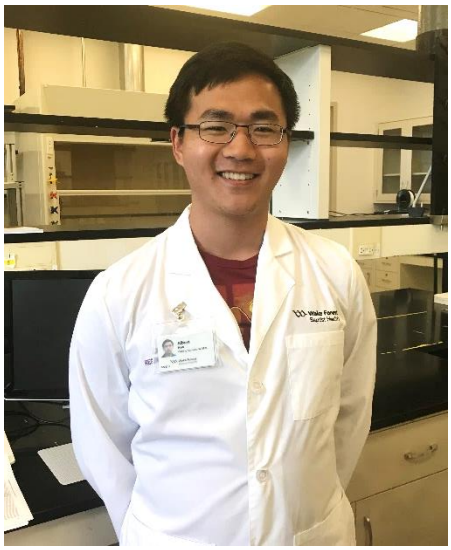
Wake Forest School of Medicine

Institute for Regenerative Medicine

WFIRM Summer Scholars Program 2019 – Scholar's Blog
Summer Scholars 2019 Profiles



Albert Han

Rice University, Bioengineering

Faculty Advisor: *James Yoo, MD, PhD, Professor*

I am currently a student at Rice University studying bioengineering. In high school, I was involved in various science and engineering clubs, which built my growing interest in technology alongside my desire to explore health and biology. Thus, coming into college, I was excited to explore a major that combined both of those interests while also building foundational knowledge from a wide variety of engineering disciplines, which the bioengineering degree encompassed. One of the main fields of bioengineering that I wanted to explore early on was tissue engineering and regenerative medicine, and starting the summer of my freshman year, I was fortunate enough to join Dr. Antonios Mikos' tissue engineering lab. Since then, I have been working with my graduate student mentor, Mollie Smoak, in fabricating tissue scaffolds using decellularized extracellular matrix (dECM) for skeletal muscle regeneration applications. We focused on fabricating and characterizing electrospun dECM scaffolds. My work in the lab has furthered my interest in regenerative medicine, and I hope to continue to explore different areas of the field during my time at WFIRM. Outside of regenerative medicine, I have also been a part of multiple engineering design teams since my freshman year and will continue on a senior design project this coming semester.

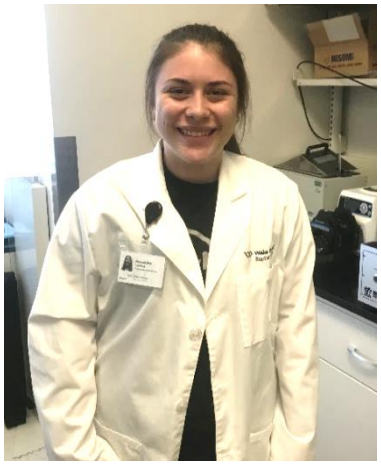
As a summer scholar at WFIRM, I will be under the guidance of Drs. Yoo and Lee, as well as graduate student Gregory Gillispie. I will be working with "bioinks" for 3D-printing tissue scaffolds. 3D-printing allows for the creation of complex, specific structures that can serve as scaffolds for cells and tissue to grow on, which can then be used to help regenerate tissue, among other applications. However, the materials used for 3D-printing often require specific physical properties and printing conditions in order to be stable, printable, and viable for cells to grow in. Thus, I will be finding how different print conditions and cell densities in the bioinks affect printability and cell viability, which can help define the range of conditions the bioinks can be printed.

After graduation, I plan to attend medical school and continue to explore research there. My goal is to become a physician who works to improve public health and further medical findings, and I hope to utilize my experience in research or engineering when doing so.

Alexandra Saldana

LeTourneau University, Biomedical Engineering

Faculty Advisor: *Anthony Atala, MD, Professor, Director of WFIRM*



Hello, I'm Alexandra Saldana from Spring, Texas. I am a junior at LeTourneau University in Longview, Texas majoring in Biomedical Engineering with a focus in biomechanics. Before coming to WFIRM I didn't have much exposure to regenerative medicine or research. My university focuses more on the mechanical side of my degree with projects steered in that direction. For example, I built a 3D printer during my first semester. I have always been interested in regenerative medicine and thought about it being a possible future career route. This program is a great opportunity for me to gain knowledge and experience in regenerative medicine and research.

