, hippocampus and frontal cortex of rats treated with or without a COX-2 inhibitor.

Mentor: Eric A. Rodriguez

Documented Medical Treatment Preferences Following Acute Severe Stroke

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After severe stroke, patients, families, and clinicians often face difficult, time-sensitive decisions about whether to continue or forgo life-sustaining treatments. One way in which patients can present their wishes is through Do Not Resuscitate (DNR) or Do Not Intubate (DNI) orders. These orders indicate whether the patient wishes to be resuscitated and/or intubated if they experience cardiac arrest. Methods: A retrospective medical chart review was conducted to determine the proportion of patients who have DNR/DNI orders and associated patient and clinical characteristics. Ischemic stroke patients

with National Institutes of Health Stroke Scale Score (NIHSS) of ≥10 were included in this study. Results: Only 26% of patients had a DNR/DNI order present in their medical chart. Patient clinical characteristics associated with DNR/DNI orders include white race (p-value = 0.0043), high NIHSS (p-value = 0.0007), mechanical ventilation (p-value = 0.0474), and age (p-value = 0.0001). DNR/DNI utilization is associated with hospital mortality, moving to comfort measures only, extubation after moving to comfort measures only, withdrawal of artificial nutrition after moving to comfort measures only, hospice utilization, and palliative care consultation (p-value = 0.0001). Conclusions: Severe stroke patients who are older, white, and undergo mechanical ventilation are more likely to have a DNR/DNI order in their chart. Palliative care consultation, hospital mortality, moving to comfort measures only, extubation and withdrawal of artificial nutrition after moving to comfort measures only, and hospice utilization are also associated with patients having DNR/DNI orders in their chart.

Mentors: Dr. Amber R. Comer, PhD, JD, Department of Health Sciences, IUPUI School of Health and Human Sciences

Temperature Effects on UV Photocrosslinking to Antibodies at the Conserved Nucleotide Binding Site

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Conjugating reporters to antibodies will enhance antigen detection efficiency and sensitivity in diagnostic assays. Here, the effects of temperature on antibody conjugation efficiency utilizing the UV-NBS antibody conjugation strategy for site-specific covalent functionalization of antibodies with indole-3-butyric acid (IBA)-FITC was studied. Taking advantage of the nucleotide binding site (NBS), found in the Fab variable domain of all antibody isotypes, ligands can be site-specifically conjugated to antibodies. IBA has high affinity to the NBS allowing for FITC modified IBA to be conjugated at the NBS using a UV crosslinker. To demonstrate the impact temperature has on the number of conjugations and resulting stability of the antibody conjugate, Rituximab (15μM) and IBA-FITC (300 μM) were incubated for 10 minutes and photo crosslinked by exposure to 1 J/cm^2 at different temperatures: 0, 15, 25, 37, 50, and 70°C. The absorbance at 280 and 494nm of the antibody-IBA-FITC conjugate was used to quantify the average number of conjugations per antibody. Conjugation efficiency was lowest at 0°C while leveling off as the temperature increased (15°C-50°C) until a temperature of 70°C at which point the antibody began to denature. Thermal denaturing of the antibody caused non-specific crosslinking, increasing the average number of conjugations while reducing the antibody recovery yield. The 15°C sample was used to test the conjugation stability over 14 days of storage at room temperature. In summary, the range of temperatures between 15°C-50°C yielded a minimal change in the number of conjugations while showing a significant deviation in conjugation efficiency at extreme temperatures.
Mentor: Nathan J. Alves, Assistant Professor of Emergency Medicine, Assistant Professor of Biomedical Engineering, IU School of Medicine

Transcription Termination Factors in Cancer Cells

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KH and p15RS are transcription termination factors involved in the genetic stability of cells. It is unknown how these termination factors mechanistically repair DNA breakage. While similar, they do have differing expression in tumors. This paper examines the difference between p15RS and KH in HTC 116 cells, which are proliferating cancer cells. KH and p15RS knock down cells were made using transient and viral infection, and successful knockdown was confirmed using a Western blot. These cells were then examined using a variety of procedures: antibody fluorescence, flow cytometry, and cell colonization. Once these methods were complete, they were used to find differences between KH and p15RS knockdown cells to see how these transcription termination factors differ.
Mentor: I-Ju Yeh, Department of Biochemistry and Molecular Biology, IU School of Medicine

Direct Amide Synthesis from Carboxylic Acids Using N-Haloimide Reagents

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A method for the amination of carboxylic acids has been developed using a N-chloro phosphonium salt (NCPS) generated in situ from N-chlorophthalimide and triphenylphosphine. The NCPS was found to serve as both an aminating agent and coupling agent to produce acyl phthalimides and amides, respectively. The NCPS was found to directly laminate aliphatic, aryl, allylic, and benzylic carboxylic acid substrates. The employed NCPS was also found to effectively couple carboxylic acids to a variety of primary and secondary amines. The proposed methodology represents an alternative towards the amination of carboxylic acids run under ambient conditions. Overall substrate scope, robustness of reaction, and mechanistic work will be presented.

Mentor: Sebastien Laulhe, Department of Chemistry and Chemical Biology, IUPUI

Copper-Catalyzed Amination of Boronic Acids

Timothy B. Fulton, Sebastien Laulhe
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The design of aryl imides remains a critical focus for synthetic chemists due to their prevalence in medicinal and bioactive compounds. Traditional methods of aryl imide synthesis utilize harsh reaction conditions or expensive, toxic transition-metal catalysts like palladium. The research herein introduces a novel reaction pathway that favors room temperature and a cheaper, safer copper catalyst. The screens performed have suggested DMF and potassium carbonate as the ideal solvent and base pair to couple boronic acids to N-chlorophthalimide. Additionally, the current optimization suggests that copper (II) is favored over copper (I) sources. Further research will be done to further optimize the reaction conditions for optimal yield including more exhaustive substrate, base, and ligand scopes. A full presentation of screens that have been performed will be presented.

Mentor: Sebastien Laulhe

Interface Development for Coupling Real-Time Multichannel Functional Electrical Stimulation with Musical Software

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Functional electrical stimulation utilizes low-energy electrical stimulation as a therapeutic means for treating individuals whom express modalities associated with central nervous system injury. Stimulators used for this purpose lack flexible control of multiple channels, which is needed to coordinate muscle group activation properly. Similarity of multi-channel stimulation to music and modern digital music software provides a possible solution. This project aimed to develop the 1st bottom up drivers to take a multi-track music file and stream it through a multi-channel FES stimulator. MATLAB and a dynamic link library were employed in this work in order to interact with a stimulus generator. Once connection was established, MATLAB waveform functions were used as stream output, which was visualized using data acquisition tools. Streaming mode uses a circular buffer where one part of the buffer is loaded on the PC while the other is sent to and stored on the stimulator. Testing the optimal size of the buffer was a main objective. The goal is to have a small buffer to reduce latency, but ensure it is large enough such that no gaps occur in the data. The buffer capacity was capable of reaching as low as 4000 bytes while using MATLAB waveform functions. To ensure that no gaps occurred in the data, buffers were increased to 30000 bytes when using .wav files as the waveform source. With minor adjustments, moving towards integration with music technology is possible.

Mentor: Ken Yoshida

Voice Assistant

Brian Gaitan
School of Informatics, IUPUI

Voice assistants have become an incredible opportunity for everyone to engage with information in different ways, but voice assistants have at times not been very successful with recognizing medical terminology. Voice assistants are rather successful at general search topics; however, they do not always give people the answer they want or expect. What we know now is that researchers are working on how to improve search generally but there are still open challenges of how to help users find the medical or health information they want using voice assistants. These challenges can be due to terms that are not easy to pronounce, and people also have different accents and way of saying things. For my research project, I will develop a voice search prototype and test the system by having users say a set of medical terms. The goal is to understand how well the system understands users. Additionally, we will talk with users to see how we can improve the information returned to make things better match what they expect while returning accurate content to the user. We hope to understand how to improve the voice search for users.

Mentors: Aqueasha Marie Martin-Hammond

Steady and Near Steady State Cancer Cell Model

Robert Lorch[1], **Alan Gan[2]**, Jared Barber[3]
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Breast cancer affects around 3.5 million Americans, and metastasis is involved in 70-90% of cancer-related deaths. To better understand cancer cell mechanics in diagnostic microfluidic devices and during metastatic migration, a two dimensional cancer cell model was developed by Barber and Zhu. To assist with the calibration and development of this more comprehensive model, a model of cancer cells in and near steady deformation states is created. The model is comprised of a triangular mesh of viscoelastic elements (damped springs). Balancing forces results in a system of differential equations. A steady state solver and implicit time-integrator are implemented in order to consider the equilibrium configuration and time dynamics of the cancer cell. The model is similar to the original model except that it is used to consider experiments taking place during extremely slow flow conditions and therefore ignores external fluid forces acting on the cell. This makes this new model both simpler in terms of construction and more efficient in terms of computational runtime. This tool is used to consider how internal elasticity affects cell behaviors. In the future, the tool can be used to explore more complex and physiologically realistic cytoskeletal structures and calibration of model parameter values using multiple experiments available from the literature.

Mentor: Jared Barber, Department of Mathematical Sciences, IUPUI

Characterization of Aldehyde Dehydrogenase 1A (ALDH1A) Inhibitors for Cancer Treatment

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Recently, the role of human aldehyde dehydrogenase (ALDH) isoenzymes has been a subject of interest as they play key roles in both healthy and disease conditions. The human ALDH superfamily consists of 19 isoenzymes that are responsible for the metabolism of aldehydes. The ALDH1A subfamily, in particular, metabolizes retinaldehyde and is involved in the regulation of important processes including cell differentiation, proliferation and cell death. ALDH1A isoenzymes have been implicated as key

contributors to cancer outcomes. ALDH1A activity is used as a marker for cancer stem cells. In accordance with this, high ALDH1A activity correlates with reduced survival, increased chemo-resistance and increased chance of relapse in several solid cancer types, including breast and ovarian. Despite the clear importance of ALDH1A enzymes in cancer, the exact roles of these enzymes are unclear. ALDH1A subfamily inhibitors may help uncover the contributions of individual isoenzymes in healthy and disease conditions. This study focused on developing structure-activity relationships for ALDH1A inhibitors, based on our initial hit compound, CM10, using enzyme kinetics assays, structural biology and cell culture experiments. We performed an initial screening assay against the 1A isoenzymes and followed it up with EC_{50} determination. The screening results showed that the CM10 analogs inhibited effectively ALDH1A activity. These findings are consistent with prior survey of compounds from this same chemical series and extend the findings into novel chemical entities. The development of these ALDH1A inhibitors are leads toward potential treatments that could improve of patient outcomes for solid tumors that develop resistance to standard therapies.

Mentors: Cyrus Takahashi, Mikhail Chtcherbinine and Thomas D. Hurley, Department of Biochemistry and Molecular Biology, Summer Undergraduate Research Experience in Biomedical Sciences, Indiana University School of Medicine

Determining Efficiency of 3D Pose Estimation in Real Traffic Environments

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To obtain a full understanding of and successfully reconstruct poses of humans, who are 3 dimensional beings, 3d pose reconstruction is essential as it stores essential information that is loss using 2d reconstruction. A space is required to obtain an accurate depiction of a human's actions. World Health Organization, "Global Status Report on Road Safety 2018," reports that 54% of those killed in road traffic are pedestrians, cyclists, and motorcyclists. Our dataset consists of 1,428 clips of pedestrians walking, running, and standing in real life traffic environment. The results from a real traffic scene prove to be more accurate for our testing in comparison to a controlled environment. We are using our dataset and extracting the frames from the video sequence at about 32 FPS. In each frame we are able to detect the position and intention of the pedestrian(s) and form a 3d pose. Throughout this study, we have learned the importance of being able to work simultaneously using 2d and 3d data to create a pose estimation or intention of a pedestrian. This paper will focus on observing and analyzing what specific situations do 3d pose estimations excel at inferring motion and intention of pedestrians in traffic environments. By having a firm understanding in what situations 3d pose estimations are most effective at detecting a person's locations and direction of motion, autonomous and driver-assisted vehicles will have a better understanding of where a pedestrian are and as a result become more efficient at understanding pedestrian initiated circumstances and reacting accordingly to the situation occurring.

