FIU | Engineering & Computing

Biomedical Engineering

BIOMEDICAL ENGINEERING

UNDERGRADUATE RESEARCH CELEBRATION

FALL 2021

DISCOVER | DESIGN | DEVELOP | DELIVER

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

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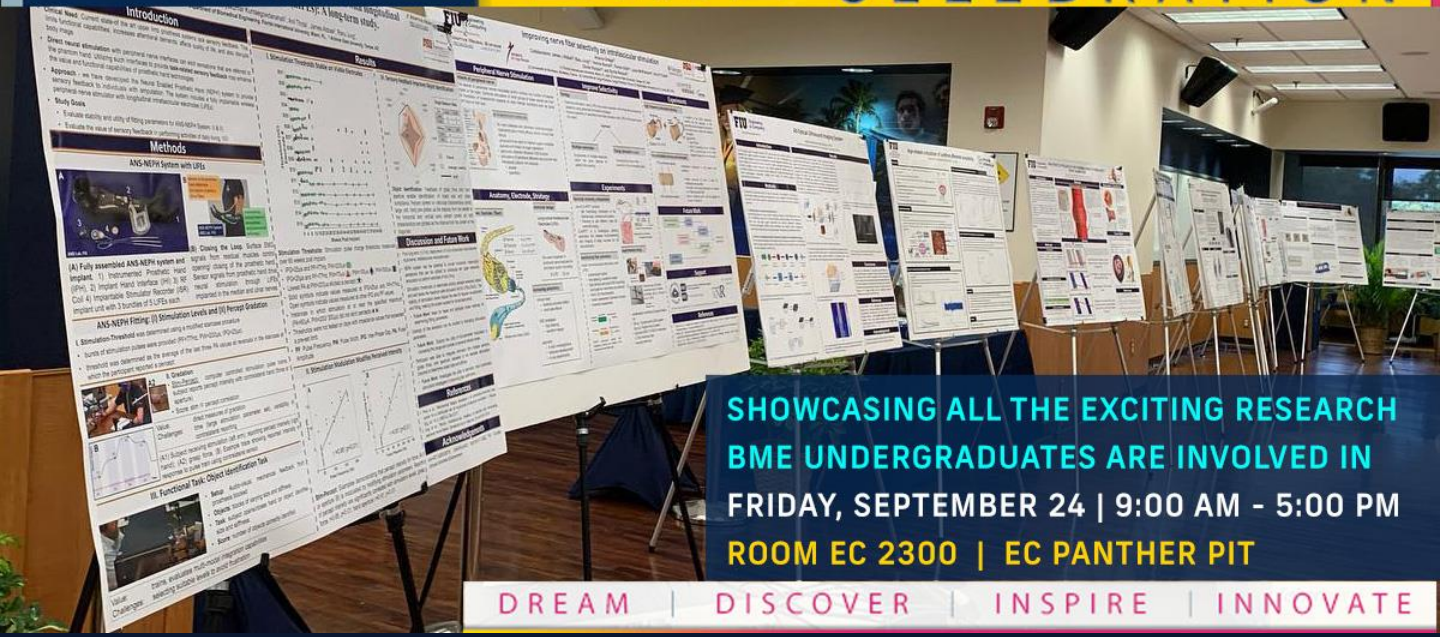
Biomedical Engineering

BME UNDERGRADUATE CELEBRATION



SHOWCASING ALL THE EXCITING RESEARCH BME UNDERGRADUATES ARE INVOLVED IN

FRIDAY, SEPTEMBER 24 | 9:00 AM - 5:00 PM

ROOM EC 2300 | EC PANTHER PIT

DREAM | DISCOVER | INSPIRE | INNOVATE

FIU | Engineering & Computing

Biomedical Engineering

12th Annual
UNDERGRADUATE RESEARCH CELEBRATION

September 24, 2021

8:45-9:00 AM	Welcome Remarks (EC 2300)
9:00 -10:00 AM	Seminar by Dr. Mary P. McDougall (EC 2300)
10:00-10:30 AM	Short Break
10:30 AM-12:30 PM	Students Poster Session (Panther Pit)
12:30-2:00 PM	Lunch and Networking with Students (Panther Pit)
2:00-3:30 PM	Panel Discussion (EC 2300 & Zoom)
2:00-3:30 PM	Open House Lab Tour (EC 2360)
3:30-4:00 PM	Awards Ceremony (EC 2300)
4:00-5:00 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,

Ranu Jung, Ph. D.
Wallace H. Coulter Eminent Scholar Chair in Biomedical Engineering,
Professor and Chair of Biomedical Engineering

