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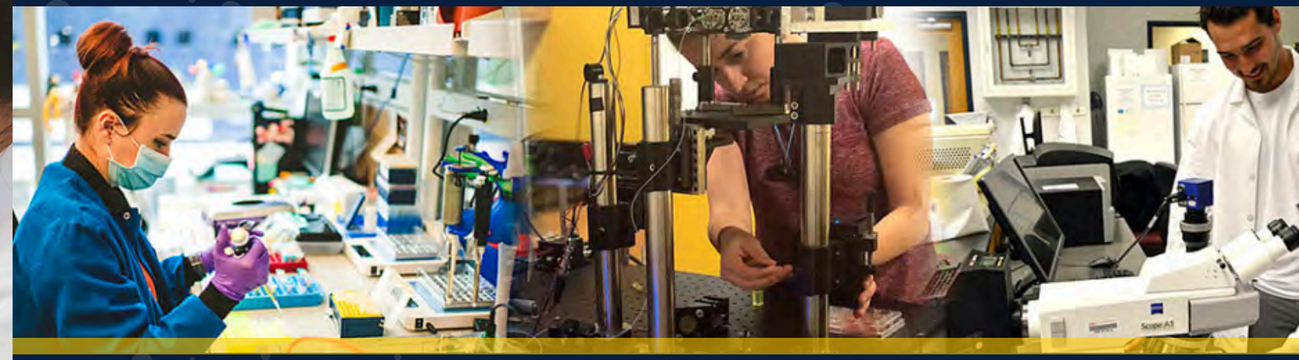
Biomedical Engineering

UNDERGRADUATE RESEARCH DAY

FALL 2024

DISCOVER | DESIGN | DEVELOP | DELIVER

DREAM, DISCOVER,
INSPIRE, INVIGORATE



FIU | Engineering & Computing

Department of Biomedical Engineering

The Department of Biomedical Engineering at Florida International University (FIU) located in Miami is committed to preparing ambitious students who want to combine their love of problem-solving with their desire to help others through this fascinating growing field that applies cutting-edge technologies and modern engineering techniques to improve healthcare.

bme.fiu.edu

Presented through the generous support of the Wallace H. Coulter Foundation

Florida International University | College of Engineering and Computing

Department of Biomedical Engineering

10555 West Flagler Street Suite EC 2600 Miami, FL 33174

FIU | Engineering & Computing
Biomedical Engineering

15th Annual
UNDERGRADUATE RESEARCH CELEBRATION

November 8, 2024 — EC 2300

8:30 AM-9:00 AM	**Breakfast**
9:00 AM-10:00 AM	**Seminar by Thomas J. Royston, Ph.D.** "Force, Fibers, Fractals and Fractional Calculus in Acousto-Elastography"
10:00 AM-10:30 AM	**Short Break**
10:30 AM-12:30 PM	**Poster Session**
12:30 PM-2:00 PM	**Lunch and Networking With Students**
2:00 PM-3:30 PM	**Panel Discussion**
3:30 PM-4:00 PM	**Award Ceremony**
4:00 PM-5:00 PM	**Reception**

Department of Biomedical Engineering (BME) bme.fiu.edu | @fiubiomed

MESSAGE FROM THE CHAIR

Congratulations Biomedical Engineering Undergraduate Researchers! Today marks a milestone in your undergraduate education, where you showcase your self-motivated contributions to research. You set a great example to all, that learning does not end in the classroom and research is a vital component of your undergraduate experience.

I am delighted that there has been a steady increase in the number of undergraduate students participating in research. Each of you has a vital role in your research projects, no matter how big or small your contributions are. The Undergraduate Celebration presentations reflect your ability to work both individually and in teams, to converge information and ideas to discover the unknown, and to find innovative solutions. During this special day, we also recognize our outstanding students in the Coulter Undergraduate Research Excellence (CURE) Program. The BME Wallace H. Coulter endowment allows us to support students in the CURE Program as they participate in a tiered research experience alongside a faculty mentor and participate in career development workshops.

As you move forward in your undergraduate education, continue motivating yourself and others around you to enhance your knowledge, remain inquisitive, and continue to grow in all aspects of learning. Thank you to all our BME Alumni for their active participation in our Undergraduate Celebration and for sharing their real-life experience as medical students, graduate students, academicians, or industry/corporate members. This truly reflects your enthusiasm to give back to the next generation of biomedical engineers!

Best wishes for continued success,

Jorge Riera Diaz, Ph.D.
Associate Professor, Interim Chair of Biomedical Engineering

BME KEYNOTE SPEAKER

FORCE, FIBERS, FRACTALS AND FRACTIONAL CALCULUS IN ACOUSTO-ELASTOGRAPHY

SHORT BIO: Dr. Tom Royston is Professor and Head of Biomedical Engineering at the University of Illinois Chicago (UIC) since 2009 and has been a faculty member at UIC since 1995, with appointments in Biomedical Engineering and Mechanical Engineering. Tom's NIH and NSF-supported research in mechanical wave motion and imaging in porous and nonporous viscoelastic materials, and acoustics applied to medical diagnostics and therapy has been recognized with the NSF Career Award, the NIH NIBIB Nagy Award and the Acoustical Society of America (ASA) Lindsay Award. He is a Fellow of the American Society of Mechanical Engineers, the American Institute for Medical and Biological Engineering, and the ASA. He is a founding member of the International Society for Magnetic Resonance in Medicine Magnetic Resonance Elastography Guidelines Committee. He has authored over 100 peer-reviewed journal articles, and 200 additional conference and other publications.

Thomas J. Royston, Ph.D.

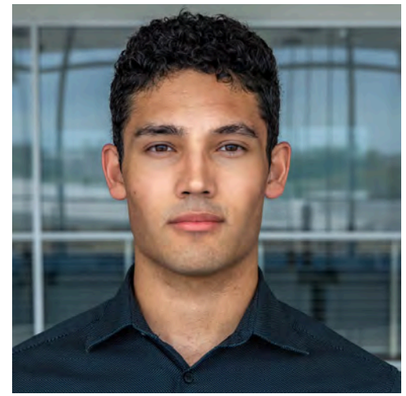
Professor & Head of Biomedical Engineering, Interim Vice Chancellor for Innovation and Strategic Partnerships
University of Illinois Chicago

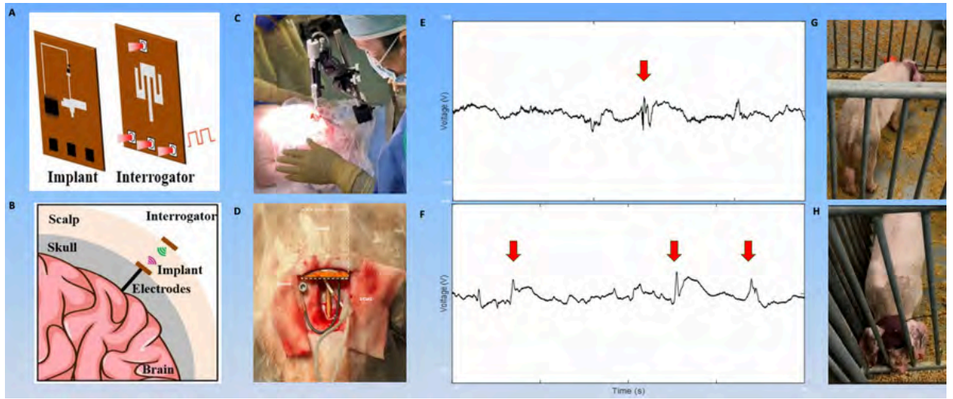
ABSTRACT: Dynamic elastography attempts to reconstruct quantitative maps of the viscoelastic properties of materials by noninvasively measuring mechanical wave motion in them. The target motion is typically transversely-polarized relative to the wave propagation direction, such as bulk shear wave motion. In addition to neglecting waveguide effects caused by small lengths in one dimension or more, many reconstruction strategies also ignore nonzero, non-isotropic quasi-static preloads. Significant anisotropic prestress is inherent to the functional role of some biological materials of interest, which also are small in size relative to shear wavelengths in one or more dimensions. In our research we examine the interplay between the confounding effects of nonzero stress conditions, anisotropy and finite boundaries. A coordinate transformation approach to simplify the reconstruction of prestressed transversely isotropic material properties based on elastography measurements is introduced.

Battery-Free, Wireless Neural Monitoring Implant for Epilepsy Detection in Large Animal Models

Authors: Pablo Boada, Melany Gutierrez-Hernandez, Sally P. Duarte & Jorge Riera Diaz
Faculty Advisor: Jorge Riera Diaz, Ph.D.

Monitoring neural activity is essential for diagnosing and treating neurological disorders such as epilepsy, Parkinson's disease, and Alzheimer's. Traditional systems use wires or batteries, which limit patient movement, introduce the risks of infection, and generate heat. These issues become more problematic for long-term use. To address these challenges, we are developing a battery-less, wireless implant that can monitor neural activity continuously and with minimal invasiveness. Our objective is to validate this system through in vivo experiments on epileptic pigs, demonstrating its ability to capture and transmit neural signals effectively without the limitations of traditional systems. The implant communicates wirelessly with an external interrogator using radio frequency (RF) signals. The implant detects neural signals, mixes them with an RF carrier signal, and transmits the combined data back to the interrogator for processing. Key components of the system, such as a Schottky diode and a bipolar junction transistor (BJT), help ensure efficient signal transmission. In vivo experiments involved implanting the device in pigs and continuously recording neural signals. The wireless nature of the implant allows for free movement, simulating real-life conditions for patients. Preliminary results show the system is capable of accurately recording evoked potentials and epilepsy-related neural activity, which is crucial for validating the implant design. Moving forward, we will explore ways to process the epilepsy data to differentiate between normal and abnormal neural activity. This will involve postprocessing techniques like Fourier Transform or wavelet analysis, with the help of MATLAB. Future work will focus on increasing the system's sensitivity and adding multichannel capabilities. In conclusion, this study presents a promising solution for wireless, battery-free neural monitoring, showing potential for long-term use and offering a valuable alternative to current technologies.