Mentors: Dr. Renran Tian, Department of Computer Information Technology, Purdue School of Engineering and Technology, IUPUI; Tina Chen, IUPUI

Contribution of G-Protein Coupled Receptor 31 (GPR31) to β-Cell Health Under Diabetogenic Stress

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Center for Diabetes and Metabolic Diseases, Indiana University School of Medicine

Islet β-cell inflammation, dysfunction, and death are characteristic of type 1 diabetes (T1D) and type 2 diabetes (T2D). 12-hydroxyeicosatetraenoic acid (12-HETE) is an inflammatory mediator that binds to the G-Protein Coupled Receptor 31 (GPR31) to activate pathways related to oxidative stress and eventually β-cell dysfunction and death. Therefore, we hypothesize that inhibition of GPR31 can provide a potential treatment for diabetes. To characterize GPR31, glucose tolerance tests were performed on GPR31 knockout (KO) and wildtype mice to show normal blood glucose levels and glucose tolerance in KO mice. Pancreatic islets from GRP31 KO and wildtype mice were then isolated and treated with a

mixture of cytokines IL-1, TNFα, and IFNγ overnight to mimic inflammatory conditions. In KO mice, a statistically significant increase in expression of the genes *Insulin* and *Pdx1* indicates improved β-cell health, a trend showing a decrease in *CHOP* and spliced-*Xbp1* expression indicates reduced ER stress, and a statistically significant decrease in *Gp1x* expression indicates reduced oxidative stress compared to wildtype mice. Finally, peritoneal and bone marrow-derived macrophages were obtained from KO and wildtype mice and stimulated with LPS or IL-4. Macrophage polarization and activation was characterized using flow cytometry. We conclude that GPR31 and its role in the lipoxygenase pathway may contribute to ROS production, oxidative stress, and inflammation experienced by β cells. In the future, GPR31 could serve as a potential therapeutic target for treating diabetes.

Mentor: Raghu Mirmira

Use of the PFC-VTA network in decision making

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Decision making is a necessary skill that everyone is inevitably involved in and can be impaired by different neurological disorders, such as addiction. Decision making is tested in tasks with two choices, one of which is reinforced by a reward in a learning process called instrumental conditioning. We use a model of cortical dynamics designed for two choice instrumental conditioning tasks. This model describes what takes place in the prefrontal cortex (PFC) during decision making. However, learning rewarded behavior during instrumental conditioning is also known to be based on dopamine signaling. The PFC sends excitatory signals to the ventral tegmental area (VTA) that contains two groups of neurons: dopamine (DA) and γ–aminobutyric acid (GABA) neurons. These neurons play a role in signaling the magnitude and timing of the reward. Reward prediction errors (RPE) are the differences between the expected and received rewards. RPE is encoded by the interaction between DA neurons and inhibitory GABA neurons. Altogether, our model explains how the PFC-VTA network encoding predicted and actual rewards can account for the dynamics during decision making.

Mentor: Alexey Kuznetsov, Department of Mathematical Sciences, IUPUI

The Role of *elf3* in Ethanol Dysregulated Transcriptional Networks

Matthew Hawkins
Purdue School of Science, Department of Biology

Fetal alcohol spectrum disorders (FASD), are a grouping of disorders caused by exposure to alcohol during prenatal development. FASD occurs in approximately one in one-thousand live births in America, and in certain populations across the United States, the number of those affected by FASD can rise up to nine in one hundred school-aged children. The effects of FASD include reduced body size and weight, learning disabilities, delayed psychosocial development, and defects in organ growth and function. Currently, no specific treatment/ therapies are available to those affected by FASD. In initial findings, transcription factors (*elf3* and *sox2*) were found to be sensitive to ethanol exposure. In previously performed experimentation using loss- and gain-of-function trials, *sox2* was determined to aid in the process of rescuing the ethanol treated model. Since this relationship in ethanol exposure and transcription factor dysfunction has been established, analysis of the individual role of *elf3* via wholemount in-situ hybridization (WISH) is needed for the determination of potential rescue methods of ethanol treated models.

Mentor: Dr. James Marrs, Ph.D.

Construal Level Theory of Psychological Distance: Direct Democracy and the Democratic Relationship

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On paper, the promise of direct democracy, should be able to connect citizens closely to the policy making process. This close connection should foster a better relationship between a government and the people it governs. However, the empirical results are mixed. We argue this is because scholars have too narrowed a focus. Instead of focusing solely on the casting of a vote, or one measure of the health of the democratic relationship, we take a more holistic approach. We draw on Construal-Level Theory (CLT) of psychological distance to better understand this link between political context and political connectivity. CLT states that an individual's psychological distance from a goal will affect how that individual conceptualizes the goal. When applied to direct democracy, the different laws that states use in the ballot initiative process change the psychological distance that their citizens feel in regard to the process. More recent theoretical research suggests that simply measuring one element of civic personality is not broad enough to truly capture the democratic relationship. We broaden our initial work to include, internal and external political efficacy as well as trust in the government and trust in the community. We find results that confirm our hypotheses in two out of the three cases, suggesting that, in fact, the construal that the individual employs is closely tied to their evaluation of their democratic experience.

Mentor: Aaron Dusso, Department of Political Science, School of Liberal Arts, IUPUI

Electrospun Nanofibers for Carbon Fiber Composite Reinforcement

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Carbon fiber composites are a promising developing alternative for many metals used in industry due to their high strength to weight ratio. These composites are currently being commercialized in many industries, including the aerospace, defense, and automotive industries. However, polymer reinforced composites have become more appealing for research purposes due to the increase of mechanical strength they exhibit with respect to current composites. The traditional composites usually do not show great interlaminar shear properties as there is not much reinforcement through the thickness; however, the composites can be strengthened through the process of electrospinning a Carbon Nanotube (CNT)-Epoxy solution between the layers. Electrospinning is simple, low cost, and an applicable method to many industries. The novelty of this project is to be able to reinforce the composite without compromising its weight. Therefore, the electrospinning method, which allows for aligned nanotube layers to be deposited in thin sheets, was used to spread the solution onto the reinforced carbon fiber fabric (prepreg). The prepreg was then vacuum pressed and cured to make the final coupons. The results revealed that the reinforced polymer composites showed a 20% increase in mechanical strength. The gain in strength implies that under same-load conditions applied to both the control and reinforced composites, the reinforced composites will be able to reduce 20% of the weight required by the control composites or conversely be able to endure 20% more load in many industry applications.

Mentors: Mangilal Agarwal, Department of Mechanical and Energy Engineering, Integrated Nano systems Development Institute, Purdue School of Engineering and Technology; Hamid Dalir, Department of Mechanical and Energy Engineering, Integrated Nano systems Development Institute, Purdue School of Engineering and Technology; Pias Biswas, Department of Mechanical and Energy Engineering, Integrated Nano systems Development Institute, Purdue School of Engineering and Technology

Infant Mortality in Indiana: Building the Social Infrastructure to Improve the Health of Communities

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IU School of Liberal Arts

In the state of Indiana, the Infant Mortality Rate greatly exceeds the national average. Within the city of Indianapolis, different social determinates of health such as socioeconomic status, race, and geography have created a system in which the Infant Mortality Rate stays stubbornly high despite multiple efforts from policymakers and clinicians. Even though there is money being pumped into solutions for this epidemic, there has been no real change for the communities that facing the highest rates of infant mortality. Our project seeks to highlight the shortcomings in current Indiana policy and show that a change in policy from promoting healthy behaviors, to promoting a healthy environment can save lives. Analyzing state and local demographic data has shown that these high infant mortality rates are not coincidental and have disproportionately affected areas that are largely made up of people of color and low socioeconomic status. Our project focuses on the communities in Indianapolis that have the highest rates of poverty and segregation that lead to high infant mortality. In our research, our team has found that there are many different disparities that lead to high rates of infant mortality in these communities that are far out of their control. Throughout our research, we have gained an understanding on how to fundamentally change how Indiana addresses this problem and change the lives of communities across Indianapolis. We hope that this research will go on to create holistic change and improve the lives of thousands of people living in the Indianapolis area.

Mentors: Kyle Minor, IU School of Liberal Arts, IUPUI; Kenzie Mintus, IU School of Liberal Arts, IUPUI

Role of the Interferon-β in the immune response to *Chlamydia* infection

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Chlamydia is the most widespread bacterial sexually transmitted disease and is commonly transmitted through vaginal, oral, and anal sex with an infected person. This sexually transmitted disease, caused by *Chlamydia trachomatis*, could result in damage of the female reproductive system, ovarian scaring, and ectopic pregnancy in humans. The main purpose of our study is to determine the role of the Interferon-β in the immune response to this *Chlamydia* infection. We previously reported that a disruption in TLR3 function leads to a reduction in several cytokines and chemokines including interferon-β (IFN-β) synthesis. Our data showed that disruption in IFN-β function causes an increase in *Chlamydia* inclusion and genital tract fibrosis, as well as a dysregulated in the gene expression and protein activation of multiple inflammatory mediators. To determine the mechanism of how IFN-β function affects the outcome of genital tract *Chlamydia* infection, we investigated the role of IFN-β by comparing outcomes of infection between the IFN-β knockout mice and wild type mice C57BL/6 as a control. Quantitative real-time polymerase chain reaction (qPCR) was used to analyze the genes linked with various cell- signaling components associated with the immune response to *Chlamydia* infection in IFN-β knockout mice and wild type mice. Our qPCR data showed IFN-β knockout mice had an increase in *Chlamydia* replication and a significant decrease in IL-6 synthesis. From the data, we hypothesize that the interferon-β knockout mice will suffer increased *Chlamydia*-caused genital tract pathology when compared to wild type mice.

Mentor: Wilbert A. Derbigny, Department of Microbiology and Immunology, IU School of Medicine, IUPUI.

Visualizing Dynamic Binary Instrumentation

Vladimir Jacinthe, Nyalia Lui, James Howard
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This poster presents a web application called Visual Procedure. Visual Procedure is a web application that makes a visual representation of data that's collected from a running C++ program. The data is collected via a Dynamic Binary Instrumentation (DBI) app that detects each procedure invoked, the library each procedure resides in, the procedure's address in memory, the call frequency, and the number of instructions which make up the procedure instructions. It should be noted that there was a similar project done in the past which attempted to detect performance issues in software. However, the goals of this project aren't for detecting issues; The goals of Visualizing Dynamic Binary Instrumentation is to gather a procedure's data, determine the resource and make a visual representation of the data collected using an Ubuntu Virtual Machine and Pin++.

Mentor: Nyalia Lui and James Howard

Macrophages Display Robust Activity during Liver Regeneration

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The liver has its unique ability to replace the lost of injured tissues after partial hepatectomy (PH) through a process called liver regeneration or compensatory hyperplasia. The objective is to understand the event at the later stage beyond 10 days after PH. We performed PH on male mice and collected livers at various stages after surgery. We analyzed the expression of a group of genes in the liver through qPCR and In Situ Hybridization. We found that the expression of Macoilin 1 (MACO) and Macrophage Scavenger Receptor 1 (MSR-1) exhibits similar expression pattern during liver regeneration. The results also show consistent changes. These genes encode protein markers of macrophages. They both reached peak on Day 13, decreased on Day 11, and increased again on Day 21 after PH. The In Situ hybridization tells the location of macrophages between hepatocytes. We concluded that the regenerating livers show inflammatory events even at a later stage of the liver regeneration. They exhibit robust activity of macrophages. This phenomenon needs to be further explored.

Mentor: Dr. Guoli Dai

Spinophilin's Role in Regulating the Aggregation of the Huntingtin Protein

Crystal Johnson[5,6]**,** Darryl S. Watkins[1, 3], Anthony J. Baucum II[2, 3, 4]
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Huntington's disease (HD) is an autosomal dominant, fatal neurodegenerative disorder that causes signaling perturbations and eventually apoptosis in a specific neuronal population within the brain called the striatum. The principle cell type within the striatum is the medium spiny neuron (MSN). In HD, the huntingtin (Htt) protein has a repeated trinucleotide sequence (CAG) that has expanded. The expanded CAG repeat sequence encodes for polyglutamine (polyQ) within the HD protein. This expansion in polyQ tracts caused by increased CAG repeats initiates the misfolding and subsequent intracellular aggregation of Htt driving its histopathological hallmarks. Research suggests that the aggregation and toxicity caused by Htt can be regulated by the direct inhibition of the activity of a serine/threonine phosphatase, protein phosphatase 1 (PP1). Our lab along with others has shown that spinophilin, a novel multifunctional scaffolding protein, enriched in dendritic spines of MSNs, is a major, potent modulator of PP1's enzymatic activity in the brain. Spinophilin forms a complex and traffics PP1 to myriad substrates it but can also inhibit PP1 activity at specific substrates. We have utilized STHdh cell lines derived from mouse

striatum containing either a low polyQ (7 repeats; STHdh $^{Q7/Q7}$) or an expanded polyQ (111 repeats; STHdh $^{Q111/Q111}$), we have begun to determine that spinophilin may interact with HTT and that it could modulate Htt aggregation. Spinophilin's ability to regulate PP1 activity provides a novel molecular target to potentially develop alternative therapeutic interventions for Huntington's disease.