This summer I am working with primary mentor Dr. Anthony Atala and postdoc Carlos Kengla. Our project is to bioprint a urethra using a GelMA architecture suitable for urothelial and smooth muscle tissue formation. While doing this, we also hope to decouple the effects of shear stress and pressure during bioprinting to establish thresholds for printing optimization.

After I graduate from LeTourneau University, I plan on attending graduate school. I am currently deciding between studying for an occupational therapy degree or obtaining a master's degree in prosthetics and orthotics. I am excited to see what the future holds!

Anna Deal

Georgia Institute of Technology, Biochemistry

Faculty Advisor: *Anthony Atala, MD, Professor, Director of WFIRM*

My name is Anna Deal, and I am a rising senior at the Georgia Institute of Technology (Georgia Tech), where I study Biochemistry with a minor in Applied Physiology. My main goal has always been to go to medical school to become a doctor; however, since starting at Georgia Tech I have had the opportunity to participate in research and that has piqued my interest in that research side of science. The main aspect of the WFIRM Summer Scholar's program that interested me was being able to combine medicine with research. Being a part of this program has already given me greater insight into becoming a physician while maintaining an active research agenda. As a student at GT, I have been fortunate to have access to state-of-the-art modern instrumentation and an intensive laboratory curriculum which have allowed me to develop my laboratory techniques and have given me confidence to participate in the research this summer.

I am working with Dr. Atala and Dr. Weis on a project dealing with Necrotizing Enterocolitis (NEC) in premature babies. In NEC part of the intestine dies and is no longer able to absorb nutrients for the baby. It is most common in babies born at <33 weeks. In our project we are working to determine the efficacy of injecting placental stem cells into the infant's intestine to stimulate the regeneration of healthy intestinal cells. In the absence of this procedure, babies may have to under surgery to remove part of the intestine which can cause further complications or even death.

I am currently applying for admission to the medical school class of 2020. I hope to become a physician with both a clinical practice and an active research agenda. At this point, I do not have a specific specialty I am interested in pursuing or specific research interest. Through my work at WFIRM, I have become interested in gastroenterology and research on intestinal diseases; however, I am keeping my options open for the time being.

Anna Jones

University of North Carolina at Charlotte, Biology

Faculty Advisor: *Giuseppe Orlando, MD, PhD, Marie Curie Fellow and Assistant Professor*

As my education journey has progressed, I have been bestowed that opportunity to engage in several collegiate science courses that have enhanced and broadened my comprehension. Among those courses were a general biology laboratory course and a general chemistry laboratory course. During the general biology laboratory course, my lab partners and I performed a semester-long research project evaluating the efficacy of various antibiotics in suppressing Echerichia coli proliferation. We then composed an essay detailing our research and formulated a scientific poster that we presented to our laboratory instructor and classmates at the conclusion of the semester. Moreover, in this biology course, we studied PCR (Polymerase Chain Reaction), gel electrophoresis, transposable DNA sequences, conservation biology, dissections, and a copious number of other topics. Conversely, in the general chemistry laboratory course, we performed acid-base titrations, carried out dilutions, learned about mass spectroscopy, and executed calorimetry experiments.

My scholastic interests include a myriad of topics, including ophthalmology, general chemistry, and physiology. Specifically, I am utterly enthralled with the topic of my summer research project, which focuses on the extracellular matrix (ECM) and its biological function in human pancreatic islets. I find both the physiology and pathology of the pancreas to be quite intriguing, for I think that it is fascinating that it is both an endocrine and exocrine organ with various vital functions. Moreover, I attend the University of the North Carolina at Charlotte, and I am entering my junior year this fall semester as a biology major.