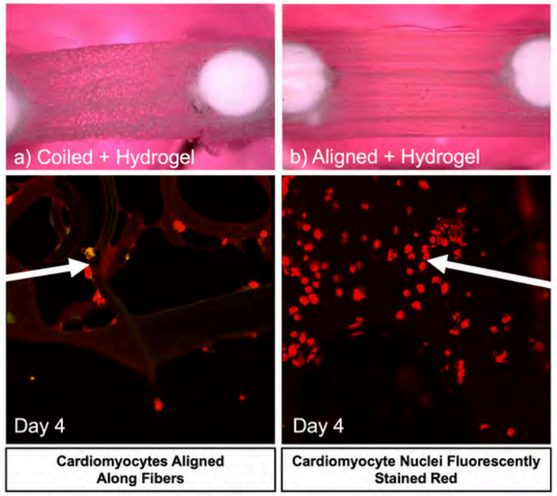




Bioinspired Approach To Cardiac Tissue Regeneration

Authors: Laura Guerrero, Alexi Switz & Anamika Prasad
Faculty Advisor: Anamika Prasad, Ph.D.

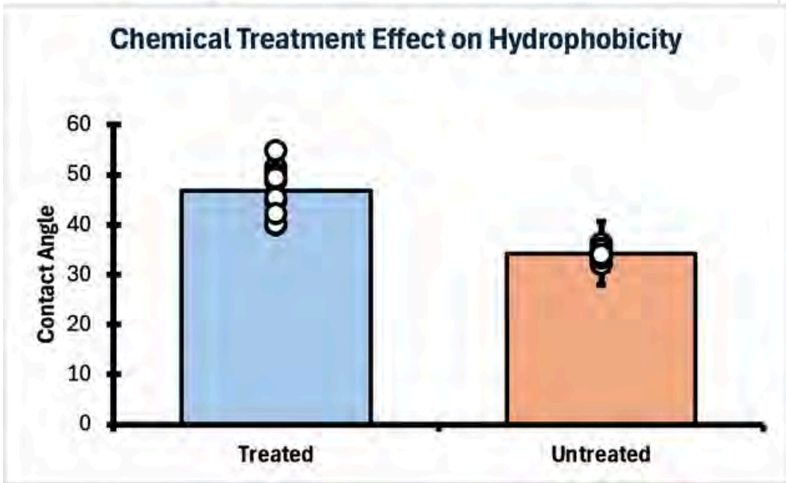
Heart damage following a myocardial infarction (MI) remains a significant health challenge worldwide. This project aims to develop a novel cardiac patch utilizing electrospun fibers to treat post-MI heart damage. We hypothesize that the helically coiled fibers will exhibit enhanced elasticity, facilitating compatibility with the dynamic movements of cardiac tissue. Additionally, the porous structure of these coils is anticipated to promote nutrient diffusion and cardiomyocyte infiltration, crucial for tissue regeneration. Regeneration of functional cardiomyocytes is key for contractile function recovery working towards improving pumping efficacy previously affected by MI. The integration of fibroblast is of great relevance as it mimic the extracellular matrix components that provide structural support to heart tissue also involved in wound healing post-MI recovery. The study objectives are to reliably differentiate human induced pluripotent stem cells to cardiomyocytes, develop a manufacturing protocol for producing cardiac patches and test the biocompatibility with native myocardium cells. The study incorporates the evaluation of mechanical properties and long-term integration of the cardiac patch within the damaged myocardial tissue. Understanding the interaction between the electrospun fibers, cardiomyocytes, and fibroblasts will provide valuable insight into optimizing scaffold design for more effective heart tissue regeneration as it holds immense biomedical significance, offering a promising solution for the treatment of heart damage post-MI, potentially improving patient outcomes and quality of life. Additionally, the patch manufacturing protocol can be utilized in not only cardiovascular tissue engineering, but across other tissue engineering fields as well to develop free standing in-vitro tissue.



PDMS Optimization for Valvular Tensile Testing

Authors: Joshua Villamizar, Andrea Rivera, Daniel Chaparro & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

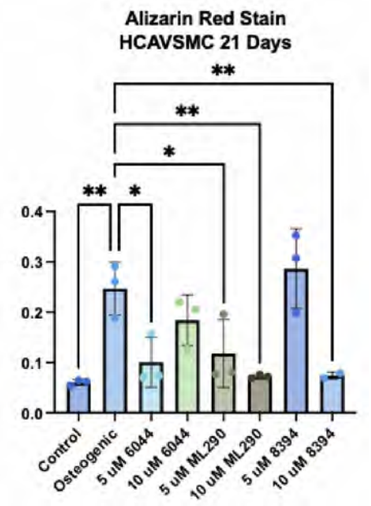
Aortic valve disease (AVD) is a prevalent condition that can lead to serious cardiovascular complications, such as aortic stenosis and heart failure, if not diagnosed and managed early. The ability to identify subtle changes in the mechanical properties of the aortic valve leaflets before disease progression could offer a key advantage in early detection and intervention. Our group has developed a method to quantify mouse aortic valve leaflet (MAVL) tensile mechanical properties, bridging the gap between cellular biological processes and valve mechanics in widely used genetically modified mouse models of AVD. However, the method, which consists of adhering the tissue to rubber membranes and tracking the strain of the composite, has yielded inconsistent results due to improper adhesion of the tissues to the membrane. The objective of this study is to develop a hydrophilic polydimethylsiloxane (PDMS) membrane that promotes a near-perfect chemical bond with MAVLs. The experiment consists of curing of PDMS membranes and performing plasma oxygenation and silanization surface treatments to promote MAVL adhesion followed by mechanical stretching using a FlexCell biaxial tensile testing system. Early results demonstrate that the PDMS mixture enhances the sensitivity of leaflet tensile testing, although perfect bonding between the membrane and leaflet remains a challenge. To mitigate this, we also create and test different mixture concentrations of silicone in our PDMS membrane blend to find the ideal mixture for this objective.



The Effects of Relaxin Agonists on Vascular Calcification in Osteogenic Conditions

Authors: Valery Butto, Afreen Jaman, Ana Valentin Cabrera & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

Heart disease is the leading cause of death in the United States, with atherosclerosis being a primary underlying factor. Atherosclerosis is a chronic disease characterized by the accumulation of lipoproteins in the arterial walls, triggering chronic inflammation, narrowing the arterial walls, and obstructing blood flow. A feature of advanced atherosclerosis is the deposition of bone-like mineral in the plaque, known as vascular calcification, the best predictor of a cardiovascular event. Currently, there are no treatments to slow or reverse vascular calcification. Studies have demonstrated that relaxin, a vasoprotective and anti-fibrotic hormone, is safe in humans; however, relaxin is expensive to synthesize and has poor bioavailability. ML290, 6044, and 8394 are allosteric biased agonists of the human relaxin family peptide receptor 1 (RXFP1) and offer a more cost-effective solution while effectively targeting the RXFP1 receptor. This study investigates the effects of these agonists on vascular calcification. Our experiments consisted of 21 days, where we aimed to determine whether the agonists reduce vascular calcification in a dose-dependent manner in vitro. We seeded vascular smooth muscle cells in osteogenic (OG) media to induce calcification, where our wells consisted of a control group, OG media, and OG media with a dosage of 5 and 10 μM of each agonist. On Day 21, cell lysates were collected, and Alizarin Red staining was performed to assess calcium binding and visualize the varying levels of calcification in each well. Preliminary data suggests these small molecule relaxin receptor agonists can reduce vascular calcification in vitro.



A Mathematical Model of the Myogenic Response in Cerebral Arterioles

Authors: Paulina Perez, Niloufar Khakpour & Nikolaos Tsoukias
Faculty Advisor: Nikolaos Tsoukias, Ph.D.

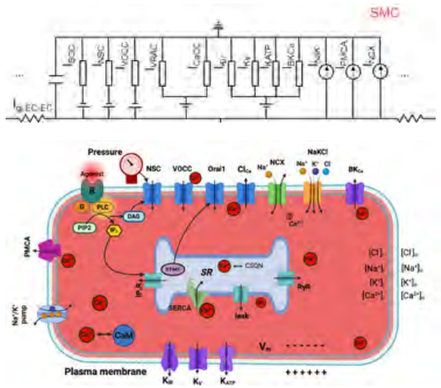
Introduction: The microcirculation responds rapidly and precisely to different stimuli in the brain to adjust local blood perfusion based on demands. This process is critical for brain functioning and its dysregulation contributes to pathological conditions. In response to an increase in blood pressure cerebral arteries constrict. At a macroscale this allows for a stable blood supply to the brain independently of pressure fluctuations (myogenic autoregulation). At a microscale, myogenic responses in small penetrating arterioles may regulate blood distribution in the brain and localized changes in blood supply. Pressure increases are sensed by Vascular Smooth Muscle Cells (SMC) that respond by elevating cytosolic Ca2+ levels, engaging the contractile apparatus yielding an increase in circumferential stress and constriction. Non-Selective Cation channels (NSCs) may play a primary role as sensors of the pressure elevations. Their opening depolarizes the cell membrane, opens Voltage-Operated Calcium channels (VOCCs) leading to an increase in transmembrane Ca2+ influx. Mathematical modeling can assist experimentation in elucidating the mechanisms underlying the microvascular control of cerebral blood flow (CBF). In this study, we developed an SMC model of electrophysiology and Ca2+ dynamics and integrated it with a minimal model of arteriole biomechanics. The model can capture the dynamics of Ca2+ and membrane potential in SMCs and the diameter response of arterioles as pressure changes.