Mentors: Anthony J. Baucum II, Department of Biology, Indiana University-Purdue University; Stark Neurosciences Research Institute; Department of Pharmacology and Toxicology, Indiana University School of Medicine, Indianapolis, Indiana; Darryl S. Watkins, Indiana University School of Medicine Medical Neuroscience Graduate Program, Stark Neurosciences Research Institute

Deletion of SerpinA1 is Beneficial to Intervertebral Disc of Female Mice

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[1]Indiana Center for Musculoskeletal Health

Intervertebral disc (IVD) degeneration is a leading cause of back pain and affects 5% of the population in developed countries. This degeneration takes place during aging but can be accelerated due to injuries or excessive loading on the spine. Treatments are limited to suppression of symptoms via physical therapy and anti-inflammatories, with no known cures or preventions being available. Previous experiments showed a downregulation of SerpinA1 gene expression in older mice during IVD degeneration, requiring further testing on younger mice. We hypothesized that knockout of the SerpinA1 gene would increase IVD degeneration. The degeneration scores of L1/L2 motion segments of 18 and 28-week-old female knockout were compared to 16-week-old wild type female mice. IVD degeneration between the groups was not different, but there was a significant increase in the area of the nucleus pulposus by 53%. Further measurements of the IVD structure are currently underway. While there was no agreement with the hypothesis, the increase in IVD size due to the gene's deletion might suggest an increase in disc health on young mice, which might be used as a prevention for future degeneration. Nevertheless, further studies must be performed, using greater sample sizes and controls of different age groups to clarify the mechanism underlying the benefit of reduced SerpinA1 to the IVD.

Mentor: Nilsson Holguin, Indiana Center for Musculoskeletal Health

Reduction of Brain Tumor Size by Interaction with LRP5-Transfected Osteocytes

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Breast cancer is a serious cancer that affects one in every eight women in the United States, and often spreads to the brain. Brain metastasis has a very low survival rate with no effective treatment. Previous *in vitro* studies showed that tumor cell interaction with osteocytes reduced cancer cell viability. Therefore, an *in vivo* study was performed utilizing a mouse model that contained two groups of mice injected with cancer cells and treatments, either PBS (placebo) or osteocytes transfected with LRP5 plasmid. LRP5 is a gene that acts as a receptor for Wnt signaling and regulates tumor-osteocyte interaction, though this interaction mechanism is not fully known. The hypothesis in this study was that osteocytes transfected with LRP5 plasmid reduce the size of tumors due to the anti-tumor action of osteocytes from the *in vitro* study. To evaluate this hypothesis, two groups of mice were employed. The placebo group received the cancer cells with PBS and a second injection of PBS. The second group initially received the cancer cells with osteocytes treated with LRP5 and a second injection of only LRP5-transfected osteocytes. After two weeks, histology was performed on the mice brains to analyze tumor sizes. Results showed that compared to the placebo group, those brains injected twice with osteocytes treated with LRP5 had tumors approximately 43% smaller than the placebo tumors. This indicates that the osteocytes treated with LRP5 plasmid contributed to a reduction in tumor size. Additional studies are recommended to further develop a treatment that reduces brain tumor sizes.

Mentor: Hiroki Yokota

Screening Tool for Psycho-social and Cognitive Outcomes in AYA Cancer Survivors

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An AYA (Adolescent and Young Adult) cancer survivor screening tool was designed in order to identify psycho-social and cognitive weaknesses in survivors. The results of the screening tool may be used to implement interventions that will increase AYA cancer survivors' quality of life. The areas focused on for the screening tool were Emotional, Social, Fatigue, Anxiety, Spiritual, Executive Functioning, Attention, Memory, Language Processing, and School / Employment, which cover where survivors most commonly experience difficulties. The screening tool was administered in the form of an interview, and survivors were asked to answer the questions on a scale of frequency (very frequently, frequently, occasionally, rarely, never). Their answers to these questions would often prompt a follow-up question, and additional information about situations or times that they experience these issues would be compiled. After talking with several survivors, it was clear that their experience with cancer created many challenges in their lives even after treatment had stopped and they were declared 'cancer free.' Therefore, it supported the idea that cancer leads to a variety of psychosocial and cognitive outcomes. This screening tool serves as an important step in finding and solving issues that AYA cancer survivors experience after treatment.

Mentors: Tammy J. Sajdyk, Department of Pediatrics, Division of Hematology / Oncology, IU School of Medicine; Donna J. Romack, Department of Pediatrics, Division of Hematology / Oncology, IU School of Medicine; Jamie L. Renbarger, Department of Pediatrics, Division of Hematology / Oncology, IU School of Medicine

Research and Development of Adaptable Platforms to Support Experiential Learning

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Abstract: EASEL (Education through Application Supported Experiential Learning) is a web and mobile platform that allows instructors to provide experiential learning content that utilizes Just-in-Time teaching & learning practices. The goal of this work has been to learn and apply interdisciplinary skills of design and development using EASEL as a project-based learning experience. Two low-fidelity interactive prototypes were produced to improve the EASEL mobile and web experience. A mixed methods UX study was conducted to gauge student sentiment. User Experience (UX) tests assessed the general attitudes that students have towards technology, the use of technology in the classroom, and, specifically, attitudes towards the EASEL mobile app prototype and concept. The results of the UX study provided valuable input into designs and features for future versions of the EASEL application. The development goal is to implement a cross platform application using React Native that is feature rich and supports experiential learning themes. Utilizing the Broke Agile method of development allows for feature development to occur in a compartmentalized fashion, thereby increasing flexibility. Services and abstractions such as Google Firebase and Expo were used in combination with React Native in order to implement features such as geolocation, push notifications, and file submissions. The findings from the project yield useful insights into the special challenges presented by cross platforms for mobile devices and provide a foundation for future research and development.

Mentors: Corinne Renguette, Department of Technology Leadership & Communication, Purdue School of Engineering & Technology; Christian Rogers, Department of Computer Graphics Technology, Purdue School of Engineering & Technology; Laura Hazelton Jones, Department of Technology Leadership & Communication, Purdue School of Engineering & Technology

Graph Perturbation Effects on Graph Classification Using the GAM Model

Gunner Lawless, Tianchong Gao, Feng Li, Palanisamy Sundar
Purdue School of Engineering & Technology: CIT, IUPUI

Deep learning models for graphs have shown promising achievements in recent years for the tasks of node and graph classification. Despite these recent advancements, very little research has been done to challenge the robustness of these models against adversarial attacks. In this work, we test the robustness of the GAM graph classification model against various adversarial perturbations. We begin by generating two different types of adversarial data sets: one with randomly generated perturbations and another with perturbations generated using the NETTACK algorithm designed for attacks against node classification. After generating these data sets, we analyze how these perturbed graphs affect the GAM model's accuracy in a poison and evasion attack setting. We further propose ideas as to why neural networks designed for graph classification behave in the way that they do and call for further investigation.

Mentor: Feng Li

Characterization of molecular self-assemblies of thiamine diphosphate-dependent decarboxylases using ion mobility-mass spectrometry

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X-ray structures of thiamin diphosphate (ThDP)-dependent enzymes such as pyruvate decarboxylase (PDC) have all shown that the cofactor is bound at the interface between two monomers creating two active sites per homodimer. However, although the minimal oligomerization state is dimer, these enzymes were generally found as homotetramers, more accurately described as dimers of active dimers. As the branched-chain 2-keto acid decarboxylase from *L. lactis* and yeast PDC were shown to exist in dimeric states retaining catalytic activity, the apparent requirement for the tetramer was reconsidered. The requirement for the tetrameric form of *P. putida* benzoylformate decarboxylase (BFDC) was as well tested by making disruptive mutations at the dimer-dimer interface. While this proved to be feasible, the oligomeric status was identified by analytical ultracentrifugation that required relatively high protein concentrations, likely higher than intracellular concentrations and those under kinetic assay conditions. Native electrospray ionization mass spectrometry (ESI-MS) coupled with ion mobility measurement (IM) has the capacity to study macromolecules. Ion-mobility mass spectrometry (IM-MS) has been shown to preserve tertiary and quaternary structures of proteins in gas phase under the timescale of a typical MS experiment. As such it has found increasing use in the analysis of macromolecular assemblies, particularly protein complexes. Surprisingly, IM-MS has rarely been used to investigate the oligomeric state of ThDP-dependent enzymes. Here we have analyzed the self-assembly of BFDC and its dimer-dimer interface variants using IM-MS. Success of this method implies its applications to further analyze oligomeric states of other enzymes in this superfamily.

Michael J. McLeish, Department of Chemistry and Chemical Biology, IUPUI; Ian K. Webb, Department of Chemistry and Chemical Biology, IUPUI

Goals of Care Conversations Following Acute Severe Stroke

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For patients and relatives to make appropriate medical decisions and avoid prolonged suffering after severe stroke, establishing goals of care is vital. Method: A retrospective medical chart review, using a standardized chart tool, was used to collect data about Ischemic stroke patients with a National Institutes of Health Stroke Scale Score (NIHSS) of ≥10. Results: A total of n=344 charts were reviewed. A small proportion of patients, 85%, had at least one documented GOC conversation in their chart. GOC

conversations were initiated by a non-clinical member of the care team 47% of the time. The most prevalent discussions in GOC conversations regarded feeding tubes (40%), code states (43%), and discharge disposition (66%), patients' values and goals regarding survival and how/where a patient wants to be discharged (52%), and either limiting the use of life-sustaining treatments or continued use of aggressive treatments (47%). Patient and clinical characteristics associated with a documented GOC conversations were a DNR order (p-value=.00), hospital mortality (p-value=.01), hospice utilization consult (p-value=.00), Palliative care consult (p-value=.00), mechanical ventilation (p-value=.00), PEG tube (p-value=.00), and moving the patient to comfort measures only (p-value=.00). Conclusion: Documented GOC conversations are associated with older patients that are mechanically ventilated and have PEG tubes. Even though 85% of patients had a documented GOC conversation in their chart, most of these conversations regarded discharge disposition with a non-clinical member of the care team. The results of this study show that clinicians are not having GOC conversations with patients about aggressive medical interventions.

Mentor: Dr. Amber R. Comer, PhD, JD, Department of Health Sciences, IUPUI School of Health and Human Sciences

The Effect of Diet on the Skeletal Phenotype in FMR1 Knockout Mice

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FMR1 gene mutations result in fragile X syndrome, an X-linked genetic disease that affects more males than females. FMR1 mutations result in low production of FMR1 protein, leading to intellectual deficit, cognitive impairments, autistic spectrum disorder, and reduced bone mass. To study whether changing the diet would affect the skeleton of mice with FMR1 gene deletion, we collected bones of mice fed with control diet (CD) or with a modified diet with high omega-3 fatty acid levels (HFD) and analyzed them by micro-computed tomography. In femoral mid-diaphysis, WT and KO male mice have increased tissue volume (TV) and material density when fed with HFD, compared to CD. No changes were observed in female mice. In distal femur, WT and KO male mice fed with HFD showed increased bone volume (BV), BV/TV, material density, and trabecular thickness and number, compared to CD; whereas only WT female showed increased BV, BV/TV, and trabecular number when fed with HFD. However, BV, BV/TV, and material density were lower in heterozygous (HET) vs KO or WT female mice fed with HFD. TV in cancellous bone of 2nd lumbar vertebrae was higher in KOs than WT males fed with HFD, whereas it decreased and increased in WT and HET, respectively, in female mice. Further, HFD increased BV, BV/TV, and trabecular thickness and separation in KO female mice. We conclude that HFD administration could partially benefit the skeleton of individuals with fragile X syndrome, depending on the bone studied, and on the gender of the patients.

Mentor: Lilian Plotkin, Department of Anatomy and Cell Biology, IU School of Medicine Indianapolis

Enhancing Data Storage and User Interface of the Online Tool "regSNPs-intron for iSNVs screening"

Marty Mammel, Vivek Bigel; Larry May, **Geoffrey Mastbrook**
Computer Sciences, Purdue School of Science and Engineering; Computer Information Technology, Purdue School of Engineering and Technology

Rebuilding an application named "regSNP-intron", with the purpose of increasing its efficiency, speed, and accuracy is the main objective. The application houses a database containing extensive characteristics of DNA components, and, currently compares its data against user input figures. The software presents the user with precise data which helps determine if a single nucleotide variant has a connection to heritable diseases. After dissecting the current code for "regSNP-intron" application, we utilize a virtual server equipped with MongoDB and using Python to rewrite the code. Completing these tasks provide deeper knowledge and appreciation for efficient programming. Future medical students

and staff will greatly benefit from having a rebuilt “regSNP-intron” application. In the end, the project goal is to provide an application which is computationally faster while providing equally accurate data to the user.

Mentor: Xiao Luo, Computer Sciences, Purdue School of Science and Engineering

Temperature Effects on the Inhibition of Plasmin

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Transient ischemic attack and pulmonary embolism are serious life-threatening pathologies which are rooted in undesired blood clot formation. Plasmin is a fibrinolytic enzyme that is responsible for cleaving the fibrin that forms blood clots. Digestion of undesired thrombosis is a vital bodily function. This research seeks to study the effects that temperature has on the inhibition of plasmin by a small molecule inhibitor, pentamidine. Using a spectrophotometer, the absorbance of plasmin with chromogenic substrate S-2251 (150μM) in PBS (phosphate-buffered saline) solution was monitored over 10 min at five different temperatures: 4, 23, 37, 45 55C in the absence of inhibitor. The linear range of the observed enzymatic activity was converted to initial velocity (μM/min, slope) which is indicative of enzymatic rate under each unique assay condition. The second study included the addition of the benzamidine based small molecule inhibitor pentamidine. The anticipated outcome is that pentamidine will inhibit plasmin, reduce initial velocity, at low temperatures (≤ 23C). At higher temperatures pentamidine will detach, allowing plasmin to enzymatically cleave S-2251. In the absence of inhibitor, enzymatic activity increased from 23C-37C and at temperatures 37C-55C enzymatic activity decreased. A possible reason for the decrease in activity could be due to plasmin denaturing at the elevated temperature.