The focus of my summer research project is the pancreatic extracellular matrix and its biological properties in improving beta cell insulin secretion. Dr. Giuseppe Orlando's team and I are studying this subject with the hope that one day novel treatments of Type 1 diabetes may be effected. Specifically, the objective of this project is to demonstrate that the encapsulation of islets preserves their functionality and enhances their well-being. In this project, we are going to remove the extracellular matrix from a pancreas, and we are going to envelop isolated human pancreatic islets in the extracted extracellular matrix along with a unique substance called alginate. This process will form three-dimensional, hydrophilic spheres called capsules. Once the capsules are formed, they will be evaluated using tests and assays. Particularly, the efficacy of the islets will be assessed using a Glucose Stimulated Insulin Release (GSIR) test, which determines how much insulin the islets are producing in response to differing glucose levels. The rationale behind this project is that the extracellular matrix is "responsible for transmitting a wealth of chemical and mechanical cues, which affect cellular differentiation, maintenance, and biological function" (qtd. in Chaimov et al.). Therefore, one would endeavor to develop an environment for the islets that best emulates their native, physiological environment, and the pancreatic ECM-derived capsules provide that imperative environment.

Conclusively, I aspire to become an ophthalmologist, for I think that the eye is a marvelous organ with an astounding complexity. Thus, I would love to ascertain a Bachelor of Science degree in biology and attend medical school with the objective of obtaining an M.D. degree. Subsequently, I would love to be matched with an ophthalmology residency where I could commence my profession in providing remarkable eye care to the populace.

Anuksha Gerald

University of Maryland, Bioengineering

Faculty Advisor: *Sang Jin Lee, PhD, Associate Professor*

My name is Anushka Gerald and I am a rising senior bioengineering major at the University of Maryland. My interest in regenerative medicine has stemmed from my interest in doing work which will lead to better patient outcomes. I have had an interest in biology since my early high school years but after working with researchers and doing my own research, I have fallen in love with the work done in the field of regenerative medicine.

I have worked at the Tissue Engineering and Biomaterials Lab at the University of Maryland under Dr. Fisher. My previous research has been working toward finding the optimal conditions to culture mesenchymal stem cells and hematopoietic stem cells in 3D printed polystyrene constructs. We explored various surface treatments to achieve the highest proliferation of the stem cells.

At WFIRM I am working with Dr. Sang Jin Lee. I will be exploring the optimal material formulation for a DLP printed hydrogel seeded with HEPG2 cells in static conditions. I will also be looking at cell behavior and differentiation in a dual chambered bioreactor.

Brandon Kassouf

Georgia Institute of Technology, Biomedical Engineering

Faculty Advisors: *Yuanyuan Zhang, MD, PhD, Associate Professor*

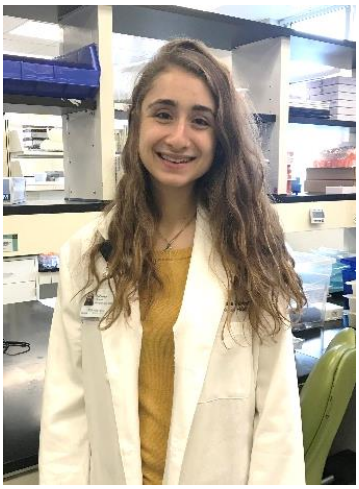
Throughout my academic career, I have looked to become involved in biomedical research to further my understanding of the medical innovation process. For my senior thesis in high school, I worked with a professor at the College of Charleston to modify an anti-seizure drug's structure for incorporation into an implantable, biodegradable drug-delivery system. Through organic synthesis reactions and purification techniques, I sought to convert the drug, valproate, into a diol form that would be compatible with polyurethane synthesis. This chemical research confirmed my interest in designing medical devices, encouraging me to major in biomedical engineering at Georgia Tech. Upon beginning college, I wanted to start tackling medical problems by leading the development of a prototype. Other students and I formed a team to develop an effective diagnostic and rehabilitative device for patients with upper-limb muscular spasticity. With continual feedback from professors at Emory and Georgia Tech, we were able to design an enhanced nine-hole peg test that accomplishes this goal and are preparing to test the device on patients. After studying current rehabilitative strategies and realizing their limitations, I wanted to explore regenerative medicine as a field that could tackle these medical problems at their biological root. Ultimately, WFIRM has enabled me to study this area of biomedical innovation by allowing me to perform stem cell research that could improve neuromuscular regeneration and muscular function.