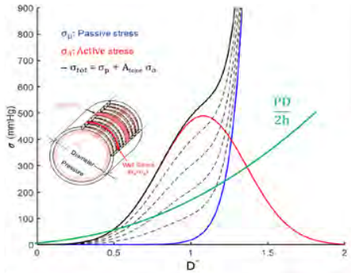
Materials and Methods: The SMC model accounts for cell membrane electrophysiology and calcium dynamics as previously described (Kapela et al, 2008). It accounts for main components of the cell membrane and intracellular Ca2+ stores (Fig.1). Several ion channels (including calcium-activated K+ (BKCa), non-selective cation (NSC), inward rectifying K+ (Kir), voltage-operated Ca2+ (VOCC)), ion pumps and exchangers determine ionic balances and Membrane potential (Vm) at test and during stimulation. Intracellular stores with IP3 (IP3R) and ryanodine (RyR) receptor channels are included.

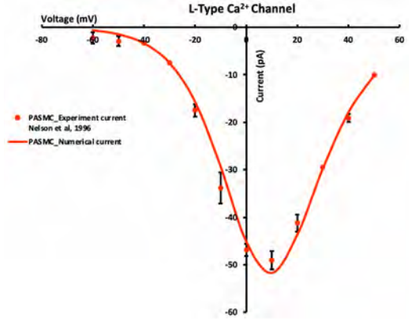
A minimal biomechanics model relates cytosolic Ca2+ in SMCs with the circumferential stress of the arteriole (Fig.2). An exponential stress-strain relationship accounts for the passive elastic properties of the vessel wall. A bell-shaped dependence of the maximum active SMC force on length is assumed. The degree of SMC activation (Atone) is assumed to have a sigmoidal relationship with [Ca2+]i (Eq. 1), where KMCa is the [Ca2+]i at half maximal active tone and ntone is the Hill coefficient. Active stress (σa) dependence on SMC Ca2+ is assumed to follow a Hill equation. Laplace law relates total stress (active σa and passive σp) to pressure (P), diameter (D) and arteriolar wall thickness (h). We assume that the open probability of NSC channels depends on otot effectively accounting for the opening of NSC as pressure increases. By activating NSC channels, which induce Ca2+ influx and enhance contractility, thereby recapitulating myogenic autoregulation.

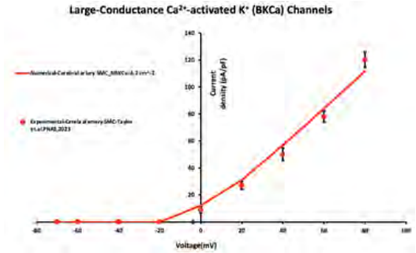
Results, Discussions, and Conclusion: The model can satisfactorily capture experimental data for the changes in SMC Ca2+, Vm and the constriction of arteriolar diameter as pressure increases (Fig. 3). In the absence of active tone (i.e. passive vessel biomechanics, dotted blue line) the model predicts SMC dilation as pressure values increase, consistent with experiments under zero extracellular Ca2+ concentration.

The model supports a central role of NSC channels in this process. Stress-induced opening of NSC channels can substantially increase transmembrane Ca2+ influx, directly through the open NSCs or by opening of VOCCs following the NSC-induced membrane depolarization. The level of Ca2+ elevation can yield physiologically relevant constrictions to maintain global perfusion levels or to tightly regulate local blood supply. This model will serve as a basis to develop integrated models of blood flow control in the brain that will incorporate realistic network reconstructions, detailed description of network hemodynamics and biotransport model of oxygen delivery to tissue.









Hemodynamic Flow Pattern Changes in Mice With and Without Vascular Calcification

Authors: Shirel Belilty Benmergui, Aasma Dahal, Daniela Leizaola, Valentina Dargam, Joshua Hutcheson & Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

Vascular calcification (VC) is a leading contributor to cardiovascular diseases. People with chronic kidney disease (CKD) are at a high risk of VC. Previous work in our laboratory has shown a distinct difference in peripheral flow patterns in mice with CKD and CKD+VC using an in-house near-infrared device – NIROS (near-infrared optical scanner). However, it was unclear whether the observed flow pattern differences were caused by the presence of CKD alone or specifically by the presence of VC. Therefore, this study will focus on observing the peripheral flow pattern difference by comparing three mice groups: (i) mice on a normal diet (control group), (ii) mice with CKD, (iii) mice with CKD and VC. An occlusion-based study was conducted using NIROS for data acquisition, followed by image processing using MATLAB to obtain hemodynamic parameters (oxyhemoglobin (HbO) and total hemoglobin (HbT)). Flow correlation patterns were obtained using Pearson's Correlation Coefficient (PCC), and a statistical analysis was performed using one-way ANOVA. Results showed a significant decrease ($p<0.05$) in hemodynamic flow correlation (in terms of HbO and HbT) in CKD+VC mice group as compared to the other two mice groups. This suggests that the oxygenation flow patterns in the peripheral tail possibly got disrupted when the mice developed VC and not CKD. Future work will focus on similar peripheral imaging studies with a larger sample size.

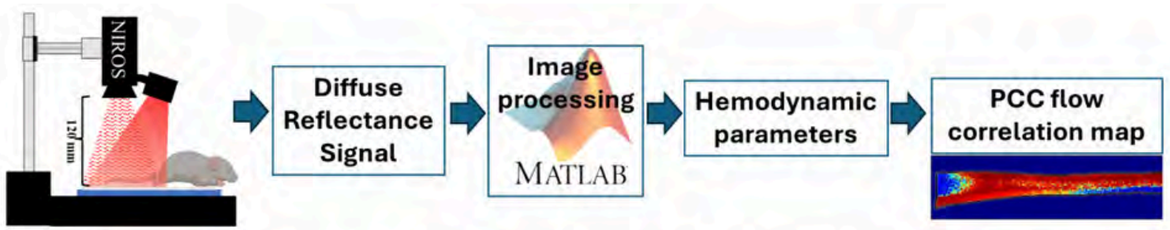


Figure 1. Steps involved in assessing hemodynamic flow pattern differences with vascular calcification in mice.

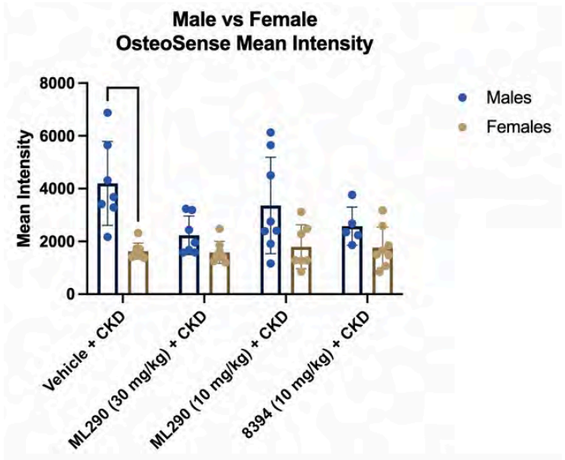
Pre-clinical assessment of hRXFP1 agonists ML290 and 8394 as therapeutics for vascular calcification

Authors: Ana Fonseca , Ana Valentin Cabrera & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

Vascular calcification is the most significant predictor of cardiovascular disease and mortality, especially in patients with chronic kidney disease. Medial vascular calcification occurs when calcium phosphate deposits stiffen the arterial wall, impairing vascular function.

Relaxin, a naturally produced hormone closely related to dilatation and loosening of muscles during childbirth, has been recently presented as a possible treatment for cardiovascular diseases. Relaxin despite being highly vasoprotective and antifibrotic has limitations due to its short stability and bioavailability in vivo, reducing its therapeutic potential. As an alternative, targeting the relaxin family peptide receptor type 1 (RXFP1) is being researched, as it allows to implement the hormones benefits while overcoming its drawbacks. ML290 and 8394 are allosteric agonists of the human relaxin family peptide type 1, both of which have demonstrated an ability to mitigate calcification progression and mineral presence in cultured vascular smooth muscle cells. This study aimed to determine if 8394 and ML290 (10mg/kg and 30 mg/kg dosages) can inhibit vascular calcification progression in an in vivo model of chronic kidney disease. Chronic kidney disease was induced in hRXFP1/hRXFP1; apolipoprotein E-deficient (Apoe-/-) mice by administering an adenine-rich diet for 6 weeks, followed by a high adenine-high phosphate diet for the remaining 2 weeks of the experiment. Simultaneously, we will administer a daily dosage of either ML290 (10mg/kg), ML290 (30mg/kg), 8394 (10mg/kg) or vehicle through oral gavage.

Results suggest a significant decrease in cardiovascular calcification progression in mice that received ML290 at 30mg/kg dosage, establishing it as a possible treatment for medial vascular calcification. However, there were clear sex-dependent differences between the female and male results, with females presenting less calcification overall, making the results of the treatment unclear for this demographic.



Development of a Smartphone Compatible Thermal Imaging Tool and App for Biomedical Applications

Authors: Charles Policard, Oscar Infanzon, Fernando Sebastian Chiwo, Stephanie Amaro & Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

Thermal imaging plays a vital role in biomedical applications, especially for monitoring wound healing and detecting inflammation. This project aims to develop a portable thermal imaging tool by integrating a Seek thermal sensor with a Raspberry Pi 4 and an Android smartphone interface. The system offers a cost-effective solution for real-time thermal image acquisition in clinical settings. A custom-designed 3D-printed smartphone case enhances portability, while the "Thermal Foot" app automates data acquisition, storage, and analysis. Initial tests were performed using a hot plate set between 20°C and 50°C to compare the accuracy and precision of the Seek sensor with the FLIR ONE EDGE Pro. Results revealed a measurable offset between the two sensors, which can be corrected. Ongoing efforts are focused on integrating this system with the SPOT device to combine thermal imaging with tissue oxygenation measurements for enhanced multi-modal wound assessment. This comprehensive approach has the potential to improve diagnostic accuracy of wounds.