KEYNOTE SPEAKER

ENGINEERING APPROACHES TO INCREASE THE ACCESSIBILITY OF MAGNETIC RESONANCE IMAGING AND SPECTROSCOPY

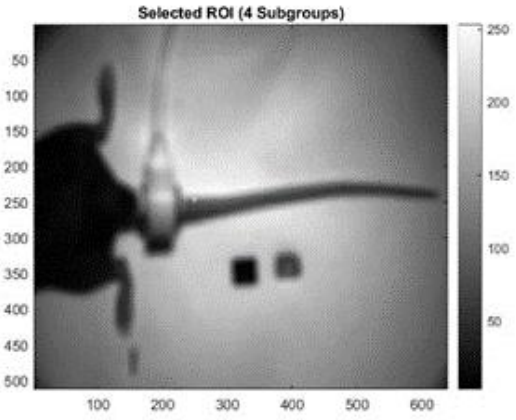
ABSTRACT: With the immense power of Magnetic Resonance Imaging and Spectroscopy (MRI/S) comes great complexity, expense, and commensurate engineering challenges to increase the accessibility and approachability of the modality. Low-field, less expensive, more accessible scanners require tailored hardware solutions to increase the sensitivity. On the other end of the spectrum, the sensitivity gains of using high fields are proving extremely challenging to access for both imaging and spectroscopy, also requiring engineering solutions to acquire quality, homogeneous images and enable broadband spectroscopy. The complexity of basic image quantification can even be a deterrent to the translation of new and exciting techniques to the clinic, requiring big-data approaches to quantitative MRI that allow measurement of multiple tissue properties in a single, time-efficient acquisition. This work will present a variety of applications in which engineering approaches are continuing to enable increasing access to the enormous potential of Magnetic Resonance Imaging and Spectroscopy.

Dr. Mary P. McDougall
Associate Professor, Biomedical Engineering Director, Undergraduate Programs, Biomedical Engineering | Texas A&M University

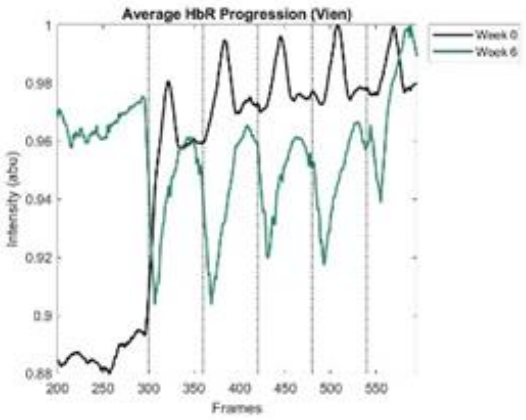
Oxygenation Changes during Progression of Chronic Kidney Disease in Mice using Near Infrared Spectroscopy

Authors: Haniyeh Alirezaei, Daniela Leizaola, Valentina Dargam, Kevin Leiva, Hooi Hooi Ng, Joshua Hutcheson, Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

Chronic kidney disease (CKD) is caused by damage to the kidneys and leads to abnormal renal tissue and artery oxygenation. However, it is unknown whether CKD affects oxygenation in in the peripheral vasculature. The objective of our study is to observe temporal changes in peripheral vasculature perfusion in a mouse model of CKD. Adult C57BL/6J mice (N=12) were assigned the following diets for 12 weeks: 1) control group (n=3F,3M) fed a normal chow, 2) CKD group (n=3F,3M) fed an adenine-supplemented diet to induce CKD. For each measurement, the tail was occluded 5 times (25s occlusion, 30s deflation, 5s interval) using a tail occlusion cuff and imaged with a non-contact, near-infrared optical scanner to map dynamic changes in tissue oxygenation. Near infrared spectroscopy is a noninvasive noncontact method used in determining the concentration of oxy-hemoglobin [HbO], deoxy-hemoglobin [HbR], and total hemoglobin content [THC]. Images were obtained at weeks 0 and 6. From our preliminary data, we observed that the peaks in HbR shifted from week 0 to week 6 in the CKD group. We did not observe a distinct shift in the control mice. The shift demonstrates a delayed rate of change of [HbR], possibly due to the onset of CKD by week-6 in the mice. Ongoing efforts will assess these changes across weeks in both CKD and control groups and develop appropriate pharmacokinetic models for perfusion rates.



Tail occlusion imaging of mice.