This summer, I am working with Dr. Zhang to study differences in exosomes from urine-derived stem cells, or USCs, that are cultured under hypoxia (1% oxygen) versus normoxia (21% oxygen). As extracellular vesicles involved in cell signaling, exosomes can transport genetic material and proteins from one cell to another. Much research has demonstrated the significance of these vesicles in dispersing growth factors that promote tissue regeneration. Furthermore, hypoxia has been shown to activate transcription factors for pro-regenerative genes in stem cells that promote tissue healing. In prior studies, hypoxia induced the exosomes of mesenchymal stem cells to carry higher levels of growth factors. Therefore, my lab group hypothesizes that exosomes from hypoxic USC will carry more pro-regenerative RNA and growth factors than the normoxic group. By comparing genetic and proteomic profiles of these exosomes, we hope to identify the group of USC and exosomes that will best promote neuromuscular tissue

regeneration.

After earning my B.S. in biomedical engineering, I plan to pursue an MD and PhD. By continuing to study translational regenerative medicine, I hope to eventually specialize in tissue engineering and clinical testing.

Caterina Grasso



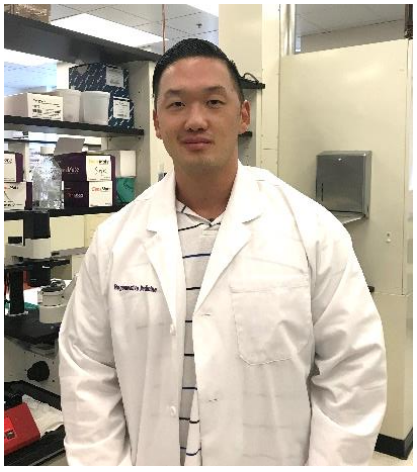
Rice University, Bioengineering
Faculty Advisor: *Anthony Atala, MD, Professor, Director of WFIRM*

Hi! My name is Caterina Grasso and I am a Bioengineering major at Rice University in Houston, Texas. Coming into the WFIRM Summer Scholar program I had no prior lab experience, and this was one of my biggest drives to apply to this program. I really wanted to get involved in research, and regenerative medicine was such an intriguing field to become invested in. Being involved research that has the potential to change the face of medicine to such a large degree, by offering an entirely new approach to medical treatment by using a patient's own cells in therapy, seemed so impactful. And especially, working for the WFIRM, which emphasizes the importance of a direct clinical application through a history of implementation of their research and technologies into partner hospitals, captivated me as I could see the direct application of what was being discovered.

In my summer here at the WFIRM, I will be working with my mentor, Adam Jorgenson, and our principle investigator, Dr. Anthony Atala. We will be working on developing a skin organoid, a cell-based spherical representation of human skin, which models true skin on both a structural and functional level. The cells in the organoid should migrate to form epidermal, dermal, and hypodermal layers as well as demonstrate selective permeability, like true skin. This will be tested using a drug that is known to diffuse through skin, and detecting that it can similarly diffuse through the organoids. In the long run, developing this organoid will allow for its application in WFIRM's larger body-on-a-chip system, which is useful for testing a drug's effect on a range of organs, closely simulating the body as a whole. Implementing the skin organoid will be useful for testing transdermal drug delivery routes, and assessing how a drug passing through the skin may alter its therapeutic effect.

In the future, I intend on continuing my education in the field of bioengineering. I hope to use my research experience to determine if I want to obtain a PhD and continue a path in academia, or if I want to purse an industrial application after a Master's in Engineering Degree. Either way, I think regenerative medicine will play a very large role in the future of this field, and I hope to remain involved in this innovation and discovery aspect of regenerative medicine.

Daniel Lee



Winston Salem State University, Exercise Science
Faculty Advisor: *Sang Jin Lee, PhD, Associate Professor*

Prior to joining the WFIRM summer scholar program I graduated from Winston Salem State University with a Bachelors in Exercise Science and Minors in Biology and Chemistry. I graduated with Summa Cum Laude honors and I received the Exercise Physiology achievement award for highest GPA in the department. I chose Exercise science due to its curriculum being based more on Anatomy and Physiology which is my favorite subject in science. Also, I got to learn the scientific aspect of exercising and I have incorporated things I have learned into my work outs. I got interested in regenerative medicine due to my time in the Army. During my first tour in Afghanistan I was wounded from indirect fire attacks and 2 of my friends were severely wounded. One of my friends lost his leg from the explosion. When I heard they could not reattach his leg I became passionate to get involved in regenerative medicine research to help discover new ways to treat

amputees. I hope one day we can regenerate human limbs and implant them to our wounded soldiers.