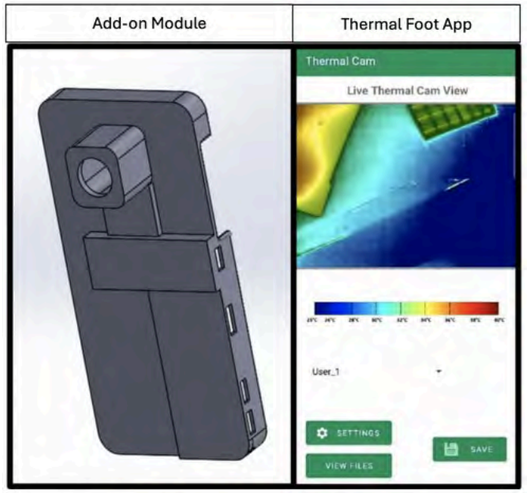
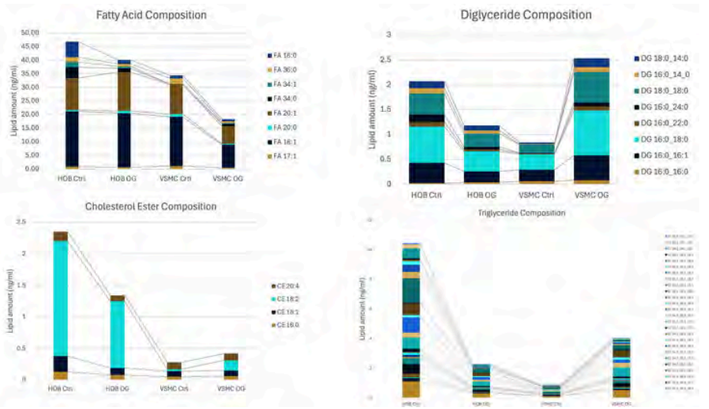


Figure 1.0: Thermal Add-on Module to Smartphone camera and Thermal Foot App

Lipidomic and Proteomic Characterization of Calcifying Extracellular Vesicles

Authors: Anthony Camaraza Diaz, Katherine Kaiser, Lilian Valadares Tose, Francisco Fernandez-Lima & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

Vascular calcification, characterized by the deposition of mineral in arterial walls leads to complications such as myocardial infarction. Under conditions of stress, diabetes, hypertension, and hypercholesterolemia, vascular smooth muscle cells (VSMCs) in the medial layer of arteries can adopt a phenotype similar to osteoblasts (HOBs), which are responsible for bone formation and mineralization. These VSMCs can then produce hydroxyapatite, a key mineral involved in both bone and vascular calcification, which HOBs produce naturally. Both VSMCs and HOBs secrete extracellular vesicles (EVs) that carry lipids and proteins to initiate the mineralization process. Despite these similarities, recent data suggest that VSMCs generate calcifying EVs through a mechanism distinct from that of HOBs. Further, clinical data demonstrate an inverse correlation between bone mineral density and vascular calcification, a phenomenon known as the calcification paradox. To further investigate differences in mineralization between these tissues, we are conducting lipidomic and proteomic characterization of extracellular vesicles (EVs) from both vascular smooth muscle cells (VSMCs) and human osteoblasts (HOBs) treated with osteogenic media. The collected EVs, isolated through ultracentrifugation, will be analyzed using liquid chromatography for their protein and lipid content. This analysis aims to provide a better understanding of the specific lipids and proteins within these EVs that contribute to calcification and differences between VSMCs and HOBs that may provide new insight into mechanisms underlying the calcification paradox.



Manual vs Automated Strain Analysis of Mouse Aortic Valve Leaflets

Authors: Paola Andere-Palomino, Daniel Chaparro & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

The extracellular matrix (ECM) of aortic valve leaflets (AVLs), composed primarily of collagens, proteoglycans and elastin, plays a vital role in maintaining the structural integrity and function of these tissues. ECM homeostasis and remodeling confer the tissue's mechanical properties. Pathological remodeling of the ECM such as excess collagen deposition (fibrosis) leads to valvular dysfunction seen in aortic valve disease. Measuring strain in mouse aortic valve leaflets can provide valuable insights into the composition and behavior of the ECM and thus tissue function. This study evaluates the effectiveness of manual and automated methods for strain assessment in mouse AVLs, addressing the impact of both techniques on the accuracy of measurements essential for understanding valvular function and associated ECM remodeling. The experiment contrasts the manual method utilizing ImageJ software with the automated approach through Ncorr digital image correlation, with a particular focus on the reliability of strain measurements under differing imaging conditions. Results indicate that neither method consistently outperformed the other; instead, measurement accuracy was significantly influenced by sample preparation and image quality. Moreover, while the automated method demonstrated potential efficiency advantages in scenarios with optimal imaging, both techniques yielded comparable results when used on samples with clear imaging characteristics. This comparison underscores the necessity for high-quality imaging in strain analysis, paving the way for improved methodologies in future research.

Fig 1. Mean percent error of each set for Leaflet Trial 1 in the X Direction

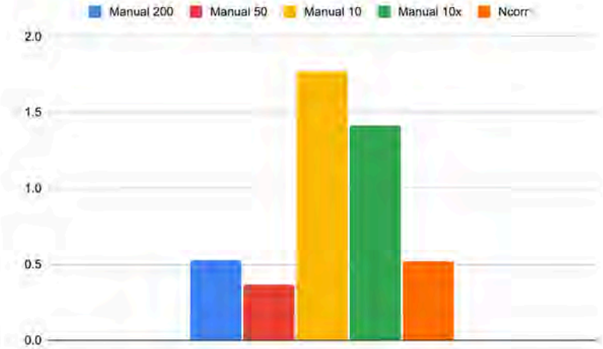
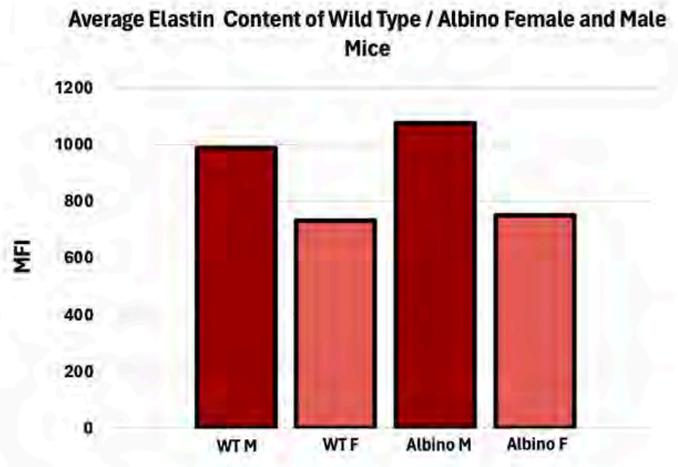


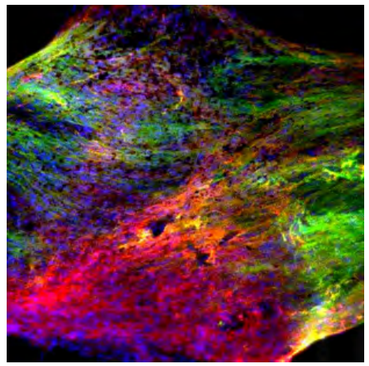
Fig 2. Mean percent error of each set for Membrane Trial in the X direction

Sex and Pigmentation-Dependent Differences in Aortic Valve Leaflet ECM

Authors: Lorena Alvarez, Daniel Chaparro & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

The aortic valve has three leaflets (AVLs) that allow blood to flow in one direction from the left ventricle to the rest of the body. Pathological remodeling of collagen and elastin in these leaflets impairs their function, leading to disease, with elastin fragmentation thought to be a key initial step in disease progression. Recent clinical findings indicate that aortic stenosis is associated with more AVL fibrosis in females while males tend to have AVL calcification. Little is known about baseline sex-dependent differences in AVL structure. Interestingly, studies in mice have shown a positive correlation between melanocytic pigmentation and elastin: hyperpigmented mice have more abundant and disorganized elastin, while hypopigmented mice have little to none. Our preliminary data indicate that male leaflets have more elastin than female leaflets while collagen content is similar. Although the extracellular matrix (ECM) composition of these tissues has been described, the combined effect of biological sex and melanocytic pigmentation on elastin and collagen abundance and organization has yet to be determined. To investigate sex and pigmentation dependent differences in ECM composition, albino and wild-type male and female mouse AVLs were resected and stained for collagen and elastin. Tissues were then imaged by confocal microscopy and quantified using MATLAB. Both albinism and female sex were associated with less elastin but we observe no difference in collagen content. Current research efforts in this project include using multimodal imaging methods to fully characterize differences in elastic fibers.





Early Detection of Inflammation and Ischemia in Diabetic Foot Ulcers Through Differential Thermal Maps with Smartphone-based Thermal Imaging

Authors: Stephanie Amaro, Fernando S. Chiwo, Daniela Leizaola, Renato Sousa, Jose P. Ponce, Stanley Mathis, David G. Armstrong & Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

Diabetic foot ulcers (DFUs) are one of the most common and critical complications of diabetes. It is estimated that one in three diabetic patients tend to develop DFUs during their lifetime. Thermal imaging is widely used to assess inflammation, infection, and ischemia in diabetic foot ulcers. Unlike the large thermal cameras, our lab has used a low-cost smartphone compatible wireless thermal camera to assess DFUs in a multi-week clinical study. The objective of this research is to develop quantitative metrics to differentiate inflammation, infection and/or ischemic conditions in DFUs using thermal maps. In-vivo thermal measurements from our prior clinical study across 16 DFU subjects imaged across 4-6 weeks were used calculate a differential representation of the temperatures observed across the foot area. A distinct temperature increase was observed in inflammation regions when compared to that of the entire foot, and a distinct temperature drop was observed in ischemic or necrotic regions when compared to the entire foot. A discrete contour plot of these inflamed and/or ischemic regions can provide promising insights into the thermal characteristics associated with different stages of DFU progression and potential assist in early predictions of infections and demarcate necrotic regions that should be surgically removed.