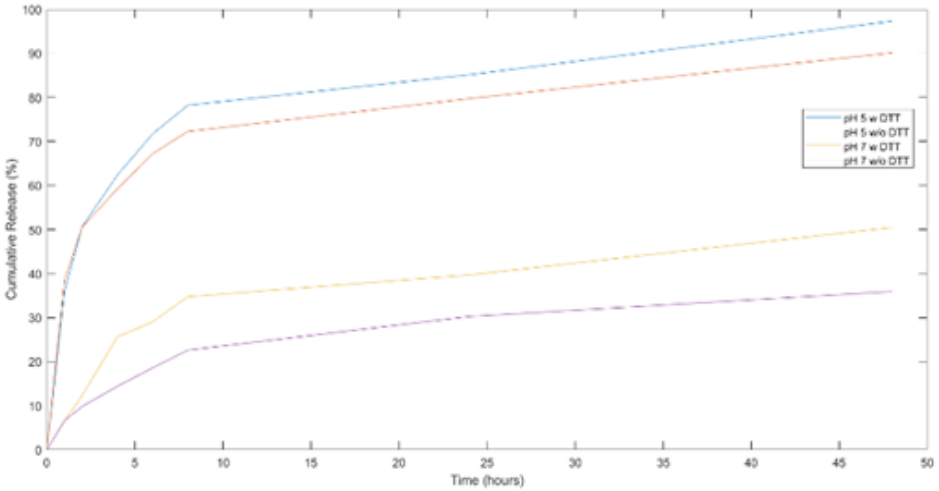


Changes in deoxyhemoglobin in response to occlusion.

Facilitated Release of Doxorubicin from Biodegradable Mesoporous Silica Nanoparticles (MSN)

Authors: Melissa Venedicto, Cheng-Yu Lai (MME)
Faculty Advisor: Cheng-Yu Lai, Ph.D. (MME)

Cervical cancer is one of the most common causes of cancer death for women in the United States. The current treatment with chemotherapy drugs has significant side effects and may cause harm to healthy cells rather than cancer cells. In order to combat the potential side effects, a nanoparticle composed of mesoporous silica was created to house the chemotherapy drug doxorubicin (DOX). The silica network contains the drug, and a pH study was conducted to determine the conditions for the nanoparticle to disperse the drug. The introduction of disulfide bonds within the nanoparticle created a framework to efficiently release 97% of DOX in acidic environments and 40% release in neutral environments. The denotation of acidic versus neutral environments was important as cancer cells are typically acidic. The chemistry was proved with the incubation of the loaded nanoparticle into HeLa cells for a cytotoxicity report and confocal imaging. The use of the framework for the anticancer drug was shown to be effective for the killing of cancerous cells.

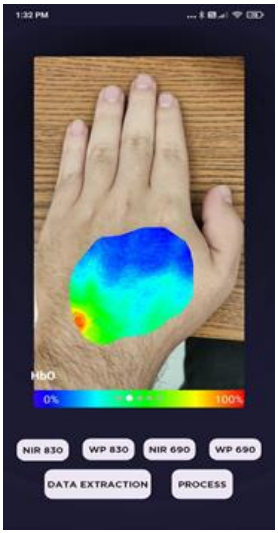


pH midigated release of doxorubicin drug from mesoporous nanoparticle.

Smartphone App Designed for Automated Extraction of Oxygenation Data and Wound Area Estimation

Authors: Alexander Trinidad, Kacie Kaile, Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

Monitoring oxygenation in and around a diabetic foot ulcer (DFU) can give us more insight than just a visual inspection. We recently developed a Smartphone Oxygenation Tool (SPOT) to acquire tissue oxygenation data over 2D areas without contact. The SPOT device consists of a clip-on device, a custom mobile app, and a smartphone that gathers near-infrared (NIR) data. During pre-processing our app required manual input to extract individual frames (corresponding to discrete wavelengths). Manual inputs are time-consuming and subject to user error. In an effort to reduce user input during data processing our first objective was to develop an algorithm that automatically extracts multi-wavelength NIR data. Our second objective was to develop a new app feature that auto-estimates the wound area. In this first study, 100% of the auto-extraction trials have been successful, while also reducing overall processing time by 30%. The SPOT device estimates physiological information from tissues, but not provide wound size measurements. In the second study, the app was modified to determine the wound area using a known size of a fiducial reference marker that was demarcated on a digital color image. The app was tested to estimate objects of a known area with an accuracy ranging from 80.4-91.8%. Future work involves testing the updated smartphone app along with the SPOT device during in-vivo clinical imaging studies on DFUs, and assess its operator user-friendliness as well.



Tissue oxygenation overlain as a pseudo-color map onto the digital color image using the custom smartphone app.

Valve Interstitial Cell Secretion of Collagen in Response to Augmented Elastin

Authors: Oriana Marrone Mantovani, Claudia Ponce Aportela, Claudia Iannini, Sharan Ramaswamy
Faculty Advisor: Sharan Ramaswamy, Ph.D.

Critical congenital heart valve defects in young children have very limited treatment options, partly due to the unavailability of proper-sized valves for their replacement, an inability for prosthetic valves to support somatic growth, as well as the scarcity of hearts for transplants. The CV-PEUTIC's laboratory has found a way to generate allogeneic elastin coating on the surface of bio-scaffolds for potentially facilitating complete valve regeneration. Elastin is known for its chemotaxis properties that permits native cell migration thereby enabling tissue remodeling events (Heinz 2020). We thus hypothesized that the secretion of collagen from valvular interstitial cells (VICs) would be increased when seeded onto elastin-rich scaffolds as compared to scaffolds without this elastin component. Collagen is a primary extracellular matrix component and would thereby enable us to confirm if augmented elastin in scaffolds can accelerate collagen secretion, which would thereby provide preliminary evidence of accelerated valve regenerative events, facilitated by the presence of increased allogeneic elastin in the scaffold. By histologically assessing and quantifying the amount of collagen present in the engineered tissue layer secreted by the VICs, sectioned at 16 um, using a collagen histological staining protocol, we aim to prove that our valve scaffolds have enhanced regenerative properties. If our hypothesis is proved to be right, we would subsequently then proceed to investigate how immune cells would respond to the tissue regeneration events within our allogeneic, elastin-rich valve scaffolds.