My interests include working out and reading a lot of articles regarding fitness and nutrition. Through my time in the exercise science program I have learned to look up new fitness trends through scientific articles instead of advertising and social media. I am a dog dad to 2 Pit-bull mixes (pit/boxer and pit/lab). My sports interests include soccer (Chelsea), football (Raiders), hockey (Kings), and Mixed Martial Arts. I enjoy motorcycles, going to breweries, going to wineries, and food. I also enjoy cooking and creating new recipes.

My research project this summer is on the utilization of decellularized extracellular matrix to develop bone tissue-specific bioink for 3D bioprinting. Tissue engineering is fabricating tissues with the use of engineering concepts. The 3 important things needed are scaffolds, signals, and cells. In this project we will utilize stem cells for the cell component and the decellularized extracellular matrix for signals and scaffold components. We are aiming to print a 3D scaffold that can maintain its 3D structure and stability. We hypothesize that the use of Decellularized Extracellular Matrix (dECM) for bioink development will produce a tissue-specific microenvironment for induced tissue growth for bioprinting of bone tissue due to the dECM containing collagen type I, ECM components, and bone morphogenetic proteins (BMPs).

My plans are to go to medical school and get into the MD/PhD program. I plan to get my PhD in Biomedical Engineering and I hope to get into neurosurgery with a specialty treating the spinal cord. My dream job location would be to work at Walter Reed to treat patients who are our wounded soldiers and continue to conduct research in regenerative medicine.

Davis McGuirt

Elon University, Biology

Faculty Advisor: *Khalil Bitar, PhD, Professor*

I am a rising senior at Elon University working towards obtaining a BS in Biology with a focus in Allied Health and Therapy. I found interest in this course mostly because of my desire to learn more about regenerative medicine; however, I also wanted to improve my laboratory skills. My developing interest in regenerative medicine began two years ago while I was working as a clinical scribe. On multiple occasions, I was fortunate enough to shadow several surgeons performing various operations. Some of these operations required the removal of tissue from a patient, often times without replacement of the tissue. I asked one surgeon why they couldn't use replacement tissue from a donor and he explained to me the complications that can arise from such an approach. He also mentioned to me that there were now artificial tissues that could be used instead for replacement. This was very intriguing to me, and I was later introduced to several articles featured in medical journals that spoke more upon this new technology. One name I saw frequently mentioned was WFIRM, known for its cutting edge research in the field of regenerative medicine. After learning that WFIRM offered a summer internship experience, I knew I had to apply.

Although I am no stranger to scientific research, the concept of working in a laboratory where fabrication of tissues and organs is the goal was incredibly new to me. At Elon, I conduct behavioral ecology research which requires more outdoor work and less time at the lab bench. Although I really enjoy my ecology research, I knew I wanted an experience like the one offered here at WFIRM where experimentation rather than observation is typically required.

This summer I am working with my mentor, Dr. Khalil Bitar, and his postdoctoral fellow, Dr. Prabhash Dadhich. My goal is to develop a muscular template for replacing damaged portions of the small intestine, one which displays both proper cellular alignment and mechanical integrity. The small intestine, like any part of the gastrointestinal tract, is difficult to replicate because of the functionality required for moving food through it. This process requires very