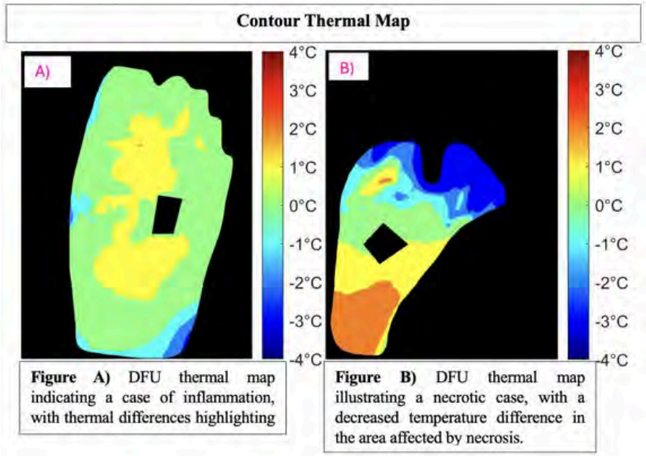


Figure A) DFU thermal map indicating a case of inflammation, with thermal differences highlighting

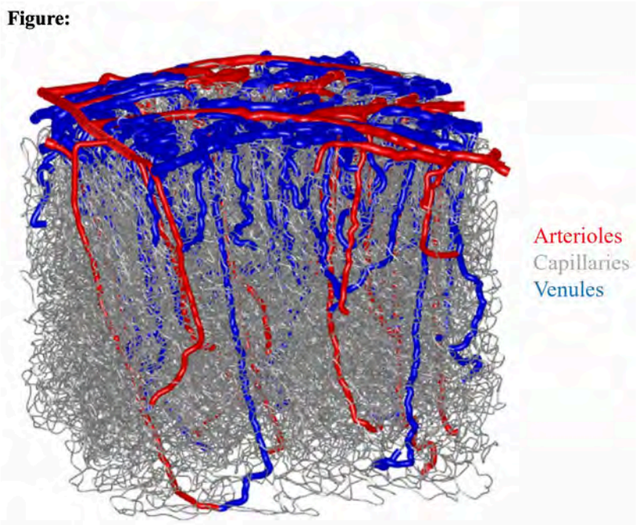
Figure B) DFU thermal map illustrating a necrotic case, with a decreased temperature difference in the area affected by necrosis.

Reconstruction of Realistic Cerebral Microvascular Network for Blood Flow Simulation

Authors: Maria Macias, Mia Roman, Dabasish Kumar Saha & Nikolaos Tsoukias
Faculty Advisor: Nikolaos Tsoukias, Ph.D.

Neurovascular coupling (NVC), the process through which neural activity modulates cerebral blood flow (CBF), is essential for maintaining normal brain function but is often disrupted in neurological disorders such as Alzheimer's disease, dementia, and small vessel disease. A detailed understanding of the cerebral microvascular architecture is necessary for accurately modeling this relationship and simulating cerebral blood flow dynamics. Given the complexity and scale of the microvascular network (MVN), experimental investigation is highly challenging. Therefore, reconstructing a geometrically accurate MVN is a crucial step toward simulating blood flow in the brain. In this study, we present a realistic cerebral MVN derived from two-photon microscopy imaging data of vibrissa primary mouse sensory cortex. Utilizing principles of graph theory, we capture the intricate vascular structures and connectivity patterns. Nodes represent vessel junctions, while edges correspond to vessel segments, encompassing pial arteries and veins, penetrating arterioles and venules, and capillaries. Vessel strands are segmented to the approximate length of an endothelial cells (ECs), allowing for the seamless integration of capillary endothelial cells (cECs), pericytes (PCs), arteriolar endothelial cells (ECs), and smooth muscle cells (SMCs) into a multicellular vascular network. This reconstructed MVN will allow for simulating blood flow regulation in the context of NVC, advancing our understanding of neurovascular functions and the mechanisms governing cerebral blood flow in both health and disease.

Figure:



COX-2 overexpression in astrocytes of a parkinsonian mouse model: a quantitative analysis of immunofluorescence

Authors: Ana Laura Rumbaut, Jorge Riera Diaz, Kim Tieu & Harry Brown
Faculty Advisor: Jorge Riera Diaz, Ph.D.

Parkinson's Disease (PD) is the second most common neurodegenerative disease in the world. However, many aspects of its pathogenesis and development remain an enigma. Blood-brain barrier (BBB) damage in PD because of chronic neuroinflammation is a relatively unexplored area of research, but literature suggests that these factors contribute to neurodegeneration. Due to astrocytes' primal function of supporting the BBB, these cells pose an ideal subject to study changes in BBB integrity. On the other side, cyclooxygenase-2 (COX-2) synthesizes prostaglandin E2 (PGE2) under inflammatory conditions, which is a potent vasodilator, and in excess could have a detrimental impact on BBB stability. In our study, we use immunofluorescence to detect COX-2 overexpression (through SP21 monoclonal antibody) by GFAP-positive astrocytes in hippocampal tissue of wild-type (WT) vs. paraquat-treated (pq) mice, which is known to emulate parkinsonian conditions in rodents. The tissue samples were further observed under confocal microscopy and quantitative analysis of the images demonstrated changes in astrocyte morphology corresponding with PD-characteristic reactivity, such as irregular shape and thickened processes, along with spatial co-existence of COX-2 in astrocytes endfeet and cell body, and a significant increase in signal intensity of SP21, not seen in WT samples. These findings suggest the instrumentality of COX-2 in the chronic inflammatory cascade propagated by astrocytes and its potential effect in the stability of the BBB. Further research aims to study specific vascular changes in the BBB upon stimulation of COX-2 by astrocytes through in vitro models, allowing us to elucidate a novel mechanism of neurodegeneration and broadening the horizons for treatment development.

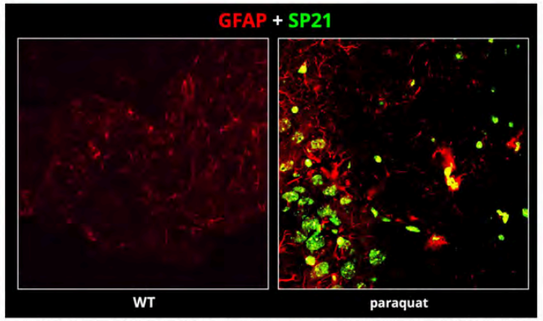


Fig. 1 - Confocal images of hippocampal tissue of WT (saline) and paraquat-induced mice, stained with GFAP (red) for astrocytes and SP21 (green) for COX-2.

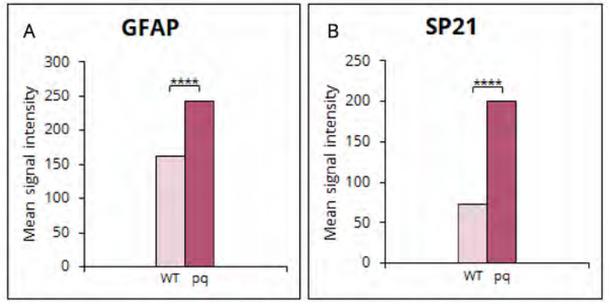


Fig. 2 - Comparison of mean fluorescent signal intensity of GFAP (a) and SP21 (b) in WT vs. paraquat-induced tissue. p<0.0001 (values were compared to the maximum threshold of each signal)

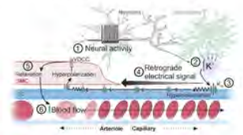
Measuring Membrane Potential Changes in Cultured Cerebral Primary Endothelial Cells Using Fluorescence Microscopy

Authors: Amy Del Castillo, Elyna Gonzalez, Niloufar Khakpour & Nikolaos Tsoukias
Faculty Advisor: Nikolaos Tsoukias, Ph.D.

Cerebral blood flow (CBF) is crucial for brain function. Neurovascular coupling (NVC) is the process which regulates cerebral blood flow (CBF) by sending vasoactive signals to the brain. NVC ensures an adequate supply of oxygen and nutrients to brain regions through precise signal exchanges, (e.g. such as neuronal release of K+ ions), which triggers electrical signals that travel to adjacent vessels and increase blood flow.

This study will use optical electrophysiology to assess membrane potential dynamics in cultured cerebral primary endothelial cells (ECs). Cell seeding is executed on 10 mm round coverslips using PBS and other growth factors until they reach 80% confluency. Coverslips will be placed in a perfusion chamber and exposed to a voltage-sensitive fluorescent dye for 30 minutes. Two different dyes will be tested, FluoVolt and DiBaC4 (ThermoFisher). The chamber will be put on a fluorescence microscope stage. The cells will be excited at λexc=480nm and light will be collected at λemm=515nm using a CCD camera. The cells will be subjected to various extracellular K+ concentrations. Low K+ levels (5-15mM) cause hyperpolarization of the cell membrane due to the activation of Kir channels. At high K+ levels (60mM), the cells depolarize. The dye's ability to capture voltage changes will be examined, and intracellular sharp electrodes will be used to independently assess the cell's membrane potential and calibrate the fluorescent signal. The study will present a method for measuring electrical signaling in situ (e.g., brain tissue slices or isolated microvessels).

Neurovascular Coupling



Longden et al. Nature Neuroscience, 2017

Figure 1: Capillary endothelial cells (cECs) detect neural activity and send out electrical impulses that raise local cerebral blood flow (CBF) in a process known as capillary-mediated neurovascular coupling.