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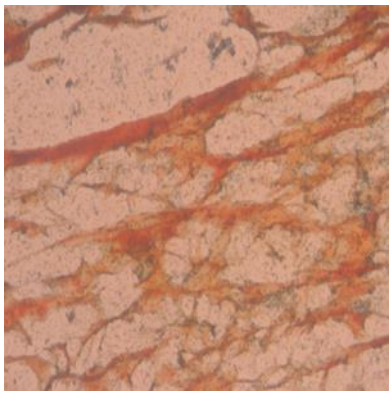
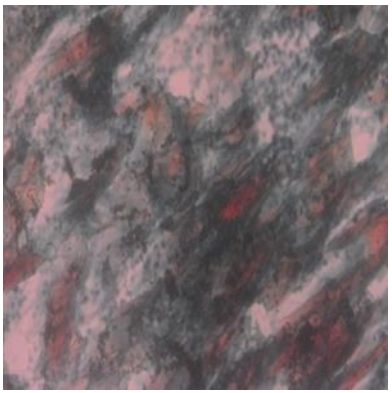


Raw PSIS representation using Pentacrome movats stain.



Engineered ECM valves representation using Pentacrome movats stain.

Standardized Approach to Assess Performance of Non-Contact Thermal Measurements

Authors: Mariel Chavez, Kacie Kaile, Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

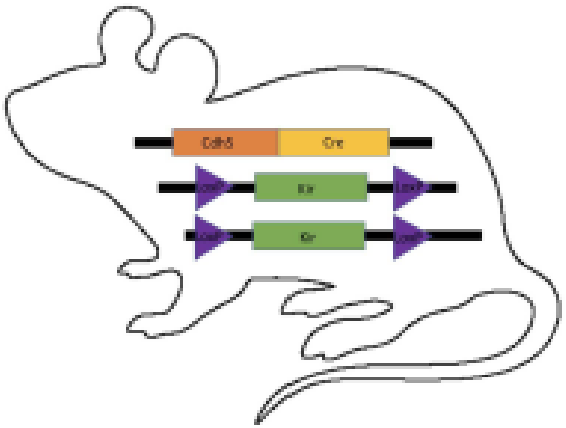
Chronic wounds can often stall in the inflammatory phase, and elevated temperatures occurring at the wound site may indicate the onset of infection. Previous wound imaging studies detected a clinically relevant thermal elevation of 2.2℃ when there is inflammation present on the tissue. Thermal wound imaging has become an attractive option due to its non-invasive and painless way to monitor and evaluate how a wound is healing. However, a thermal imaging device accessible for patients to evaluate their wounds at home has not been developed yet. A Forward-Looking Infrared Radiometer (FLIR) is a commercial device that attaches to a smartphone and measures thermal changes across a wide area. The main objective of this experiment is to design a standardized approach to assess the accuracy and precision of non-contact low-cost thermal imaging devices. The experimental design consisted of a phantom with three preselected locations marked with fiduciary markers. The phantom was heated spanning 4℃ (29℃ to 33℃) of temperatures with 0.5℃ increments. Temperatures were recorded at locations with three different devices; FLIR One, an infrared thermometer, and a contact thermometer (which indicates the true temperature). Temperature recordings were analyzed and compared across all devices. FLIR demonstrated 93.0±0.29% accuracy and 92.4±0.14% precision. It was observed that FLIR had better accuracy at a closer height and at temperatures higher than 30.5℃. Future work will involve integrating FLIR for our ongoing wound imaging studies.

The thermal devices compared in the experiment.

An Endothelial-Specific Kir Knockout Mouse using the LoxP-CRE System

Authors: Tiffany Moreno, Nikolaos Tsoukias
Faculty Advisor: Nikolaos Tsoukias, Ph.D.