Mentor: Nathan J. Alves PhD, Assistant Professor of Emergency Medicine, Assistant Professor of Biomedical Engineering, IU School of Medicine

Overexpression and Purification of Periplasmic Nitrate Reductase from *Campylobacter jejuni*

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Periplasmic nitrate reductase (Nap) catalyzes the reduction of nitrate to nitrite in *Campylobacter jejuni*; the most common cause of gastroenteritis, compared to *Salmonella typhimurium*, *Shigella*, and *Escherichia coli*. In an oxygen-limiting environment, such as the gastrointestinal tract (GIT), *C. jejuni* uses nitrate as the terminal electron acceptor. Therefore, understanding the function of *C. jejuni* Nap can help to understand its pathogenesis. The *nap* operon consists of the *napABGHLD*. NapA is the catalytic subunit and the NapLD subunits may play a role in the maturation of NapA, so the NapLD subunits must be expressed with NapA to ensure its maturation. The expression of NapA increases when there is a *C. jejuni* infection, thus this subunit is hypothesized to have substantial control over the growth of *C. jejuni*. NapA contains a molybdopterin cofactor (Moco) which contains two pterin rings, a controversial sulfido group, and a cysteine residue. The molybdenum-coordinating cysteine residue has previously been mutated to serine, alanine, and aspartate, and in this study, the mutant variants were grown and heterologously expressed in *E. coli* host. The growth patterns of the variants and the wild type were investigated, and the variants have shown more growth than the wild type. The alanine and aspartate variants were also investigated by purification through affinity and size exclusion chromatography to acquire pure protein to study the effects of the mutations on steady-state kinetics in the future.

Mentors: Breeanna Mintmier and Partha Basu, Department of Chemistry and Chemical Biology, IUPUI School of Science

Effects of CX-4945 on Behavior of Male Ts65Dn Down Syndrome Model Mice

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Down syndrome (DS) is the most common trisomic chromosomal disorder, with approximately 1 in every 700-1000 newborns affected. Three copies of *Dual-specificity tyrosine-phosphorylated regulated kinase 1A* (*DYRK1A*), present on chromosome 21 in humans, plays a crucial role in neuronal development and is a possible pharmacological target to correct DS phenotypes. The Ts65Dn DS mouse model shows differently expressed levels of DYRK1A protein in the cerebral cortex, cerebellum, and hippocampus compared to euploid littermates. CX-4945 inhibits DYRK1A in an ATP-competitive manner. We hypothesize that trisomic mice treated with CX-4945 during a period of postnatal development of known overexpression of DYRK1A in the brain will exhibit normalized behavioral capabilities as compared to controls due to decreased kinase activity. On postnatal day (P)14 the Ts65Dn male mice and euploid control littermates were randomly assigned to receive injections of either CX-4945 (75 mg/kg/day) or vehicle control (10% DMSO/PBS), and were given the respective treatments from P14 to P18. On P16 and P17, mice were tested on homing and locomotor activity, with the tests counterbalanced across days. The results were analyzed by two independent scorers blind to group relationship. We found that male trisomic mice treated with CX-4945 spent more time in the home location in trial one and more time in new location in trial two when compared to PBS-trisomic mice, but not to the same degree as euploid control mice. From these data, CX-4945 did not have a noticeable effect on behavior capabilities in male trisomic mice when compared to their euploid counterparts.

Mentor: Randall J. Roper, Department of Biology, IUPUI

An Exploration of Racial Patterns of Association between Life Course Measures of Health and Parental Social Advantage

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Cumulative Disadvantage (CD) is a theory that explains how differences in lifespan stressors contribute to racial health disparities. Further, CD may have intergenerational effects on health. The primary objective of this study was to investigate racial differences in PSA measures, health, and their association with each other. In the parent study, the LIFE tool was created to measure CD. 51 adult women (24 African American, 27 white) were recruited via the Komen Tissue Bank. Participants completed the LIFE Tool survey, from which data for this study are drawn. Seven items about PSA were selected based on potential to impact offspring outcomes, and dichotomous answers were summed to create an index. χ^2 tests of association were performed for the individual items of the PSA index and total PSA above the median against three health outcomes by race: Self-Rated Physical Health, Unwanted Pregnancy, and CD. African American women had significantly higher rates of unwanted pregnancy ($p=.002$) and CD scores above the median ($p<.001$). Very good or excellent self-rated health was less prevalent among African American participants (33.3% vs. 55.6%) but not significant ($p=.111$). Significant racial differences were observed in PSA scores ($p<.001$) and in four of seven items: divorce, homeownership, financial stability, and neighborhood safety. A PSA score above the median was associated with physical health ($p<.001$), unwanted pregnancy ($p=.006$), and CD ($p<.001$). Overall, those with lower PSA scores had worse outcomes. This begins to paint the picture of intergenerational disadvantage which may help explain why racial health disparities persist.

Mentor: Tess Weathers, Department of Social and Behavioral Sciences, IU Fairbanks School of Public Health

Optimization of GC-QTOF Analysis of Diverse Volatile Terpenes, Potential Biomarkers for Cancer

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Volatile terpenes and terpenoids (VTs) are byproducts of the mevalonate (MVA) pathway which is known to be dysregulated by cancer. Our lab identified that VTs in urine may be potential biomarkers of breast cancer in murine models. However, urinary VTs have not been optimized for analysis by solid phase microextraction coupled to gas chromatography-mass spectrometry quadrupole time-of-flight (SPME GC-MS QTOF). Salting and varying pH have been shown to affect the headspace profile for volatile compounds. Standard human urine was obtained from UTAK and centrifuged at 3,000 rpm for 5 minutes. VTs were purchased from Aldrich or ThermoFisher. The urine supernatant was aliquoted and spiked with a panel consisting of 17 VTs at 50ppb. The samples were then pH corrected and analyzed by SPME GC-MS QTOF. Samples corrected to pH values of 5, 7, and 9 were analyzed in triplicate to determine the optimal pH to detect VTs. Aliquots were also analyzed in triplicate with and without NaCl to quantify the effect of salt saturation on VTs in headspace. Data were acquired utilizing Agilent Mass Hunter software and spectral alignment was performed on sample chromatograms using Profinder. Univariate statistical analysis (Student's T-test, p-value < 0.05) was implemented to quantify differences in the total and individual terpene signals. Different terpenes and terpenoids showed higher signal in pH 5 or 7 urine headspace but none in pH 9. Also, most terpenes showed higher signal by SPME in unsalted urine, although total signal was higher in salted urine samples.

Mentors: Dr. Agarwal, Dr. Siegel, Mark Woollam.

Characterization of a Calcium Binding Protein in the Human Parasite *Toxoplasma gondii*

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Toxoplasma gondii is an intracellular parasite that causes the infectious disease Toxoplasmosis. Toxoplasma infects one third of the human population and can manifest as an acute and/or chronic infection. Current treatments for acute infection have toxic side effects, and therefore it is important to study the parasite in order to pinpoint potential drug targets. Previous studies have shown that acute infection is caused by the propagation cycle of the parasite, which is regulated by temporal calcium fluxes. However, the proteins associated with calcium signaling are not fully understood. Through genetic and bioinformatic screening approaches, our lab identified several calcium binding proteins including calcium dependent protein kinase 3 (CDPK3) and the Gra41 interactor-calcium binding protein (CABP). We hypothesize that CABP plays a role in calcium signaling during the propagation cycle of the parasite. Using CRISPR/Cas9 strategies, CABP was endogenously tagged with a hemagglutinin (HA) epitope tag. Immunofluorescence assays of the tagged cell line showed that CABP co-localizes with the endoplasmic reticulum (ER) marker, SERCA. CABP localization to the parasite ER is of special interest given this organelle's critical role in calcium signaling in eukaryotic cells. Future studies will be to investigate the specific role that CABP plays in *T. gondii* calcium signaling and the lytic cycle.

Mentors: Gustavo Arrizabalaga, Department of Pharmacology and Toxicology, IU School of Medicine, IUPUI; Noopur Dave, Department of Pharmacology and Toxicology, IU School of Medicine, IUPUI.

Screening tool for Cognitive and Psycho-social Outcomes in AYA Cancer survivors

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Due to the side effects of chemotherapy, domains such as fatigue, social relationships, memory, attention and spirituality are greatly affected in the lives of cancer survivors. A screening tool was created

on a Likert-scale to assess quality of life in Adolescent Young Adult (AYA) patients. The purpose of this tool was to identify possible psychosocial and cognitive impairments. Several patients were assessed and self-reported based on an abundance model. Results show that cancer patients experience cancer fatigue, various cognitive issues and practice spirituality as a means to cope. Analysis of data identified themes and provided interventions to reach milestones, as it is important that the patients experience a life worth living. Data collected is useful to provide implications for future AYA specific oncology research.

Mentors: Tammy Sajdyk, IU School of Medicine Department of Pediatrics Division of Hematology/ Oncology; Jamie Renbarger, IU School of Medicine Department of Pediatrics Division of Hematology/ Oncology ; Donna Romack, IU School of Medicine Department of Pediatrics Division of Hematology/ Oncology

Effects of potential interactors of mitochondrial fission protein FIS1 on mitochondrial dynamics in the human parasite Toxoplasma *gondii*.

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Toxoplasma gondii is a parasite that can infect any warm-blooded animal, through means such as undercooked meat, contact with cat feces, or via congenital transmission. Upon infection, *T. gondii* causes toxoplasmosis, which is often asymptomatic in healthy adults but can cause birth defects such as blindness and premature birth. *Toxoplasma* is a eukaryotic parasite with a single mitochondrion that is more plant-like, extremely dynamic, and it is a validated drug target. It has been observed that FIS1, a protein on the mitochondrial membrane, has a role in recruiting proteins for mitochondrial division in higher eukaryotes. We found that mislocalizing it disrupts the mitochondrial shape, indicating that it may interacting with something new or is pulling away potential interactors from the mitochondria. We found three potential FIS1 interactors by Yeast 2-Hybrid analysis that are predicted to be essential for parasite survival. TGGT1_287980 was found to localize in the inner membrane complex, which interacts with the mitochondrion, TGGT1_224270 is in the mitochondrion, and TGGT1_293840 has no known function or localization, but is unique to *Toxoplasma.* We are using a rapamycin inducible mRNA degradation system to conditionally knockdown. We will observe how decreased expression of these proteins affects parasite survival and mitochondrial dynamics. By studying the cell signaling pathways that regulate the lytic cycle of *T. gondii,* we can develop specific anti-parasitic drugs that target the events of invasion, egress, and division which are essential for the parasite survival.

Mentors: Gustavo Arrizabalaga, Ph.D. and Kylie Jacobs.

Fabrication and Synthesis of Novel Nanomaterials for Electronic Applications

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Nanomaterials can be used in many applications to improve quality, efficiency and properties. In this project the effects of carbon nanotubes (CNTs) in V_2O_5 electrodes in lithium ion batteries, and carbon black (CB) in a matrix of poly (vinylidene fluoride-hexafluoropropylene) (PVDF-HFP), polyetherimide for development of novel robust sensors have been investigated. Synthesized V_2O_5 carbon nanotube composite for battery applications has been found to yield good results in terms of high specific capacity and cyclability. Here the presence of CNT as the nanomaterial possess strong electrical and mechanical properties and improve the cycle life of V_2O_5. The method employed for V_2O_5 uses an ion-exchange column to make the V_2O_5, carbon nanotubes will be sonicated and centrifuge and then mixed with V_2O_5, which they will attach themselves on the surface. In V_2O_5, when synthesized with carbon nanotubes this will yield stronger conductivity, better stability, and better performance. Volatile organic compounds (VOCs) in the air can lead to various illnesses, so the fabrication of an array of gas sensors was created

and detect various different compounds. For gas sensors, the polymer composites with CB were spin-coated over interdigitated electrodes of gold over silicon dioxide substrate and tested with different VOCs. A cross selective array of two sensors presented high sensitivity and selectivity to a targeting aromatic compound and presented a relative response of 0.8% and 0.6% in response to 80 ppm of the VOC. The sensors fabrication, experimental testing methods, and results are presented and discussed.