DiBaC4 vs. Fluovolt Protocol (Comparison)

Step	DiBaC4 Protocol	FluoVolt Protocol
Cell/Loading Solution Preparations	• Culture cells and confirm confluence is within 80-90% range; if not confluent, remove old media, add fresh media, and incubate to allow more growth. • **Dilute DiBaC4(3) loading solution to 0.5 uM in chosen buffer (HBSS)** • Remove the media and rinse the cells 2x with HBSS.	• Culture cells and confirm confluence is within 80-90% range; if not confluent, remove old media, add fresh media, and incubate to allow more growth. • **Mix 100 µL PowerLoad, 10 µL FluoVolt dye, and 10 mL HBSS to produce loading solution.** • Remove the media and rinse the cells with HBSS.
Dye Loading	• Cover the cells with 2 mL of DiBaC4 loading solution. • Incubate cells **in the dark at** 37°C for 15 minutes to avoid photobleaching (DiBaC4 is light-sensitive).	• Cover the cells with 2 mL of FluoVolt loading solution. • Incubate cells at room temperature for 15 minutes.

Microvascular Endothelial Cells at 90% Confluency

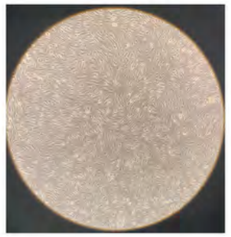


Figure 2: In vitro image of Cultured C57BL/6 Mouse Primary Brain Microvascular Endothelial Cells

Step (Cont.)	DiBaC4 Protocol (Cont.)	FluoVolt Protocol (Cont.)
Fluorescence Measurement	• Remove the solution after incubation and add HBSS to rinse cells 2x. • Excitation is performed at 480 nm and emission detection at 515 nm, capturing changes in fluorescence over 2 min at 20 second intervals • **No specific background suppressor like with FluoVolt (however, proactive measures have already been mentioned.)**	• Remove the solution after incubation and add HBSS to rinse cells 2x. • Excitation is performed at 480 nm and emission detection at 515 nm, capturing changes in fluorescence over 2 min at 20 second intervals • **Optional: Dilute Neuro Background Suppressor to 1:10 to decrease fluorescence of the background.**
Measuring Changes in Membrane Potential	• Test the different K+ concentrations (5-15 mM for hyperpolarization; 60 mM for depolarization).	• Test the different K+ concentrations (5-15 mM for hyperpolarization; 60 mM for depolarization).

Figure 4: Table Outlining Protocol Steps for DiBAC4 and FluoVolt Dye Applications

Experimental Setup for Measuring Voltage

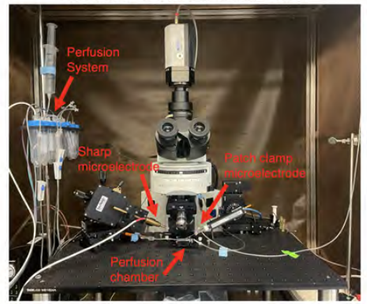


Figure 3: Experimental setup includes perfusion system, patch clamp microelectrode, sharp microelectrodes and suction vacuum.

Development and Characterization of Fibrous Mat for Bone Tissue Engineering

Authors: Jennifer Acevedo, Anja Mihajlov, Alexi Switz & Anamika Prasad
Faculty Advisor: Anamika Prasad, Ph.D.

Long Bone Fractures are a form of Complex Bone Fracture that utilizes various invasive and time-consuming treatments that become tedious for the patient. The Masquelet's method is a two-stage surgical procedure that combines the use of biologically induced membranes, spacers, and allografts. The first surgical procedure starts by cleaning the bone and placing a polymethyl methacrylate (PMMA) spacer in its place with some stabilizers, then a period of 6 to 8 weeks is waiting until the second surgical procedure, here the pericardium is cut to take the spacer out and then fill the gap with autologous bone graft. The objective of this project is to improve Masquelet's method by producing a biodegradable electrospun fibrous bone patch to wrap around the spacer and serve as a living tissue band aid for the pericardium and aid in the healing process. We electrospun PCL/PLGA fibrous mats using an in-house electrospinning setup. PCL and PLGA were chosen for their biocompatibility. We analyzed electrospinning parameters, specifically the flow rate to determine how manipulating this parameter changes fiber formation and mechanical performance. We then characterized those mats via imaging to determine fiber shape and diameter and tensile testing to determine elastic modulus. We found that we were able to successfully synthesize PCL/PLGA mats, that the average fiber diameter at 0.15ml/min flow rate was 17.8 µm and at 0.35ml/min was 14.37µm. We also found that the elastic modulus of the mats at 0.15 ml/min flow rate was 12.06 ± 3.28 MPa and that the elastic modulus of the mats at 0.35ml/min flow rate was 15.87 ±1.69 MPa. In future work, we will continue to investigate electrospinning parameters' effects on fiber formation and subsequent mechanical properties and test the biocompatibility of these fibers and their ability to assist in healing damaged pericardium.

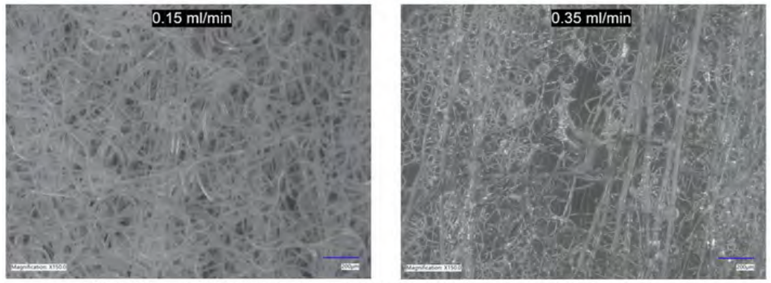
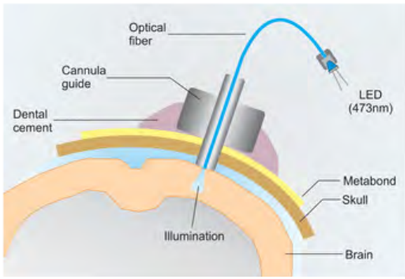


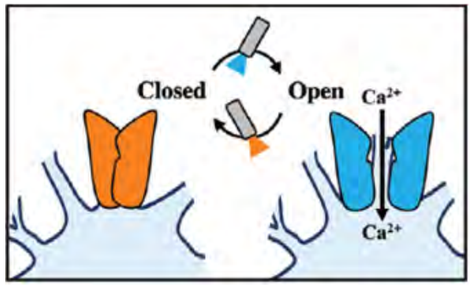
Figure 1: Keyence digital microscope images of electrospun PCL/ PLGA composite nanofibrous mats.

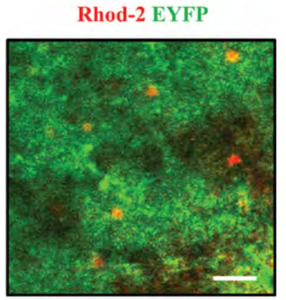
Optogenetic Approach to Preventing Seizures in Focal Cortical Dysplasia Type II Epileptic Mice

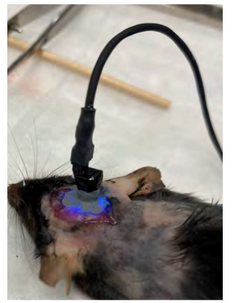
Authors: Jordan Morejon Castelli, Sally P. Duarte & Jorge Riera Diaz
Faculty Advisor: Jorge Riera Diaz, Ph.D.

Focal Cortical Dysplasia Type II (FCDII) is a malformation of cortical development frequently associated with drug-resistant epilepsy, characterized by abnormal neuronal migration, disrupted cortical architecture, and the formation of dysplastic neurons. This condition is linked to increased inflammation and hyperexcitability within neuronal networks, significantly elevating the risk of seizure activity. This study aims to investigate the role of excessive calcium signaling in astrocytes, a type of glial cell that plays a crucial role in maintaining homeostasis and modulating neuronal function. We hypothesize that heightened intracellular calcium levels in astrocytes will lead to the upregulation of pro-inflammatory cytokines, including interleukin-1 beta (IL-1β), tumor necrosis factor-alpha (TNF-α), and high mobility group box 1 (HMGB1), as well as alterations in the expression of glutamatergic receptors such as N-methyl-D-aspartate receptors (NMDARs) and metabotropic glutamate receptors (mGluRs), thus exacerbating hyperexcitability and seizure susceptibility. To test this hypothesis, we will utilize a mouse model genetically modified to express channelrhodopsin-2 (ChR2) specifically in astrocytes. An optogenetic surface light probe will be implanted to facilitate precise control of astrocytic calcium signaling through blue light (470 nm) and amber light (595 nm) stimulation over a six-week experimental period. Following different intervals of stimulation, brain tissue will be harvested for analysis using immunohistochemistry to quantify the expression levels of inflammatory markers and neurotransmitter receptors. By comprehensively understanding the interplay between astrocytic calcium signaling, inflammation, and hyperexcitability, we aim to identify novel therapeutic targets for the management of hyperexcitability and inflammation associated with Focal Cortical Dysplasia Type II.