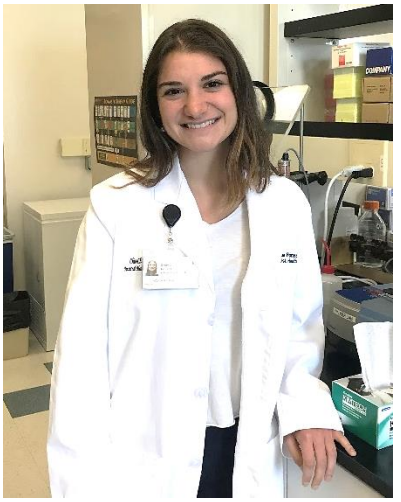
precise, coordinated muscle movements which are hard to replicate in an artificial template. However, by promoting proper alignment of muscle cells and testing the template for mechanical strength, we can attempt to replicate human tissue to the best of our ability. There exists a need for such a template because many patients suffering from a number of diseases require small portions of their small intestine to be removed. These patients may have this tissue replaced with other human tissue leading to postoperative complications. Similarly, these patients may also receive no tissue replacement at all, resulting in a shortened small intestine which is also prone to complications. Therefore, this template could act as a viable replacement for a portion of removed small intestinal tissue, hopefully one without complications.

After graduating from Elon next year, I plan to take a gap year while applying to medical school. It has been a long time dream of mine to attend medical school because I have always felt a calling to help people and, in my opinion, there is no better way than to do so with science.

Emma Koukos

Saint Michael's College, Biology

Faculty Advisor: *Stephen J. Walker, PhD, Associate Professor*



My name is Emma Koukos and I am a rising senior Biology major and Chemistry minor at Saint Michael's College. On campus, I work as a laboratory teaching assistant for the courses Cell Biology & Genetics and Ecology & Evolution and have been involved in previous molecular genetics research determining carbohydrate partitioning on a gene level. Additionally, I spent a semester in Stockholm, Sweden participating in a Translational Medicine program learning the dynamic relationship between laboratory research and clinical application.

The WFIRM Summer Scholar Program is an opportunity to build upon both my laboratory and translational interests firsthand and in an innovative manor. As the medical field is being directed towards novel, creative, and efficient regenerative methods, the Summer Scholar Program is providing preparation for the translational potential of regenerative medicine that is being experienced in healthcare today.

During the 10 weeks at WFIRM, I will be working on a project with Dr. Steve Walker involving children with autism spectrum disorder (ASD) diagnosed with chronic right-side fecal loading constipation with a background of intestinal inflammation. A clinical difference was found in the therapeutic response of the presenting patients, creating two subgroups: (1) patients who experience remission from constipation while undergoing anti-inflammatory therapy (fast responders), and (2) patients who experience recurrent right-side fecal loading constipation while undergoing anti-inflammatory therapy. The goal of our project is to determine a molecular link between children with ASD and right-side colonic hypomotility (constipation) through miRNA analysis of slow and fast responders to eventually be used as a predictive measure for slow responders in a clinical setting.

I hope to continue to build upon my time at WFIRM to pursue a career in the biomedical research field. My goal is to become involved in a project that can be clinically translated to improve public health.

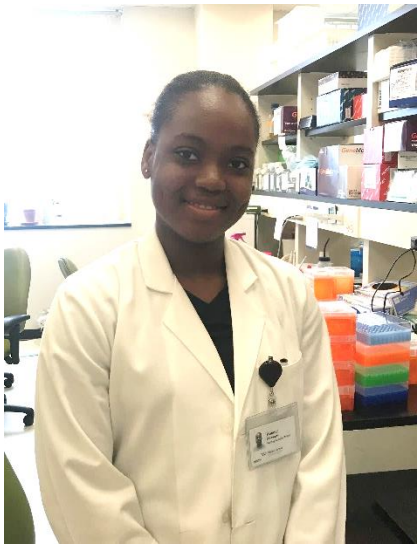
Emma Carin Statt

University of Dayton, Pre-Medicine

Faculty Advisors: *Emmanuel Opara, PhD, Professor and Yuanyuan Zhang, MD, PhD, Associate Professor*

I attend University of Dayton in Dayton, Ohio as a pre-medicine major with a fine arts minor. I have previously done quality improvement research at Public Health – Dayton & Montgomery County, but this summer at WFIRM is my first summer doing lab research. I am highly motivated to work in regenerative medicine because I was diagnosed with Type 1 Diabetes when I was 5 years old, shortly after my older brother was diagnosed with Juvenile Rheumatoid Arthritis, and so I know firsthand how desperately people are hoping for a cure for their chronic diseases. I am excited and grateful for this opportunity to learn more about the world of regenerative medicine!