Mentors: Nojan Aliahmad, Department of Electrical and Computer Engineering, Integrated Nano systems Development Institute, Purdue School of Engineering and Technology; Ali Daneshkah, Integrated Nano systems Development Institute; Mangilal Agarwal, Department of Mechanical and Energy Engineering, Integrated Nanosystems Development Institute

Scalable Gunshot Detection Systems with Convolutional Neural Networks

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Many cities with gunshot detection systems depend on expensive systems that rely on humans differentiating between gunshots and non-gunshots, such as ShotSpotter®. Thus, a scalable gunshot detection system that is low in cost and high in accuracy would be advantageous for a variety of cities across the globe, in that it would favorably promote the delegation of tasks typically worked by humans to machines. A convolutional neural network (CNN) was trained on a variety of sound data to recognize gunshots. This model was then deployed to a Raspberry Pi Model 3 B+ with an SMS modem attached. The findings generated by this research project have the potential to expand the current state of knowledge regarding sound-based applications of CNNs, and while reducing the amount of jobs that require human input, the results of this project could very well increase the standards of safety for a city's résidents.

Mentor: George Mohler, Department of Computer and Information Science, IUPUI

One Pot Oxidation of Amines via Benzoyl Peroxide & A Sulfide Activator

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The amide functionality is one of the most important motifs in organic chemistry due to its presence in pharmaceuticals, agrochemicals, and biologically active natural products. Traditionally, amide synthesis can be achieved through the standard aminolysis pathway via with a reactive carboxylic acid derivative. Such pathways do typically involve multi-step synthesis and produce reactive intermediates. While such methods are known to be high yielding, they employ reagents that are water sensitive and possess a known toxic effect. To diverging from the use of unstable/toxic reagents, more recently work has been conducted to produce amides from the unreactive and commercially available starting carboxylic acid. Such methodologies relay on either the activation of the carboxylic acid electrophilic center or transforming the substrate into a more reactive intermediate *in situ* prior to aminolysis. Herein we present a new amide methodology involving the use of acyl peroxides and a sulfide activator. Current optimization, preliminary/future substrate scope, and future mechanistic work will be presented.

Mentor: Sébastien Laulhé

Development of Tape-based Electrochemical Sensors for In-field Chlorate Detection

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Potassium chlorate is a common oxidizing component found in improvised explosive devices. Current detection methods typically require either long processing times due to laboratory transport and analysis or multiple on-site colorimetric tests. The proposed tape-based electrochemical sensors offer a low-cost, portable, and non-destructive alternative analytical platform for the identification of chlorate ions. Detection is achieved via an electrodeposited molybdate sensing layer on the electrode; chlorate catalytically alters the reduction of molybdate, the effects of which can be monitored with cyclic voltammetry measurements. The observed changes in cyclic voltammograms in the presence and absence of chlorate feature complex variations in shape and intensity and must therefore be analyzed with chemometric techniques such as multivariate data analysis. One such application is the identification of data outliers most likely due to variations between handmade tape-based devices. The outliers could be identified not only from the cross-correlation of chlorate cyclic voltammograms, but through principal component analysis with preliminary device characterization curves as well. We also hypothesized that principal component analysis may be a viable method for the generation of a sensor calibration curve, enabling quantification of chlorate. The development of these chemometric methods will provide a basis for future analysis and implementation of tape-based electrochemical sensors in crime-scene applications.

Mentor: Frédérique Deiss, Department of Chemistry & Chemical Biology, IUPUI

Cancer Cell Migration: Linking Cell Metabolism to Rho GTPases

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Cancer Cells produce protrusive and contractile forces, known to be regulated by mechanotransduction of Rho GTPases resulting in metastasis-driven cell migration. This unique property requires significant amount of cellular energy, homeostasis of the cellular energy is regulated by AMP-activated protein kinase (AMPK). Research shows that AMPK plays a significant role in anti- or pro-tumorigenesis of cancer cells. This study was conducted to determine the role of subcellular AMPK activity in the migratory potential of breast cancer cells using live cell imaging. Breast cancer (MDA_MB_231) cells were cultured in DMEM with 1% penicilin-steptomycin and 10% FBS. Cytosolic AMPK modulators including Compound C (Millipore Sigma, 5 μM) was used as a global AMPK inhibitor and A769662 (Tocris, 25 μM) was used as a global activator. Scratch assay was performed on the cancer cells with a subset of 3 groups containing 4 samples. Migration area were measured with live imaging. Area of breast cancer cells treated with Compound C were significantly different from those treated with A769662, suggesting that AMPK inhibition in breast cancer cells inhibits migration of breast cancer cells compared to AMPK activator promotes the migration of breast cancer cells over scratched area. Further tests to determine the regulation of the different GTPases involved in cell migration using FRET imaging are underway to better understand the role cytosolic and mitochondria AMPK in regulation of Rho GTPases.

Mentor: Sungsoo Na, Department of Biomedical Engineering, IUPUI

Analysis of Process Induced Deformations within Composite Manufacturing

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Recently there has been explosive growth within the engineering industry for the use of composite manufacturing, specifically carbon fiber composites. Dozens of companies are looking for ways to incorporate this light but extremely strong material into products from illustrious super cars to airplanes. However, there are problems that can arise when manufacturing this material. Deformations can arise

within many parts of the manufacturing process and there is a need to mitigate that for widespread use. A great way to decrease these deformations is to understand residual stresses and how it affects the composite. With computer simulations it is easier to find "optimization" that is, the most ideal composite that can be created with the materials given, with the least amount of deformations. With simulations, computers can predict how the materials will react during the manufacturing process and store that data, which could be analyzed for future use. Another method that can be used is electrospinning, which is a different, more versatile way to strengthen the carbon fiber composites. It is believed that this method will lead to a more optimized composite and is estimated that electro spun composites can yield a 2% increase in strength and its properties. With the help of computer simulations and pressure testing we will determine if electrospinning does lead to a more optimized composite for production within the engineering field.

Mentor: Dr. Hamid Dalir, Department of Engineering, Purdue School of Engineering, IUPUI

Shape- and Size-Dependent Refractive Index Sensitivity of Gold Nanoparticles

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Localized surface plasmon resonance (LSPR) is a property of metallic nanoparticles due to the collective oscillation of electrons of the metallic nanostructure upon light irradiation. LSPR produces resonance absorbance peak in the visible light region and can be measured by using UV-Vis spectroscopy. Gold nanoparticles, a type of metallic nanostructure, can be synthesized in many different anisotropic shapes such as rods, prism, star, etc…, each with a different refractive index unit (RIU) sensitivity. The refractive index sensitivities found to be dependent on both the shape and the size of the Au nanoparticles. The RIU sensitivities generally increase as Au nanoparticles become larger and their tips/ edges become sharper. Here, we proved that this theory is true comparing the sensitivities of three different anisotropic-shaped gold nanostructures: nanostars, nanoprisms, and nanorods. Accordingly, we have obtained the highest RI sensitivity for the gold nanostars, which has the largest number of sharp tips. Further, we have shown that, when the size of the gold nanorods increases, so does the sensitivity. Here, we utilized scanning electron microcopy (SEM), and Transmission electron microscopy (TEM) for the structure's evaluation.

Mentor: Rajesh Sardar

Simulation and Imaging of Magnetic Nanoparticles in Ophthalmological Surgery

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This study is a continuation of exploring how magnetic nanoparticles can innovate current Ophthalmological procedures in order to create a less invasive surgery with a more comfortable recovery time for the patient. Specifically, new cataract and retinal detachment surgeries involving the use of magnetic (Fe_3O_4) nanoparticles bonded to silica are being investigated. This study explores both the methods utilized to image and track the nanoparticles in order to determine the feasibility of the theoretical procedures and confirm simulation methods that have been designed in order to model the forces being applied to these particles. This study also covers the development of an extensive proprietary tool that links both MATLAB and Finite Element Method Magnetics (FEMM) to visually display the forces acting on the nanoparticle. This tool has specifically been designed with the intention of distributing it (Open-Source or Commercially) to other researchers within the magnetic nanoparticles field, therefore; it has been designed specifically to be more user-friendly and robust in comparison to an in-house program.

Mentors: Rasoul Akbari, Purdue School of Engineering and Technology, Indianapolis, IN;
Dr. Afshin Izadian, Purdue School of Engineering and Technology, Indianapolis, IN;
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Family Life, Sexual Beliefs, and Sensation Seeking Tendency in Adolescents with ADHD

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Adolescents with ADHD may be more prone to abuse substances and engage in risky sexual escapades. This may happen more often and can be more dangerous as these at-risk children tend to have difficulty making decisions in risky situations. The series of surveys analyzed were administered by the following study: Neural Response to Risky Decision Making in Youth at High Risk for Substance Use Disorders and HIV. Using this data, sexual beliefs were compared across time for the high-risk (HR), mid-risk (MR), and control groups in the study. This was then compared to each group's beliefs on family life over time and to subjects' propensity towards risky behavior and with beliefs on sexual conduct. The survey data suggests that there is not a correlation between sensation seeking, sexual conduct, and family life. Considering this, interventions targeted at beliefs about proper sexual conduct may not be effective.

Mentors: Leslie Hulvershorn; Tiffany Hatfield; Jackson Richey

Evaluating Dehydrin Mutants Impact on Cold Stress Tolerance of Arabidopsis

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To adapt to environmental changes, plants alter expression of many genes, several of which code for proteins known as dehydrins. These plant-specific proteins are thought to be significant contributors to the cold tolerance in Arabidopsis due to their correlation with the cold stress response. The overall purpose of this study is to determine whether specific mutations in dehydrins have an impact on cold tolerance in *Arabidopsis thaliana*. To test this, the phenotypic cold response of the Arabidopsis with mutations in three dehydrin genes, COR47, ERD14, and ERD10 were examined. An ERD10 mutation was obtained through CRISPR technology in a background of COR47 and ERD14 knockout. Since it is desirable to have triple mutants that now lack the presence of Cas9, self-crosses were examined for the presence of Cas9. Homozygous mutants derived from ten lines (of total 39) were found to no longer contain Cas9. Those lines include one base insertion at 85-86, three 33 base pair deletions after 83, (ERD10 mutations) and six wild types. Further, the cold-tolerant parameters were determined by testing of freezing tolerance of 16 homozygous triple mutants. No significant difference was found compared to the wild type which suggests that these three dehydrins are not critical for freezing tolerance in *Arabidopsis thaliana*, indicating that the original hypothesis was incorrect. Other parameters impacting cold tolerance could be examined. As confirmation that mutations decrease expression of dehydrins, western blots will be conducted in the future.

Mentor: Stephen K. Randall

Biochemical mechanisms underlying striatal-dependent OCD-like behaviors

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Excitatory glutamatergic neurons communicate by releasing neurotransmitter from a presynaptic neuron which acts on small protrusions, called dendritic spines, located on a postsynaptic neuron. Dendritic spines within a specific neuron called striatal medium spiny neurons (MSNs), receive glutamatergic

inputs and transduce neurotransmitter release to allow for appropriate motor function. Postsynaptic proteins, such as PSD-95 and homer1b, function to position neurotransmitter receptors in the membrane and organize downstream signaling molecules to regulate neuronal activity. Perturbations in MSN protein organization are associated with pathological disorders, such as obsessive-compulsive disorder (OCD). Specifically, excessive activity of a specific glutamate receptor, metabotropic glutamate receptor 5 (mGlu5), causes excessive self-grooming, an OCD-like behavior, in mice. Appropriate expression of mGlu5 can modulate this phenotype. Interestingly, spinophilin, a scaffolding protein enriched in dendritic spines of MSNs, regulates mGlu5 trafficking and downstream signaling. However, spinophilin's role in regulating mGlu5-induced self-grooming is unknown. To delineate the role of spinophilin on OCD-like behaviors, we treated wild-type and spinophilin knockout mice with an mGlu5 positive allosteric modulator and scored grooming behavior. In addition, we developed novel tools to delineate the mechanisms by which spinophilin modulates synaptic protein organization underlying OCD-like behaviors. Our results suggest spinophilin is required for mGlu5-induced excessive self-grooming. Also, we present novel PSD-95 and Homer1b fusion proteins capable of labeling neighboring proteins with biotin. In the future, these novel tools will be used to elucidate changes in MSN protein organization underlying excessive grooming, thus providing insight into the biochemical mechanisms underlying an OCD-like behavior.

Mentor: Anthony J. Baucum II

Heavy Metals and Faecal Coliform in Local Indianapolis Waterways

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The greater Indianapolis area is home to many water sheds participating in a Combined Sewer System that discharges untreated wastewater into waterways when overflow from rainfall or snowfall overwhelms the streamlined water treatment system. With these water sheds traversing diverse neighborhoods and ecosystems, the composition of these watersheds poses concerns for human and environmental health. In addition to Combined Sewage Overflow contamination, heavy metal pollution, known to have adverse health effects, has been traced from industrial sites and other sources along these water sheds. In an effort to better understand the combined risk of harmful exposure of faecal byproduct (naturally or systematically) and heavy metals prompted by human intervention, the presence of faecal coliform and heavy metals have been examined through microbiological and elemental analysis. Water samples were taken from six sites along the Pleasant Run watershed and a White River location. A portion of these water samples underwent membrane filtration and incubation to analyze the abundance of faecal coliform. Another portion of these samples were filtered and prepared for elemental analysis using the ICP instrument to detect the presence of metal. Due to the heat-conductive nature of heavy metals and faecal coliform's affinity for warmer environments, it is predicted that heavy metal presence in these local waterways share a positive relationship with faecal coliform.