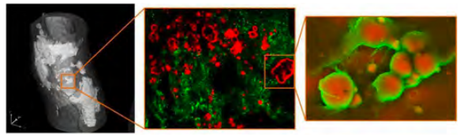


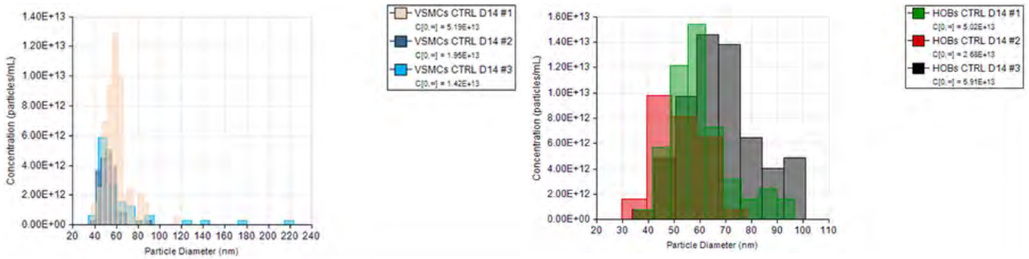


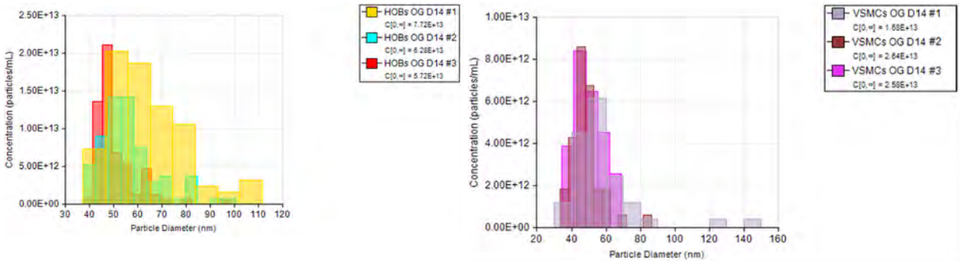
Quantifying Properties of Calcific Extracellular Vesicles from Osteoblasts and Vascular Smooth Muscle Cells

Authors: Nicole Marie Mendoza Hung, Katherine Kaiser & Joshua Hutcheson
Faculty Advisor: Joshua Hutcheson, Ph.D.

Vascular calcification is the abnormal deposition of mineral in blood vessels. It is an active, cell-regulated process that has been recognized as a key cardiovascular risk factor and is the most significant predictor of an individual's risk of a heart attack. Interestingly, this abnormal mineralization in arteries is often accompanied by reduced bone density. This contradictory relationship, known as the "calcification paradox" is commonly observed in conditions such as osteoporosis and chronic kidney disease. The specific mechanisms underlying the divergent mineralization by the primary calcifying cells in each tissue, vascular smooth muscle cells (VSMC) and osteoblasts (HOB), remain unknown. Both types of mineralization utilize the release of small membrane-bound compartments known as extracellular vesicles (EVs), which transport procalcific materials into the extracellular space to initiate mineral formation. We hypothesize that EVs released from VSMCs, and HOBs have distinct characteristics, due to unique mechanisms of formation. Osteoblast-derived EVs have been previously characterized as ectosomes, with a reported size range of 10-400 nm. VSMCs have been shown to have exosomal origins, and therefore, we hypothesize that they produce smaller EVs within the 40-160nm range. This project will compare calcifying EVs isolated from cultured HOBs and VSMCs using Tunable Resistive Pulse Sensing (TRPS) to measure EV size, concentration, and charge. We aim to use these different characteristics to identify unique features between the two EV populations, thus providing better insight into their mechanistic origins. The findings could have significant implications for developing therapeutic strategies against vascular calcification and bone-related diseases.

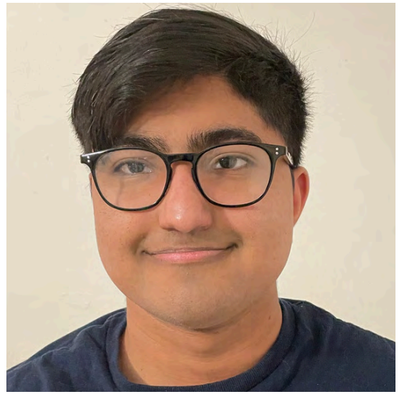






Investigating the Role of Respiratory Dynamics in Enhancing Cranio-Spinal CSF Oscillations and Toxin Clearance During Sleep

Authors: Abdul Raafay Khan, Carlos Otero, Sang H. Lee, Noam Alperin & Jorge Riera Diaz
Faculty Advisor: Jorge Riera Diaz, Ph.D.



Respiratory patterns significantly impact cerebrospinal fluid (CSF) dynamics during sleep, with emphasis on cranio-spinal CSF oscillations and metabolic waste clearance. The accumulation of amyloid-beta and tau proteins, linked to poor sleep quality in older adults, represents a significant risk factor for neurodegenerative diseases such as Alzheimer's Disease. This first quantitative investigation of the interplay between abdominal and thoracic breathing patterns across the sleep cycle employed respiratory belts, a 32-electrode BrainVision EEG cap, and polysomnography for comprehensive physiological monitoring of subjects (n=2). Subjects underwent a 4-hour sleep protocol, including a 30-minute lights-on period, with sleep stages scored following standard criteria for Wake, N1, N2, and N3 stages. Initial findings demonstrate that slow abdominal breathing during sleep significantly enhances CSF oscillations compared to awake states, particularly during non-rapid eye movement (NREM) sleep. Notably, thoracic respiration negatively influences cranio-spinal CSF oscillations through inspiration-induced negative pressure transmitted to the right atrium, increasing venous drainage and reducing CSF outflow. Quantitative analysis revealed that abdominal breathing amplitude increased by 28% during sleep, while thoracic breathing amplitude decreased. These findings demonstrate that abdominal breathing during slow-wave sleep plays a crucial role in promoting CSF oscillations and metabolic waste clearance. Future research directions include extending sleep duration to 6 hours to allow subjects to reach the important N4 sleep stage and investigating CPAP intervention benefits. This research aims to elucidate the link between poor sleep and impaired clearance of toxins from the brain, potentially informing therapeutic strategies for neurodegenerative disease prevention.

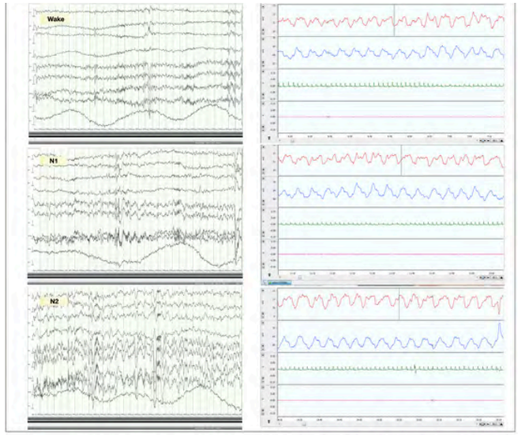


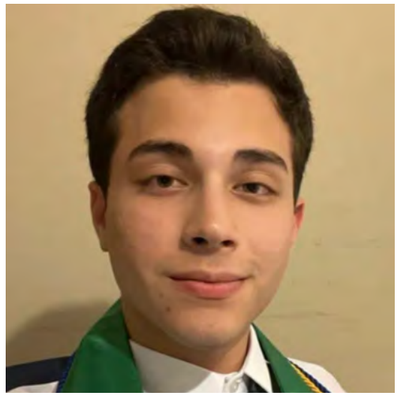
Figure 1. On the left shows sleep scored instances of Wake vs N1 vs N2 for a subject and on the right shows the respective thoracic (red) and abdominal (blue) respiration rates as well as a PSG (green) which showcases the cardiac rate. Inspiration is upwards.

Table 1: Sleep related differences between abdominal and thoracic respiration cycles

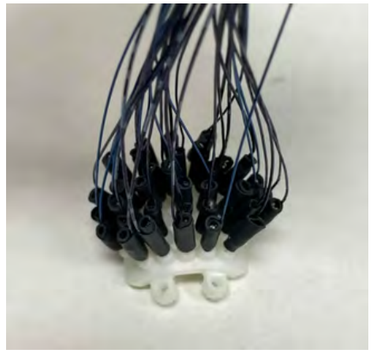
	Awake	Sleep
Onset of inspiration	*Abdominal coincides with thoracic*	*Abdominal precedes thoracic*
Duration of inspiration and expiration	Thoracic: Inspiration >> expiration Abdominal: Inspiration << expiration	Thoracic: Inspiration > expiration Abdominal: Inspiration ~ expiration
Smoothness	Thoracic: Rippled inspiration Abdominal: Smooth inspiration and mildly rippled expiration	Thoracic: Rippled mid-to-end inspiration Abdominal: Symmetric and smooth inspiration and expiration

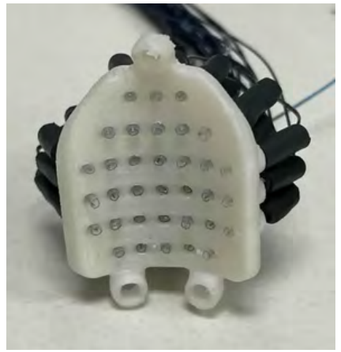
3D Printed EEG fMRI Helmet Model in Rodents

Authors: Edgar Collazo & Jorge Riera Diaz
Faculty Advisor: Jorge Riera Diaz, Ph.D.



According to the Cleveland Clinic approximately 50 million people worldwide suffer from neurodegenerative disorders every year. Rodent models are some of the most universally utilized research models when studying neurodegenerative diseases due to their ease of access, versatility, and general compatibility with such disorders. In human models' multichannel EEG fMRI has been a tool used to diagnose and monitor the progress of diseases such as Epilepsy, Alzheimer's, Dementia etc. for decades now. Rodent testing models have presented challenges for simultaneous EEG fMRI studies in the past due to small surface area of scalp and concerns over general proximity of high numbers of multichannel electrodes thus usually only allowing a small number of electrodes in sometimes invasive procedures. Only relatively recently have advancements in animal testing protocol and technology allowed for studies such as reliable noninvasive EEG in rodents to become possible. Through the use of 3D printing techniques and an improvement on a previously published design for an EEG fMRI helmet in rodent models, up to 32 channel recordings are now possible via the utilization of a standardized helmet design composed of a non-conductive plastic and small electrodes; the electrodes consisting of platinum rods encased in silicon and filled with a conductive paste typical of human EEG multichannel recordings soldered to tinned copper alloy wires. Possible future applications may be improvements to ongoing research or development of new research regarding neurodegenerative diseases using rodent model testing utilizing a now more accessible EEG fMRI technique.