The communication between active neurons and the vasculature, termed neurovascular coupling (NVC), enables local increases in cerebral blood flow (CBF) to allow for the delivery of oxygen and nutrients to areas of brain activity. This process is essential for survival and its disruption is associated with brain disorders. It is also the physiological basis for neuroimaging modalities such as fMRI. The communicating cells and chemical messengers involved in NVC are still under debate with the majority of research efforts focusing on mediators released onto nearby arterioles. Interestingly, recent evidence suggests that in addition to arterioles, capillaries may also mediate NVC. Inwardly rectifying K+ channels (Kir) in capillary Endothelial Cells (cEC) can sense neuronal released K+ and induce hyperpolarization and rapid dilations of the upstream feeding arterioles. In this study we aim to establish an EC specific Kir knockout mouse (ECKir-KO) for investigations of this signaling pathway. The KO mouse will be developed using the Cre-LoxP system. Cre recombinase recognizes two repeated LoxP sites, excises the LoxP flanked (floxed) DNA, and inactivates a gene of interest, in this case Kir. We will crossbreed a mouse with LoxP insertions around exon 2 of Kir gene (donated by collaborators at the University of Vermont), with a commercially available mouse, expressing CRE under an endothelial-specific promoter, Cdh5 (Tg(Cdh5-cre)1Spe; Jackson Labs). A homozygous LoxP mouse with CRE activity will result after two generations of breeding and will provide the EC-specific Kir KO mouse model. Each generation of mice will be genotyped through Polymerase Chain Reaction (PCR).

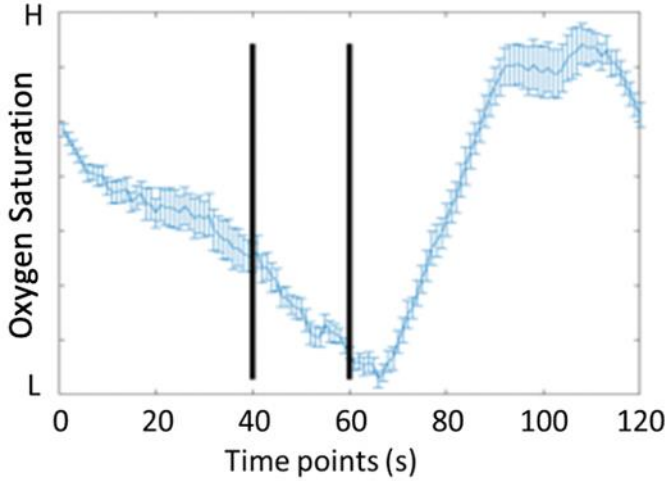


A homozygous LoxP mouse with CRE activity will result after two generations of breeding and will provide theEC-specific Kir KO mouse model.

Optimization of a Breath-hold Paradigm for Assessing Tissue Oxygenation Changes

Authors: Isabella Gonzalez, Kevin Leiva, Juan Murillo, Anuradha Godavarty
Faculty Advisor: Anuradha Godavarty, Ph.D.

One in three people with diabetes will develop diabetic foot ulcers (DFUs) during their lifetime. Monitoring of oxygenated flow to the DFU region can provide valuable insight into the wound healing process. At the optical imaging laboratory, we have developed a Near-Infrared Optical Scanner (NIROS) to perform spatial-temporal imaging of tissue oxygenation in DFUs using a breath-hold paradigm. The objective of this project is to optimize our breath-hold paradigm for assessing peripheral tissue oxygenation changes in-vivo. NIROS was used to image the feet of control subjects under a 120 second breath-hold paradigm – consisting of 20 seconds of breath-holding – to induce a change in tissue oxygenation. The modified Beer-Lambert Law was applied to calculate hemoglobin-based spatial-temporal oxygenation maps in terms of oxy-, deoxy-, total hemoglobin, and oxygen saturation. A Pearson's-based approach was further used to calculate correlation maps of the oxygenated flow, across the breath-hold paradigm, in terms of the hemoglobin-based parameters. Current results indicate that in control subjects a distinct change in tissue oxygenation can be seen across all parameters within the 20 seconds of breath-holding and within 20-sec immediately following the breath-hold. The breath-hold paradigm was optimized, and correlation maps compared for various time windows. The paradigm was reduced from 120-sec to 40-sec. A reduced breath-hold paradigm can minimize motion artifacts during imaging studies, especially when applied to wound imaging studies in clinic.

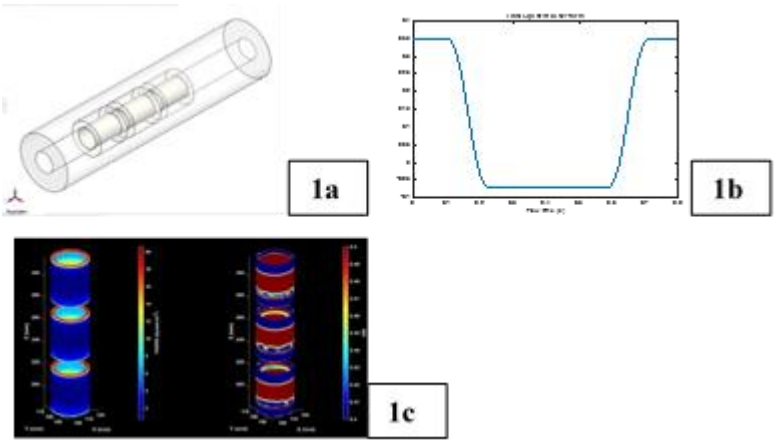


Changes in oxygen saturation in response to a 20-sec breathhold during a 120-sec imaging paradigm.