Mentor: Gabriel M. Filippelli, Center for Urban Health, Department of Earth Sciences, IUPUI

Name-Calling and Its Effect on Candidate Evaluations

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During elections, the use of negative campaigning is often utilized by candidates to attempt to undermine their opponents. A new version of this negativity has appeared recently in campaigns where a candidate will simply call his or her opponent a derogatory name. Donald Trump famously employed this "name-calling" strategy during the 2016 Republican primaries and general election. There is a significant amount of research studying the impact of variables such as negative campaigning, race, gender, partisanship, and age on candidate evaluations. However, despite the use of "name-calling" as a way for candidates to define and belittle their opponents, almost no scholarly research has been conducted specifically focused on the effects of name-calling on voters' evaluations of candidates. To test the

effects of name-calling on candidate evaluations, we employ a survey experiment where we randomly insert a derogatory term (crooked or heartless) before a candidate's name in a fictional news story. We then compare respondents' evaluations of these candidates to a control group which did not see the negative name.

Mentor: Aaron Dusso, Department of Political Science, IU School of Liberal Arts, IUPUI

Understanding the Numerical Stability of a Cancer Cell using a Star-shaped Membrane

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Breast cancer affects more than 3 million Americans, and up to 90% of breast cancer deaths are metastasis-related. During metastasis, cancer cells travel from a primary site to a secondary site through the vascular system, forming secondary cancer. While experiments have provided several insights into the process of metastasis, mathematical modeling can provide unique insights that are experimentally unobtainable. Towards this end, a two-dimensional model of cancer cell motion has been developed. Numerical stability of the method, however, can place significant restrictions on the explicit time stepping scheme used for the model, which can lengthen the time it takes to run simulations. To better understand these restrictions, a two-dimensional, rotationally symmetric star-shaped model of a cancer cell is considered. A system of differential equations for the two radii of the star membrane is formulated. The equilibrium points of the system and the numerical stability of the improved Euler's method are analyzed in order to estimate the time step necessary to guarantee well-behaved numerical solutions. In addition, sensitivity analysis is performed to find the parameters that most affect time step restrictions. Using these insights will allow for the elimination of non-physiological, star-shaped instabilities that can occur when using naïve time stepping schemes.

Advisor: Jared O. Barber, Department of Mathematical Sciences, IUPUI

Effects of treatment with the DYRK1A Inhibitor CX-4945 in the Ts65Dn mouse model of Down Syndrome

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Down syndrome (DS) occurs in approximately 1/750 live births by the triplication of human chromosome 21 (Hsa21) and leads to characteristic physical and cognitive impairments. The Ts65Dn DS mouse model exhibits similar phenotypes due to the triplication of approximately one-half the genes found on Hsa21, including Dual-specificity Tyrosine Phosphorylation-regulated Kinase 1 (Dyrk1a). Due to its involvement in brain developmental pathways, overexpression of DYRK1A may influence cognitive phenotypes and normalization of the protein or its activity could be a valid treatment to correct DS phenotypes. CX-4945, a casein kinase 2 (CK2) inhibitor used to treat certain types of cancer, inhibits DYRK1A activity in an ATP-competitive manner and may reduce excessive DYRK1A activity in vivo in Ts65Dn mice. Previous results have shown DYRK1A overexpression in Ts65Dn compared to euploid mice at postnatal day (P) 15. We hypothesized that treatment of 75 mg/kg/day CX-4945 over a period of 5 days starting at P14 will improve neurodevelopmental behaviors in Ts65Dn mice. We assessed locomotor activity and homing behavior differences in mice across three treatment groups: PBS, DMSO, and CX-4945, as well as sex differences within treatment groups. We then compared CX-4945 treated trisomic animals to PBS treated euploid and trisomic animals. Preliminary data suggest CX-4945 treated animals show improvement in both behavioral tests, as compared to controls with noticeable sex differences. This study is important as it explores a possible treatment for DS phenotypes and identifies neurodevelopmental differences between genotype and sex.

Mentor: Randall J. Roper IUPUI Department of Biology

Role of the transcription factor ZHX2 in the interplay between osteogenic and adipogenic differentiation

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Chronic Kidney Disease (CKD) is the gradual loss of kidney function, and affects 1 out 8 people. Patients often develop mineral and bone disorder (MBD), increasing fracture risk, and consequently, mortality. Also, these patients demonstrate bone marrow fat accumulation, suggesting pathogenic alterations of mesenchymal stem cell (MSCs) differentiation. Therefore, understanding molecular mechanisms in bone formation will have a positive impact to future studies. The transcription factor, ZHX2, described as a repressor, was found to promote odontoblast differentiation, cells similar to osteoblasts. In contrast, reduced levels of ZHX2 increased liver lipid accumulation during a high fat diet and was found to repress lipoprotein lipase (Lpl), important promoter of fat storage. Thus, we propose ZHX2 as a promoter of osteoblast differentiation by suppressing adipocyte gene expression. ZHX2 mRNA and protein levels were analysed during osteogenic and adipogenic differentiation in human MSCs (hMSCs) and Mouse Progenitor Cells (MPC2). In hMSCs, *ZHX2* mRNA was significantly increased after day 21 of osteogenic differentiation (3-fold vs d1, $p<0.01$) with no alterations during adipocyte differentiation. In MPC2 cells, *Zhx2* mRNA increased 6-fold after 21 days of osteogenic differentiation ($p<0.01$ vs day 1). In adipogenic media, MPC2 *Zhx2* mRNA showed a downward trend during differentiation, but did not reach significance. In summary, hMSCs and MPC2 cells demonstrated enhanced expression of ZHX2 mRNA during osteogenic differentiation with in adipogenic differentiation. In sum, ZHX2 upregulation during osteoblast differentiation suggests an important role for proper osteoblastogenesis.

Mentor: Erica L. Clinkenbeard, Department of Medical and Molecular Genetics, IU School of Medicine

Investigating the Electrical Interaction of a bi-polar Cuff Electrode with a Nerve Fiber using a Finite Element Model with Applications in LFACb

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Functional Electrical Stimulation (FES) is the technique of using electrical pulses to control nerves. One tool of FES includes Low Frequency Alternating Current Block (LFACb) which has shown efficacy in blocking neural activity. The type of electrode which is currently best for interfacing with the peripheral nervous system chronically is the cuff electrode, providing optimal stimulation while minimizing the complication of bodily rejection. Cuff electrodes are often used to restore function and control over areas of patients' bodies including the bladder and diaphragm, or in the case of epilepsy and sleep apnea allow them an improved quality of life. In-silico modeling was the basis for this study by employing LiveLink™ for MATLAB® to solve a COMSOL Multiphysics® model many times, while changing model parameters, thus characterizing the cuff electrode – nerve fiber interaction. By characterizing this interaction, a guideline was established for building electrodes that can effectively achieve LFACb for larger nerves. Lastly, one objective was to find ways for the model to better match reality. The cuff electrode – nerve fiber interaction was characterized showing that all three parameters effected the results. The optimal geometry for stimulation was also found for increasing nerve bundle sizes. Ultimately, by comparing the model to in-vivo studies, the cuff dimensions needed to achieve LFACb for increasing nerve sizes were proposed. This work shows LiveLink™ can be used to characterize a COMSOL® model to understand how its changing parameters interact and effect model output.

Mentor: Ken Yoshida, Department of Biomedical Engineering, IUPUI

Order Parameter Analysis for MD Simulations of Adenosine Triphosphate Interacting with Phosphatidylcholine Lipid Bilayers

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Adenosine triphosphate (ATP) provides the chemical energy needed in most biological processes from metabolic reactions to cellular mechanics. Hydrolysis of ATP that cleaves phosphate bonds is the mechanism by which energy is released to the environment, resulting in lower energy derivative forms of ATP as adenosine diphosphate (ADP) and adenosine monophosphate (AMP). Within biological cells, this chemical reaction often takes place in the vicinity of lipid membranes. Biophysical experiments by x-ray scattering and NMR spectroscopy have indicated that ATP binds to lipid membranes primarily through the adenine ring, leaving the phosphate chains available for hydrolysis. However, the exact dynamics of ATP, and in particular the possible cooperativity between bound ATP molecules is still unknown. Molecular Dynamics Simulations reveal that ATP, ADP, and AMP bind to lipid headgroups cooperatively and this behavior generates significant electrostatic charging of membranes even at low concentrations that are typical in biological cells. Building on that overarching understanding, effects on membrane order and system size are analyzed quantitatively to determine the extent to which ATP affects membrane structure and function. Results from calculations indicate that ATP affects lipid membrane order, in turn causing increased fluctuations in the area per lipid. This information indicates that ATP not only affects electrostatic terms, but also influences the molecular order and stability of a membrane – vital to major neuronal processes.

Mentor: Horia I. Petrache

One of our best governors: The Relationship Between Governor Oliver P. Morton and President Abraham Lincoln

Dylan Rawles
History Department – Indiana University Kokomo

Abraham Lincoln once described Oliver Morton as one of the best governors during the Civil War, but was their relationship without strife? Oliver Morton was the governor of Indiana for the entirety of the Civil War, and was a man who demanded immediate action. Lincoln on the other hand was a man who took his time and was deliberate in his steps. This difference in approach was bound to lead to a collision of personalities. Using primary sources, this project aims to show that the relationship between Morton and Lincoln was one of mutual respect with shared goals of keeping the Union together.

Mentor: Stephen Towne, IUPUI

Primary Care Mental Health Referrals and Depression Screening

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Indiana Integrating mental health in primary care settings may address individuals' needs, like frequent depression screening and treatment access, in an area lacking care comparatively. Understanding patients' outcomes when mental health is integrated in medical clinics can assist in determining if health disparities may be reduced. Data on mental health referrals to the in-house Family Therapy team at an academic Family Medicine Clinic, as well as treatment patterns and patient outcomes, were collected, stored, and analyzed in REDCap. Preliminary data indicate that 77.5% of patients referred to therapy were female; 55.6% were white; and 38.8% were African American. Of 400 patient records analyzed, 268 patients did not attend therapy, 51 attended one appointment, and 36 attended more than three sessions. Of those 36, 11.1% had an increase on the depression screening (PHQ-9) at end of treatment; 55.6% had a decreased score; 25% remained unchanged; and 8.3% did not have adequate screening. The average PHQ-9 score after therapy decreased from 10.5 to 7.7—both scores were lower than the average PHQ-9 of all patients referred for therapy (12.5). Out of all patients, those who attended more

than three sessions were likely to decrease depressive symptoms indicating efficacy of therapy. Patients who attended therapy had lower average initial scores, indicating that those who did not start therapy may have more barriers to accessing mental health care, and future research may help break the barriers and facilitate accessing integrated behavioral health by further understanding the patient.

Emilee J. Delbridge, Indiana University Family Medicine Residency, IU School of Medicine, IUPUI

Effectiveness of the implementation of a discipline-based clinic on Cariology and Operative Dentistry as an approach for Dental Education

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The study sets out to determine the effectiveness of the implementation of a discipline-based clinic on Cariology and Operative Dentistry as an approach for Dental Education at IUSD. The importance of this research is to allow former IU School of Dentistry students the opportunity to express opinions regarding their interest, concerns, and improvements of the teaching skills of the faculty and how the facility affected their individual abilities to succeed in the clinic portion. Information will be collected via the IU RedCap survey system; each participant will be sent an emailed link of the survey and a small incentive (such as a gift card) that will hopefully attract more responses. The surveys that will be used are the ClinEd IQ and DECLEI, which are two different types of survey questions that have been used to test previous effectiveness on various Dental clinics. The surveys are multiple-choice survey and follow the Lickert scale of grading along with two short answer questions. Once the survey is filled out and completed all the information will go into the RedCap survey and will be available for the editors to view. Personal information such as name, address, phone number, etc. are not available to view by the researchers and editors of the survey. At no results have been achieved due to the surveys undergoing testing. In conclusion the testing of the effectiveness of the discipline-based clinic is important to understand where to improve upon, the weaknesses that exist and create an equal opportunity learning environment. From the data collected researchers within the IU school of Dentistry will have the ability to understand what areas need to be improved in the clinical setting and what is already affective, allowing for changes to be made to overall better the clinical experience.

Mentors: Sebastian Lara, Department of Cariology, Operative Dentistry and Dental Public Health, IU School of Dentistry, IUPUI; Armando E. Soto-Rojas, Department of Cariology, Operative Dentistry and Dental Public Health, IUPUI

Understanding Isohydricity from a Water Resources Perspective

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Vegetation is responsible for cycling a substantial portion of terrestrial water via transport from roots through leaf stomata. At the leaf level, plants regulate water use by increasing or decreasing their stomatal conductance. The degree to which plants control their stomata under drought conditions varies across species and is ranked along a continuum of isohydricity. Maples, the more isohydric species, tend to be more conservative, showing show more sensitivity in their stomatal regulation due to slight changes in drought stress. Oaks exhibit a more anisohydric physiotype and do not regulate stomatal conductance as much, seemingly wasting their water resources. Preliminary data shows that oaks can access a deep-water source, explaining their seemingly wasteful behavior. During the same study period, maples were found to also be able to access the same water pool as the oaks as well as a different, more shallow pool. We hypothesize that the water source switching done by maples may happen throughout the year and could have important implications for ecosystems dominated by this species. Using the water isotope signatures from extracted xylem and soil water, we can decipher and track the presence of water from various underground pools over time and model the fractional uptake from unique soil pools for

each species. We hypothesize that maples will continue to switch water pools throughout the growing season and that it will have important consequences on ecosystem water, carbon, and energy flux.