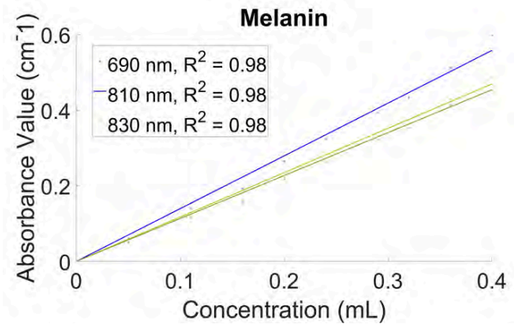




Investigating absorption properties of two synthetic absorbers used to make skin-mimicking optical phantoms

Authors: Divina Campbell, Daniela Leizaola, Maria Hernandez Hernandez & Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

The overall goal of my research is to make epidermal-dermal skin phantoms of various skin colors for near-infrared optical imaging studies. Making skin-like phantoms, which mimic different types of skin colors can help in assessing how accurate optical imaging tools are. As a first step, the fabrication of agar-based optical phantoms was standardized. Agar was the base with India ink as the absorbing agent and aluminum oxide as the scattering agent. As the next step, we focused on investigating the absorption properties of synthetic absorbers that best mimic various skin colors. Two synthetic absorbers (melanin and India ink) were prepared of various concentrations and their absorption properties were measured across near-infrared wavelengths (690, 810, 830 nm) using a spectrophotometer. The spectrophotometer provided absorbance values, allowing for the correlation between absorbance and pigment concentration in samples. Linear regression analysis showed strong relationships between concentration and absorption for both India ink and melanin, with melanin having a higher R2 value of 98%, compared to 70% for India ink across the wavelengths. Ongoing work is to use these absorbers and scatterers to develop two-layered epidermal-dermal agar-based skin phantoms of varying skin colors.



Isolation of Cerebral Microvascular Networks to Investigate Capillary-Mediated Neurovascular Coupling Using Fluovolt Dye and Sharp Electrode Techniques

Authors: Maria Alexandra Parra, Katherine Nicole Lopez
Faculty Advisor: Nikolaos Tsoukias, Ph.D.

Regulation of cerebral blood flow is essential for neuronal health, particularly in neurodegenerative diseases like Alzheimer's, where this process is impaired. Neurovascular coupling, which links neural activity to blood flow, traditionally involves arteriole signaling, but recent evidence suggests capillaries also play a direct role. This study will investigate capillary-mediated neurovascular coupling using an ex-vivo capillary-arteriolar model. We plan to use C57BL6 and Kir2.1 knockout mice to explore the role of the Kir2.1 potassium channel in neurovascular signaling. Following euthanasia, the middle cerebral artery will be dissected to isolate pial arteries and capillary networks, which will then be prepared for electrophysiology and imaging experiments. To visualize voltage changes, Fluovolt (Thermo Fisher Scientific), a membrane potential dye, will be applied to isolated arteries and incubated for 10 minutes at 37°C. Fluorescence microscopy will capture real-time voltage dynamics, while sharp microelectrodes will be inserted into capillaries to measure membrane potentials directly, providing precise electrophysiological data. Preliminary results show successful isolation of capillary networks and effective dye loading, validating this model for studying the electrical properties of neurovascular coupling. The Kir2.1 knockout model will provide insights into how this channel affects signaling between capillaries and arterioles, with implications for understanding neurovascular dysfunction. This ex-vivo model is expected to advance our understanding of capillary networks and their role in cerebral blood flow regulation, with potential therapeutic relevance.

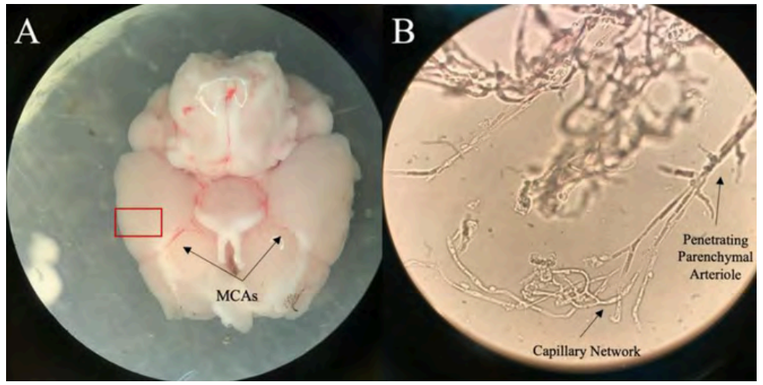
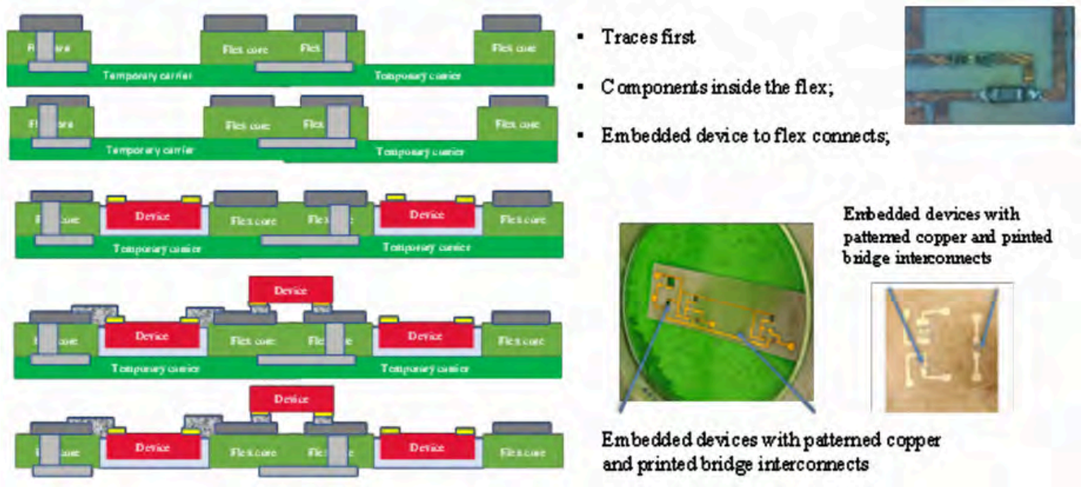


Figure 1: Isolation of microvascular networks. A) Basal view of an isolate mouse brain showing the Circle of Willis and the Middle Cerebral Arteries (MCA). A pial artery branching out of the MCA and surrounding tissue is dissected (red box). B) An isolated capillary network with its feeding Parenchymal arteriole.

Wearable Tissue Oximetry For Early VTE Diagnosis

Authors: Yousef Chwihne, Reshmi Banerjee, Ghaleb Al-Duhni, Wei-Chiang Lin & Markondeyaraj Pulugurtha
Faculty Advisor: Markondeyaraj Pulugurtha, Ph.D.

Given that existing arterial cardiovascular events correlate with a higher risk for VTE, there is a critical need for continuous, stable, and flexible monitoring systems to support disease diagnosis and assess therapeutic intervention efficacy. This includes determining correlations between symptoms and risk factors like smoking, obesity, and aging in both arterial and venous thrombosis, along with evaluating the therapeutic efficacy in the elderly population with cardiovascular and other health impairments. This approach utilizes multimodal sensing with embedded flex fan-out packaging to enhance system functionality. Leveraging a noninvasive, autonomous tissue oxygenation detection wearable monitoring device with telemetry, RF ambient energy harvesting, inductive link capabilities, and data storage, alongside 3D integration of power, sensing, and communication, this system enables advanced, real-time assessments. Single-substrate co-packaging and integration of key sensing, telemetry and control circuitry components is shown with embedded devices and printed interconnects. Initial functional verification is shown with the advanced prototypes.



CURE PROGRAM

The Coulter Undergraduate Research Excellence (CURE) Program was established by support from the Biomedical Engineering Wallace H. Coulter Endowment. Through the CURE Program, biomedical engineering undergraduate students perform research under the supervision of a faculty mentor. The three-tiered program allows students to begin as volunteer "Trainees," where they can learn more about working in a research laboratory. CURE Trainees attend laboratory meetings and shadow other researchers. After completing this volunteer phase, students can receive a stipend for their work in the "Researcher" and "Fellow" tiers. Students in these tiers receive an immersive research experience, which supplements didactic coursework. CURE Researchers work closely with their mentors to develop independent projects. CURE Fellows are expected to perform high level research and present findings at national research conferences. Funds are also provided through the CURE Program for career development activities. All CURE students take a pledge to achieve academic excellence, perform research and scholarly activities with integrity to promote global well-being, and serve as an ambassador for FIU Biomedical Engineering. Participation in the CURE Program allows students to learn technical skills in the laboratory while also strengthening abilities in critical thinking, communication, time management, and collaboration. CURE students are well-prepared to meet the challenges of life after graduation!

Presented through the generous support of the Wallace H. Coulter Foundation.

ABOUT OUR PROGRAM AND COLLEGE

The Department of Biomedical Engineering at Florida International University (FIU) located in Miami is committed to preparing ambitious students who want to combine their love of problem-solving with their desire to help others, through this fascinating growing field that applies cutting-edge technologies and modern engineering techniques to improve healthcare.

Our College of Engineering and Computing is ranked #1 for bachelor's degrees awarded to Hispanics, #1 for Bachelor's degrees awarded to Underrepresented minorities by total, #2 for master's degrees awarded to underrepresented minorities by total, and #56 among graduate programs in the country*. Nationally, we are among the Top 30 to award undergraduate degrees and Top 80 for research expenditures*. Florida International University is designated a Carnegie Highest Research (R1) and Carnegie Community Engaged Institution.

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