Computational Assessment of Oscillatory Flows to Induce Valve Calcification

Authors: Paulina Alvarez Armel, Chia-Pei Denise Hsu, Joshua Hutcheson, Sharan Ramaswamy
Faculty Advisor: Sharan Ramaswamy, Ph.D.; Joshua Hutcheson, Ph.D.

Oscillatory shear index (OSI) is a term used to quantify flow oscillations (1) and ranges from 0 (no oscillations) to 0.5 (maximum oscillations). Although OSI has shown to play a role in cardiovascular tissue remodeling, the specific levels of flow disturbances associated with heart valve pathology are still unknown. A bioreactor was designed to deliver oscillating flows in an in vitro environment to identify a co-relation between OSI and valve calcification. SolidWorks (Dassault Systèmes, Waltham, MA) geometries were imported into ANSYS (Ansys, Inc., Canonsburg, PA) for mesh processing using Fluid and Mosaic Meshing. Computational fluid dynamics (CFD) in ANSYS with a MATLAB (MathWorks , Natick, MA) script were performed for a bioreactor geometry consisting of a three-valve-cylinder (Figure #1a) and squared waveform (Figure #1b) to identify regions with 0.5 OSI and a time-averaged wall shear stress (TAWSS) at 1-4 dyne/cm2 on the scaffold outer wall. The bioreactor chamber was fabricated in a machine shop, and the immediate next step is to verify the flow and pressure values within the chamber. We intend to use the chamber to produce de novo calcified human valve tissues using 0.50 OSI flow environments in pro-calcifying media that mimics the morphology of calcific aortic valves at early, intermediate, and late stages of pathology.

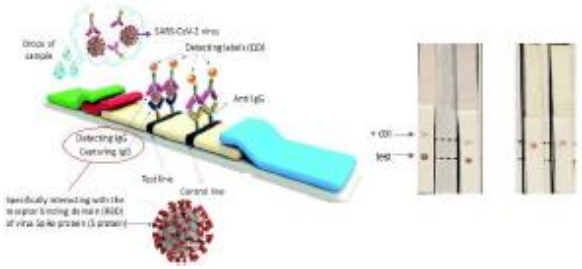


1a) 3-Valve Bulged Cylinder geometry designed in SolidWorks®. 1b) Adapted Squared Velocity Waveform. 1c) MATLAB CFD analysis for 3-Valve Bulged Cylinder with Squared Waveform.

Accurate, Sensitive, and Deployable SARS-CoV-2 Detection by Lateral Flow Assays using Anti-SARS-CoV-2 Antibody Pairs Discovered at LANL

Authors: Lyan Basora Dorville, Bryan Garcia (CSLA), Antonietta 'Mietta' Lillo (LANL)
Faculty Advisor: Antonietta 'Mietta' Lillo, Ph.D. (LANL)

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), responsible for the COVID-19 pandemic and more than 4.55 million deaths, bears a spike protein that interacts with the ACE2 receptor, leading to endocytosis. Within the spike, the receptor binding domain (RBD2) can be targeted by antibodies for diagnostic and therapeutic purposes. Monoclonal antibodies (Mabs) against the SARS-CoV-2 virus were previously isolated at Los Alamos National Laboratory (LANL) through in-vitro selection using phage and yeast displayed single-chain variable fragment (scFv) libraries. To develop a sensitive and accurate diagnostic tool for COVID-19, a lateral flow immunoassay (LFA) using LANL discovered antibodies was used for detection of RBD2. Mabs derivatized with either colloidal gold nanoparticles (CG) and photoluminescent quantum dots (QD) were used as detecting antibodies in the LFIA. Anti-human and underivatized α-SARS-CoV-2 antibodies, the control and capturing antibodies respectively, were spotted on a nitrocellulose membrane strip. The strips were blocked with a 1% BSA and dried prior to immersion in the analyte solution. The test strips were immersed in of an analyte solution containing RBD2 and CG-derivatized Mabs (Ab-CG) while control strips were immersed in an analyte solution containing only Ab-CG. Optimization of the LFA conditions yielded F07 and H05-CG, 30 minutes, .4 mg/mL, and Whatman FF80HP membrane as the optimal capturing/detecting antibody pair, blocking time, concentration of capturing antibody spotted, and nitrocellulose membrane, respectively. Future efforts include determination of limit of detection under optimal conditions, optimization of LFAs using photoluminescent quantum dots and, finally, testing optimal LFIA conditions with clinical samples.



Demonstration of Lateral Flow Assay used to detect SARS-CoV-2 receptor binding domain 2 (RBD2) using monoclonal antibodies derivatized with colloidal gold and quantum dot reporter systems.