Mentor: Lixin Wang, Department of Earth Sciences, School of Science, IUPUI

Female mice osteoclast differentiation and function increase by Pannexin1 channel deletion

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Bone resorption by osteoclasts is required to maintain bone health. Since membrane channels are important for osteoclast function, we aimed to examine the role of Pannexin1 (Panx1), a hexameric membrane channel, on osteoclast differentiation and function. For this, mice with Panx1 deleted from osteoclasts were generated by crossing mice expressing the Panx1 gene flanked by LoxP sites (Panx1$^{fl/fl}$ mice) with mice expressing the Cre recombinase in osteoclastic cells (TRAP-Cre+) to generate Panx1$^{fl/fl}$;TRAP-Cre+ and Panx1$^{fl/fl}$;TRAP-Cre- mice (controls expressing Panx1 in osteoclasts). Body composition was measured using DXA Piximus from 1 to 6 months of age. We detected a significant decrease in bone mineral density, bone mineral content, and bone area at month one in female TRAP$^{fl/fl}$;TRAP-Cre+ mice. Osteoclast cell cultures were then carried out for the different groups, by differentiating bone marrow osteoclast precursors in the presence of pro-osteoclastogenic cytokines *in vitro*. We found an increase in the relative area of the cultured osteoclastic cells from female Panx1$^{fl/fl}$;TRAP-Cre+ mice when compared to female Panx1$^{fl/fl}$;TRAP-Cre- mice and to males of both genotypes. We also tested whether the osteoclasts have differences in the ability to resorb bone, by placing the osteoclasts from each group on bone slices. Female Panx1$^{fl/fl}$;TRAP-Cre+ mice osteoclasts released more products of bone resorption to the media, compared to the other three groups. This data provides new evidence on the control of osteoclast differentiation and activity by pannexin channels, and highlights the importance of separately analyzing female and male mice when investigating bone cell function.

Mentors: Padmini Deosthale, Department of Anatomy & Cell Biology, Indiana University School of Medicine; Jung Min Hong, Department of Biomedical Sciences and Comprehensive Care, Indiana University School of Dentistry; Lilian I. Plotkin, Department of Anatomy & Cell Biology, Indiana University School of Medicine, Indiana Center for Musculoskeletal Health, Roudebush Veterans Administration Medical Center, Indianapolis, IN

Soft Tissue Manipulation Attenuates Inflammation, Modulates Pain and Improves Gait in Rodents with Induced Low Back Pain

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Neuromusculoskeletal pain disorders are common in warfighters and the general population. Non-invasive and non-pharmacological interventions are needed to expedite return to duty. Soft tissue manipulation, e.g. massage, is a form of manual therapy with known benefits, but its underlying mechanisms are not well understood or optimized. This study aimed to explore the immediate and cumulative effects of Quantifiable Soft Tissue Manipulation on pain sensitivity, function, and biomarkers in conscious rodents with chemically-induced low back pain (LBP). Unilateral, chronic inflammatory LBP was induced by injecting complete Freund's adjuvant into the backs of anesthetized rats. Instrument-assist soft tissue manipulation (IASTM) treatment was administered to the back of conscious animals under light restraint. Back PPT decreased bilaterally post-injury and was lowered even more on the IASTM-treated side initially, but later equalized with repeated IASTM applications. Interesting paw PPT improved on the contralateral but not ipsilateral paw post–IASTM suggesting cross-over effects. Gait

improved to near pre-injury values, indicating improved movement patterns and spinal elongation. Grip strength performance was highly variable. Elevated NPY levels suggest IASTM may serve to help modulate pain. IASTM may have anti-inflammatory effects as seen by lowered RANTES and increased IL-10 levels. Positive findings may be related to pain modulation and an anti-inflammatory treatment effect.

Mentor: Dr. Terry Loghmani

Initial Studies for a Structure - Functional Analysis of the Wedge Domain of *Phanerochaete chrysosporium* Desaturase

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Stearoyl-CoA desaturase (SCD) is an enzyme that is found within all eukaryotes and creates the first double bond between the ninth and tenth carbons of a saturated fatty acid acyl-CoA. Humans have two kinds of SCD, SCD1 and SCD5; mice have four, SCD1-SCD4. The crystal structure of SCD1, deposited in the Protein Data Bank as 4YMK, is the first published structure of a membrane-bound fatty acid desaturase. Using the Phyre2 structure threading web interface and Chimera, a program capable of displaying an interactive three-dimensional structure of proteins, we were able to map the sequence of the *Phanerochaete chrysosporium* desaturase (PchDes), an enzyme that results in a second double bond between carbons 12 and 13, onto the experimental three-dimensional structure of SCD1. This improved model allows us to consider possible catalytic and substrate binding. Both SCD1 and PchDes are hypothesized to release the fatty acyl CoA products after the reaction has been catalyzed through reversible hydrogen bonding. Site-directed mutagenesis is being used to test this hypothesis by creating mutants that will replace the amino acids involved in the product release mechanism and potentially affect the locations of the double bonds. Once the site-directed mutagenesis has been completed, the results of yeast expression experiments can be analyzed by gas chromatography–mass spectrometry.

Mentor: Robert E. Minto, Department of Chemistry, IUPUI School of Science, IUPUI

Modeling blood flow regulation and tissue oxygenation in the retina

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Impaired tissue perfusion has been identified as a contributing factor to the deterioration of vision in glaucoma patients. Mathematical modeling has been used previously to study metabolic flow regulation and autoregulation in the retina. In this study, a previously developed compartment model of the retinal microcirculation is adapted to include a wall-derived metabolic signal calculated from the partial pressure of oxygen in the blood and assumed to be conducted upstream through the network. The model is used to predict changes in retinal tissue perfusion as tissue oxygen demand is increased or as incoming arterial pressure is varied. The model also calculates the level of the conducted metabolic signal that reaches each vessel compartment. This compartmental model is then used to develop a hybrid model that connects a heterogeneous model of a realistic spatial map of the arterioles to a compartment model for the capillaries and veins. Flow, pressure, and partial pressure of oxygen values from the heterogeneous model serve as inputs to the compartmental model, and then the conducted metabolic signal is calculated in the veins and capillaries and is relayed to the heterogeneous arterial network. This hybrid model combines realistic levels of the conducted metabolic response with spatial data from the retinal arterial network to allow more accurate analysis of retinal tissue oxygenation.

Advisor: Julia Arciero, Department of Mathematical Sciences, IUPUI

Multi-material Topology Optimization using a Cellular Potts Model

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Topology optimization is recognized as the most effective numerical method to generate innovative and high-performance architectural layouts. Recently, multi-material topology optimization (MMTO) methods have been proposed. These methods provide the ability to synthesize structures with a plurality of materials, increasing design performance. While successful, most of these methods are extensions of classical topology optimization and rely on traditional, gradient-based optimization. This limits their application, particularly when gradient coefficients are unknown. Our work introduces a new bio-inspired MMTO strategy without the limitations of current approaches. We aim to produce a hybrid kinetic Monte Carlo method for multi-material optimization inspired by the hybrid Cellular Potts Model (CPM) algorithm. The research entails a bottom-up approach, starting with the implementation of a CPM. We implement: a Boltzmann acceptance function governing a local transition rule of material distributions, input parameters for an arbitrary number of cell types modeling spatial constraints, adhesion, and the specification of details concerning the transition rule. The CPM model is coupled with Finite Element Analysis (FEA) in a hybrid structure. The model will employ equations from topology optimization (i.e., compliance) during the development of new transition rules that produce emergent optimization. The model is now modified to the point where the structure of the CPM can be related to field variables of solid mechanics. The usage of a gradient-free Monte Carlo method makes the material dynamics at each point depend on local conditions, as opposed to global interactions; this difference is where our method diverges from traditional topology optimization.

Mentors: Andres Tovar, Department of Mechanical and Energy Engineering, School of Engineering and Technology, IUPUI; T.J. Sego, Department of Intelligent Systems Engineering, School of Informatics, Computing, and Engineering, IU

Predicting Optimal Treatment Strategies for Transplant Patients using Theoretical Modeling

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Immunosuppression is necessary to prevent transplant rejection, but it also makes patients more susceptible to infection, cancer, or diabetes. The development of a treatment strategy that maintains immune competence while preventing graft rejection is important for improving the quality of life and long-term success rate of transplant patients. The adoptive transfer of regulatory T cells (Tregs) has emerged as an alternative treatment that works to boost the regulatory (inhibitory) factors within the host immune system to reduce the immune response and promote graft tolerance. In this study, a previous ODE model of murine heart transplant rejection is adapted to include adoptive transfer as a treatment strategy. The Treg dose magnitude, timing, and frequency are varied to determine optimal treatment strategies given a single dose or multiple doses. The model predicts that delivering daily injections of 10^6 activated Tregs into the graft during the first two weeks following transplantation maximizes graft survival. While Treg delivery alone is not predicted to prevent eventual allograft rejection, it allows the graft to survive almost ten times longer than in the absence of treatment while preserving the functionality of the immune system. A new therapy involving chimeric antigen receptors (CARs) in conjunction with adoptive transfer has the potential to extend graft lifetime and lessen long-term destruction without compromising the host immune system. This model will be extended to investigate the impact of combinatorial treatment strategies involving CARs on graft survival.
Advisor: Julia Arciero, Department of Mathematical Sciences, IUPUI

Deletion of Serpina1 Gene Ineffective of Degeneration of Lumbar Disc in Young Mice

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Mechanical Engineering, ICMH

Intervertebral disc degeneration is a leading cause of back pain in the United States and affects approximately five percent of people in developed countries. IVD degeneration can be caused by a combination of genetic and environmental factors, such as aging or smoking. The Serpina1 gene has been linked to downregulation in the degeneration of intervertebral discs. Because of this correlation, Serpina1 knockout mice were used to compare the degeneration of lumbar motion segments, specifically L1/2 and L4/5. The mice used are 18- and 28-week-old female mice. We hypothesize that the lower segment, L4/5, will degenerate more than the upper segment, L1/2. To obtain this data, the Serpina1 knockout samples are harvested into two motion segments, along with the vertebrae between them. The two segments are then sent to histology and stained for Safranin-O concentration to eventually be graded on a numeric scale to determine how degenerated the discs are. The bones harvested are then scanned using a micro-CT scanner to determine bone structure. Based on the histological scoring, the degeneration scores of the L1/2 segment was not significantly different than of the L4/5 segment. Because of the mouse's natural gait, the strain put on the different segments may be spread relatively evenly across the lumbar sections, as can be seen by the degeneration scores of graders. Taking this into consideration, this could lead to reduced samples needed for future experiments because the two sections are interchangeable.

Mentors: Dr. Nilsson Holguin

Developing and Testing Acoustic Panels Made Out of Mycelium and Other Sustainable Materials and Their Impact on Musicians

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This project is focused on creating acoustic panels out of sustainable materials, specifically mycelium and cellulose. Fiberglass is one of the most common acoustic materials employed today and is used because of it has high absorption coefficients for various frequencies. Health effects from exposure to fiberglass can cause skin, eye and upper respiratory tract irritation. Creating a panel that has comparable absorption without the negative environmental impact would be beneficial, as sound treatment is needed in most buildings and musical spaces. The sustainable materials were compared both quantitatively, using an impedance tube to test for absorption in a lab setting and measuring the room impulse response to determine reverberation time using the panels in real physical spaces, and performing a qualitative user study to test the subjective performance. The result of this study concluded the sustainable materials were comparable in measured performance to fiberglass. Such findings will allow for spaces needing acoustical treatment to have low negative environmental impact and have overall comparable acoustic performance.

Mentors: Dr. Timothy Hsu, Department of Music Technology, Purdue School of Engineering and Technology, IUPUI; Dr. Horia Petrache, Department of Physics, Purdue School of Science, IUPUI.

Assessing Seizure Activity in HEK cell lines and tissue using Multi-Electrode Array (MEA)

Manasvi Shah
Purdue School of Science, IUPUI

To investigate the created excitable HEK cell lines using expression of sodium channels to add to the MEAs for recording of seizure activity and further understand its role in formation of epileptic syndromes.