Determination of optimal antibody pair: Surface Plasmon Resonance epitope binning heat map (on the left) and Percent agreement of LFA results with SPR predicted pairs. The SPR epitope binning heat map shows antibody pairs which bind to RBD2 non-competitively (green), competitively (red), and intermediate (yellow). The results of the eight sets of LFAs performed show general agreement (75-100%) with SPR.

Automated THORLABS 3-Axis NanoMax Microscope. A Tool to Evaluate Cardiomyocyte Maturation

Authors: Paulina Alvarez Armel, Alberto Sesena Rubfiaro (Physics), Jin He (Physics)
Faculty Advisor: Alberto Sesena Rubfiaro, Ph.D. (Physics); Jin He, Ph.D. (Physics)

Heart disease is the leading cause of death in the United States. Recent literature has highlighted the need for better understanding developmental processes on cardiomyocytes to explore approaches for tissue damage, drug testing, cardiovascular disease models or the design of safety guidelines for cell transplant. Current technologies allow the successful differentiation of human induced pluripotent stem cells (hiPSCs) into cardiomyocytes (CMs). However, hiPSC-CMs exhibit fetal-like characteristics and arrhythmogenic risk. The understanding of PSC-CMs maturation will lead on the designing of new strategies for cardiac regenerative medicine while minimizing its side effects. Conventional two-dimensional fluorescence imaging is used to visualize cardiomyocyte structural indicators of maturity, but the method is limited to a single depth plane. The aim was to create a graphical user interface using the MATLAB built-in GUIDE and App Designer applications. This was interfaced with ThorLabs, Inc. KPZ101 K-Cube Piezo Controller, KCH601 USB Controller Hub, and MAX313D 3-Axis NanoMax™ Flexure Stage, to allow automatic image capture and volume visualization. A set of Graphical User Interfaces for 3D imaging was created (Figures #1-3), which will be available for future use by lab members. Through fluorescence imaging, nuclei and sarcomeres were visualized (Figures #4-5) in a 15-day old hiPSC-CM tissue. In conclusion, the automation of image capturing enables to explore in-depth planes the factors that affect the structural remodeling of the PSC-CMs through the maturation process. Future directions include further automation to numerically quantify structural PSC-CMs components, integration of a motorized pinhole for greater range of motion, and improvement of RGB layer merging.

1)

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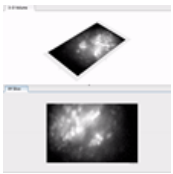

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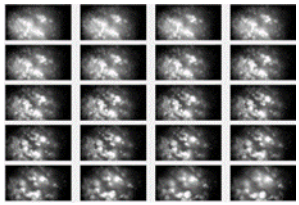

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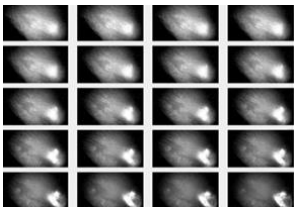
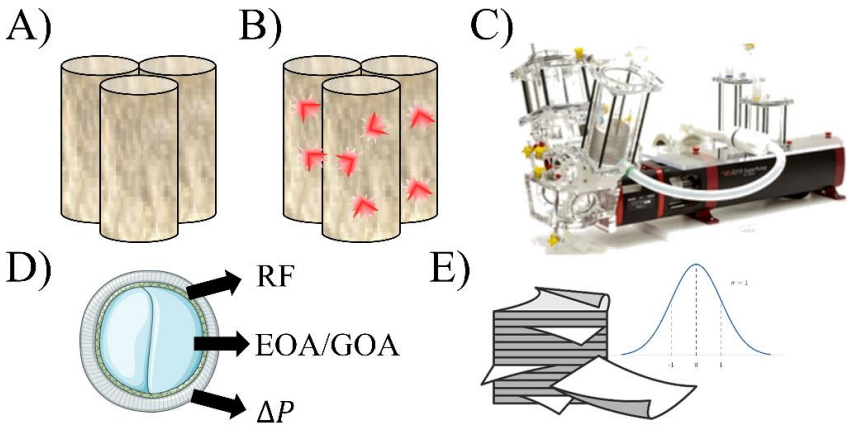


1): MATLAB GUIDE app adapted from THORLABS ThorCam™ Software. 2): Image post processing GUI. 3): Volume viewer GUI. 4): Nuclei staining with DAPI antibody at 100x magnification. 5): Sarcomere staining with Alpha Activin and Alexa Fluor 488 antibody at 100x magnification.

Determining Function of Calcified Tubular PSIS Valves

Authors: Jacobus Carstens, Asad Mirza, Andres Rodriguez, Sharan Ramaswamy
Faculty Advisor: Sharan Ramaswamy, Ph.D.