Mutations in genes encoding voltage-gated sodium channels are known for a variety of inherited human disorders affecting heart rhythm, skeletal muscle contraction and nervous system function. The main cause of epilepsy are seizures and result from abnormal neuronal function. A cause from a sudden burst of electrical activity in the brain. Nav1.2 (voltage gated sodium channel) is a protein, encoded by the SCN2A gene, mutations in which cause a wide variety of genetic epilepsy syndromes with varying severity. The study intends to compare Human Embryonic Kidney (HEK) cells expressing the wildtype (control) Nav1.2 channel along with the Kir2.1 (Potassium inward rectifier) and the mutant Nav1.2 channels expressed with Kir2.1. We expect to see increased neuronal activity in both the engineered HEK293 cells and the mouse neurons with epilepsy mutations. Double stable cell lines were created, neural dissociation has to be better optimized and mutant plasmid is generated through mutagenesis. The next phase is the selection of R1882Q and making additional disease mutations. Ultimately, testing for seizure activity under the MEAs in hippocampal neurons and understanding the relationship between the sodium channel mutations and epilepsy formation and thus conduct drug tests to find a possible cure for this disease.

Mentor: Dr. Theodore Cummins

IoT- Based Smart Safety Monitoring and Evacuation System

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The project is about an IoT based smart evacuation device that helps direct people away from the location of the fire in multistoried buildings. Sensors built-in the exit signs sense and collect data and send that data to the server connected to all the exit signs in the building. This helps the safe path algorithm map out a route towards all the safe exits in the building. According to the results generated by the algorithm, the exit signs switch between cross and arrow in all the directions possible for movement to help navigate people during an evacuation. The basic structure of the device consists of a sensor layer, a network layer, an information layer, and an analysis layer. The analysis layer uses Exponentially Weighted Moving Average (EWMA) for analysis of the situation by calculating the moving average of the data sent by all sensors every minute and determine the outlier to declare if there is a fire. EWMA is an ideal method as it will compare the current reading with the previous moving average and check the difference for analysis. The communicator acts as a link between the device and server and delivers data between each other.

Mentors: Dongsoo Kim, Department of Electrical and Computer Engineering, Purdue School of Engineering and Technology, IUPUI; John Lee, Department of Electrical and Computer Engineering, IUPUI

Chemical and Mechanical Characterization of Virgin and Recycled HDPE for use in Additive Manufacturing and Injection Molding

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High Density Polyethylene (HDPE) is a commonly used thermoplastic for consumer items such as milk jugs, yogurt tubs, and household cleaning bottles. Due to its abundancy, there is potential for using additive manufacturing to make products from recycled HDPE. However, recycled HDPE contains additives and possesses different properties than virgin. This could cause various recycled sources to behave differently during additive manufacturing processes. Purpose: The goal of this work is to characterize virgin and recycled HDPE resin obtained from a variety of sources to determine chemical and mechanical properties. The focus is to identify chemical differences in the translucent and opaque resins as well as their elastic modulus, yield strength, and ultimate strength. Methods: Recycled HDPE

from translucent milk jugs and opaque almond milk jugs were sourced, shredded, and cleaned. Samples of each were tested along with virgin HDPE using gas chromatography/mass spectrometry accurate mass quadrupole time of flight (GC/QTOF) analysis. The different resins were also melted using a sand bath, pressed into flat disks and ASTM D638 Type V coupons were cut out. A Universal Testing Machine (UTM) was used to measure the tensile strength and create stress-strain curves. Results: GC/QTOF data indicates significant differences in volatile outgassing, not only between virgin HDPE and recycled jugs, but also between the translucent milk jugs and opaque almond jugs. The mechanical testing demonstrated higher tensile strength in the recycled jugs over virgin HDPE, and dissimilar mechanical properties between the different recycled jugs.

Mentors: Amanda Siegel, Department of Chemistry and Chemical Biology, Purdue School of Science, Integrated Nanosystems Development Institute, IUPUI; Andres Tovar, Department of Mechanical and Energy Engineering, Purdue School of Engineering, IUPUI

Automatic and real-time vehicle detection on Indiana Highways

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The purpose of the whole research is to develop a method for the automatic and real-time vehicle detection system on Indiana Highways. The result of the research will provide the foundation for the development of the bigger project conducted by Transportation Active Safety Institute (TASI). TASI's project goal is to develop the automatic and real-time traffic flow calculation, automatic accident location identification and reporting system. In this research program, the main focus was to get better understanding of machine learning and Python language and apply them to collect the data to test the accuracy of the system. The needed equipment and the way to communicate with Indiana Department of Transportation (INDOT) was provided by TsiiASI. For the machine learning, YOLO (You Only Look Once) was used to detect the object. The first task of the project was to complete the training set for the machine learning. Nearly 8,000 image data are collected. The second task was to understand and be able to modify the code developed by TASI worker. For the third task, the videos recorded from INDOT camera are used to test the accuracy of the detection system. As a result of this research, the recorded testing videos are obtained, and accuracy of the results were shown in the screen. However, there are more problems need to be solved to increase the accuracy and be able to acclimate to any type of the weather.

Mentor: Stanley Chien

Developing Virtual Reality Module for additive Manufacturing

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Fused Deposition Modeling (FDM) is one of the most commonly used methods in addictive manufacturing. Briefly, the method consists of depositing layers of heated thermoplastic filaments onto a flat surface while shaping a part in accordance to the associated digital model. Today, Addictive manufacturing is deemed reliable for industrial and educational use given its simplicity and affordability; however, the successful use of FDM is still limited. This is partially due to limited knowledge about the printers as well as the long time period required in order to completely extrude a 3D model. Therefore, the objectives of this research is to develop a virtual reality module to simulate the extrusion process as well as develop a printing pattern able to reduce the use of thermoplastic material while maintaining strength properties of current 3D models. To achieve such results, the research makes use of virtual reality technology to graphically represent and simulate a 3D printing process while providing the user with an interactive way to manipulate the extrusion process. Our achievement towards the objective of the research includes understanding the current 3D printing parameters, studying the printing pattern

used in FDM and designing of a digital 3D printer model that can be used to virtually represent the operation of a real 3D printer.

Mentor: Jing Zhang

Effects of Collagen Peptide, Fish Oil, Chondroitin Sulfate, and Glucosamine on Bone Quality

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Bone is composed of inorganic mineral and organic (primarily type I collagen) phases that form a matrix. For bone to perform properly, there needs to be a correct ratio between the two phases. Osteoporosis is a disorder characterized by the loss of bone density as bone becomes thin and more porous, increasing fracture risk. It can be attributed to an imbalance in the process of remodeling when the rate of resorption is faster than the rate of formation. Osteogenesis Imperfecta is another disorder that causes bones to become brittle and deform due to mutations in genes coding for the formation of type I collagen. This study will focus on the effects of collagen peptide, glucosamine, fish oil, and chondroitin sulfate on bone quality as potential treatments for these disorders. These supplements were administered to sixteen C57BL/6 mice for four weeks to ensure that their diet remained consistent, and their growth was uninhibited. Moving forward, these supplements will be tested on a larger sample size of fifty C57BL/6 mice at ten weeks of age. After administering the supplements for four weeks, their femora and tibiae will be harvested, scanned using micro-computed topography, and mechanically tested to study the effects of the supplements on the tissue-level mechanical properties of the bone.

Mentor: Joseph Wallace

Mechanical Characterization of Virgin and Recycled HDPE and LDPE for use in Additive Manufacturing and Injection Molding

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Polyethylene (PE) is the most commonly used plastic in the world and is found in household items including toys, milk jugs, and grocery bags. Its internal structure consists of a chain of carbon atoms with two hydrogen atoms attached to each carbon. When the PE molecule is linear (unbranched) it is called high-density polyethylene (HDPE), while a branched PE molecule is called low-density polyethylene (LDPE). Due to their abundance, the use of recycled HDPE and LDPE is growing in interest; however, research to process these recycled plastics remains scarce. Purpose: The overall objective of this research is to evaluate the usability of recycled HDPE/LDPE blends for various manufacturing processes. The specific objective is to characterize their mechanical properties, observe their structure, and to establish processing methods to make them suitable for additive manufacturing and injection molding. Methods: Virgin and recycled HDPE/LDPE blends with various weight ratios (100/0, 80/20, 60/40, 50/50, 40/60, 20/80, and 0/100) were prepared. The process involved multiple heat cycles. The blends were pressed into flat disks and ASTM D638 Type V coupons were cut out. The elastic modulus, yield strength, and ultimate strength of the coupons were tested using a Universal Testing Machine. The structure was analyzed by FESEM. Results: The mechanical testing demonstrated that virgin HDPE/LDPE blends have higher tensile strength and elastic modulus. FESEM images suggest internal phase shifting. Recycled blend coupon fabrication was unsuccessful. It is hypothesized this is caused due to immiscible additives. Future work includes identifying compatibilizers for the recycled blends.

Mentors: Amanda Siegel, Department of Chemistry and Chemical Biology, Purdue School of Science, Integrated Nanosystems Development Institute, IUPUI; Andres Tovar, Department of Mechanical and Energy Engineering, Purdue School of Engineering, IUPUI

Relationships Between Mutations and Metabolites in Multi-omic Networks

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This research project deals with the in-depth study of multi-omic networks. These biological networks detail the multiple interactions amongst the many different types of molecules. Here, we are dealing with three networks: a) protein to protein relationship, b) SNP to a transcription factor relationship, and c) gene to metabolite relationship. These relationships are all unique in a different way. With these networks, we explore the downstream effect of disease risk mutations on genes, proteins and metabolites. This research is still in progress, but the conclusion that we would like to reach is finding the shortest route from mutations to metabolites. This research is significant because we will generate useful knowledge from these large-scale multi-omic networks to assist with the future therapeutic intervention.

Mentor: Jingwen Yan, Department of BioHealth Informatics, School of Informatics and Computing, IUPUI

Illustrating Citizenship: Capturing the Black Militant in the 21st Century

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This research examines how radical 21st century movements, spearheaded by black women, grapple with the production and circulation of imagery of Black women. The Black Militant Domestic (BMD) of the 1940s, was among the first movements to confront these issues. The Black Lives Matter (BLM), Say Her Name (SHN), and the Mothers of the Movement (MOM) have continued the work of the BMD through their resistance of politics of respectability in the 21st Century. These movements resist Eurocentric societal norms illustrating politicized myths (i.e. jezebel, mammy, wealth queen, and sapphire) framing the attribution of Black women within their communities, American society, and absent of intersectional influences. I investigate through critical race theory and black feminist thought, how Black women, as political actors, engage in constructing counter images of citizenship within BLM, SHN, and MOM. I compared, contrasted, and analyzed these United States-- based political movements their development, use, and presentation of (positive) counter images of black women in the political sphere from 2017 to present. Images were identified and obtained through organizational websites, Twitter, Facebook, hashtags, movement archives, and other mediums for images of black women. My research proves that the methods of black militant domestics can be paralleled with BLM, SHN, and MOM in their use counter imagery. Like the BMD, the movements actively create images and identities while fighting for inclusion of political governmental processes guided by black female leadership. Ultimately, both movements participate as effective citizens through recognition of their humanity, citizenship, and illustrated symbolism.

Mentor: Joseph Tucker Edmonds, Department of Africana Studies and Department of Religious Studies, IU School of Liberal Arts, IUPUI

On the Implementation of an Access Control Polynomial within a Hierarchical Access Scheme

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There are many contexts in which controlling access to data is of utmost importance. In particular medical institutions such as hospitals store a large amount of sensitive data and must be able to strictly control access to certain documents. Hospitals are staffed by various types of personnel who must all have different levels of access to a database. This paper implements a hierarchical access control system based on the dynamic and efficient key management of Dr. Mikhail J. Atallah. In such a scheme, different classes of personnel are granted access based on a hierarchical structure which limits them from accessing data higher up on the hierarchy but allows them to access files in a user class lower on the hierarchy. This paper proposes an improvement upon the key management scheme proposed by Dr.

Atallah through the implementation of an access control polynomial within the independent groups that make up the key-management scheme, allowing for privilege designation on a user level.

Mentors: Dr. Xukai Zou, Dr. Feng Li

Palliative Care Utilization Following Acute Severe Stroke

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Stroke is the 5th leading cause of death in the United States, killing 1 out of every 20 people. Stroke is also the primary cause of permanent disability in Americans. After severe stroke, patients, families, and clinicians often face difficult, time-sensitive decisions about whether to continue or forgo life sustaining treatments. In order for patients suffering severe stroke and their caregivers to make effective treatment decisions, patient-centered communication and setting goals of care is crucial. This study involved a detailed chart review to collect descriptive information about severe stroke patients to characterize their clinical condition, medical care, hospice and/or palliative care conversations, and treatment outcomes. Based on operational definitions developed by the team, the occurrence, timing, and characteristics of discussions involving prognosis, goals of care, and limitations of life sustaining measures was also collected**.** This study shows that palliative care is underutilized as an early intervention after severe stroke. Palliative care consultations are not occurring until after patients have undergone aggressive life-sustaining treatments. However, palliative care consultations are associated with patients being moved to comfort measures only and utilization of hospice, as well as having a DNR order in the patient's medical chart.

Mentor: Amber R. Comer, Department of Health Sciences, IU School of Health & Human Sciences, IUPUI