Aortic valve calcification is one of the most studied valve diseases and represents the most frequent cardiovascular disease after arterial hypertension and coronary artery disease. It has a prevalence of 0.4% in the general population and in the over 65-year-old population a prevalence of 1.7% [Carrai, Paolo et al. "Calcification of Cardiac Valves in Metabolic Bone Disease: An Updated Review of Clinical Studies." Clinical interventions in aging vol. 15 1085-1095. 9 Jul. 2020, doi:10.2147/CIA.S244063]. Despite advances in valve repair and replacement prosthetic devices, therapeutic discovery is still lacking owing to the inability for animal models to mimic the human response. Hence therapeutic treatment of this disease requires first having a human tissue model system that mimics the native response to an emerging therapy. We hereby propose calcifying bio-scaffold tubular valves seeded with human valvular interstitial cells (VIC's), then proceeding to test their functionality through their hydrodynamic parameters, including the transvalvular pressure gradient and regurgitation fraction to quantify if we are accurately inducing severe aortic valve calcification, which can then be used as a model system if validated via this testing. Expected results for severe calcification would be a reduction in valve performance that agrees with literature findings of similar calcified aortic valves that necessitated replacement with an artificial valve. Creation of a working severely calcified human tissue model will thereby allow for the added investigation of emerging treatment options, to manage the adverse progression of valve disease and by learning from the human tissue response, in an attempt to at minimum, delay the need for a valve replacement.

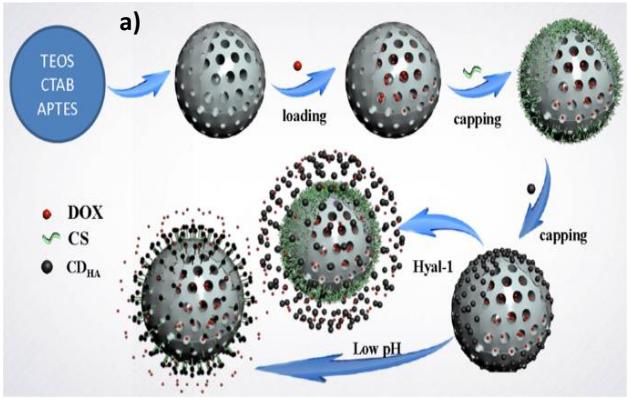


Proposed methodology:
A) VIC's seeded PSIS valves,
B) Calcification protocol,
C) Hydrodynamic testing,
D) Assess valve metrics,
E) Compare with literature Findings.

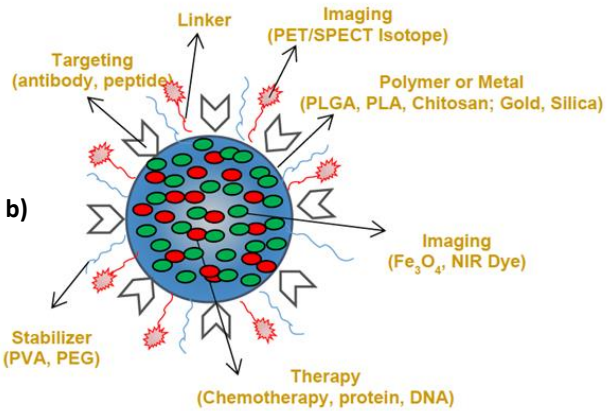
Surfactant Removal of Mesoporous Silica Nanoparticles

Authors: Angelica Garcia del Rio, Srujana Yellapragada, Anthony McGoron
Faculty Advisor: Anthony McGoron, Ph.D.

Nanoparticles have been widely studied as chemotherapy delivery vehicles to improve drug targeting to reduce off-site toxicities. Mesoporous Silica Nanoparticles (MSN) may play an important role due to its high loading capacity, versatility, high control over size and low toxicity. MSN requires a surfactant/template to create pores and control porosity. However, there is often a delay in the efficiency of its production due to a lack of understanding of the removal of the surfactants. Surfactants are substances that increase the contact between a liquid and another substance by reducing the liquid's surface tension. However, these surfactants tend to block the pores of the silica nanoparticles where the drugs are loaded, and therefore must be removed. Cetyl Trimethyl Ammonium Bromide (CTAB) and Dioctyl sulfosuccinate sodium salt (AOT) surfactants are the two surfactants that this research focuses on for nanoparticle synthesis. CTAB is cationic and AOT is anionic. Some methods of surfactant removal included reflux solvent extraction and dialysis solvent extraction. However, several factors must be considered such as the pH of the solutions, temperature, solvents used for surfactant extraction and the functional groups and zeta potential of the MSN synthesized. For example, the ideal solution pH for CTAB-MSN is different from AOT-MSN. The goal is to optimize the parameters for removing the surfactants but maintaining the MSN size.



a): Multifunctional porous silica nanoparticles.



b): The ideal multi-functional drug delivery vehicle.

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The Department of Biomedical Engineering (BME) is part of the College of Engineering and Computing at FIU and is a prime resource for biomedical engineering education, training, research, and technology development. BME is an ever-evolving field that uses and applies engineering principles to the study of biology and medicine in order to improve health care.

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