This summer, I am working with Dr. Emmanuel Opara and Dr. Yuanyuan Zhang on controlled release of IGF 1 and NGF using alginate microbeads. The goal of this project is to determine how efficient this method of growth factor delivery is and eventually, how this method of delivery can be utilized to repair damaged tissue. My future plans include medical school and working in clinical research as a physician. As of right now, I plan to work in neurology.



Honour Adewumi

Jarvis Christian College, Chemistry and Biological Sciences

Faculty Advisor: *Shay Soker, PhD, Professor*

After being recruited from a French-colonized country in the West of Africa about 3 years ago to become a student at Jarvis Christian College in Hawkins Texas, my aspirations have become limitless. I am a rising senior double majoring in Chemistry and Biological Sciences with a minor in mathematics. Since the summer after my freshman year I have carried out research at my home institution year round. My projects have focused on cancer biology and nanoscience. As the President of the Honors Research Scholars and a Welch Foundation Scholar at my Institution, I have had the humbling opportunity of mentoring other students in these areas. When I am not in the lab or class I am actively involved in Student Government Association of which I am now President (2019-2020) and I am also an athlete.

I am humbled to be one of the Class of 2019 Summer Research Scholars at WFIRM. My project this summer is focused on the physics behind the tumor environment and also the effects of chemotherapy on the extracellular matrix of other organs besides the targeted organ. We hope to learn more about the never ending cycle of metastatic cancer. After having been here for roughly four weeks, I have to say that WFIRM has a wonderful work atmosphere, everyone is really helpful; it's unbelievable.

I hope to be a physician-scientist, I intend to do this by obtaining an MD/PhD; to combine surgery and regenerative medicine research. Apart from my career goals I would like to have an impact on my community and even the world at large as a humanitarian.

Jacob Thompson
University of Iowa, Biomedical Engineering
Faculty Advisor: *Shay Soker, PhD, Professor*

My name is Jacob Thompson and I am from Fayetteville, Arkansas. I am a rising senior at the University of Iowa, studying biomedical engineering. In high school, I enjoyed my science courses, so I knew that I would pursue a STEM-related major when entering college. I have always excelled in my mathematics courses and wanted to apply my skills to improve the lives of others. The combination of enjoying scientific fields and doing well in my math courses led me to pursue biomedical engineering. My interest in biomedical engineering has only grown, and it has led me to be in a lab currently using biomaterials to facilitate cell-replacement techniques to treat retinal degeneration. These cell-replacement techniques and stem cell technologies in the lab are the main factors that are spurring my interest in regenerative medicine. I enjoy the research and how the work I do translates into clinics. Working in this lab has opened the door to several experiences in regenerative medicine, including the research experience here at WFIRM, which uses a translational approach to regenerative medicine.

This summer, I am working under Dr. Shay Soker and graduate student Ethan Shelkey. I am using tumor organoid constructs to model and determine effects of microbiota metabolites on colorectal cancer. Organoids are beneficial because they provide a 3D microenvironment for proliferating cells which mimics in vivo characteristics. Specifically, we are looking at the effect of 3-indolepropionic acid (3-IPA) on the cancer cells, draining lymph node lymphocytes, and a combination of the cell types suspended in the organoids. To determine the contribution of 3-IPA, we will look at cell viability and phenotypic and genetic expressions of the cells. In addition, we will look at the effect of 3-IPA on current immune checkpoint blockade therapies, including anti-PD-1 and anti-CTLA-4. This summer experience, working in labs that are at the forefront of regenerative medicine, will prepare me for my future academic and career goals after my undergraduate education.

Following my college graduation from the College of Engineering at the University of Iowa, I plan to pursue a PhD in my designated field of study of Biomedical Engineering. For this field, I believe that having a graduate degree is necessary to study my specialized track of tissue engineering. Within tissue engineering, I am quite interested in biomaterials and regenerative medicine. This is one of the leading edges of healthcare and has enormous potential in treating many of the diseases that our generation faces. Eventually, I plan on working for a biotech/biopharmaceutical company researching new methods within regenerative medicine for people who have been affected by either disease or accidents. I enjoy the application of the material I have learned to help build a better life for a patient that is suffering. I am interested in experiencing the industry side of biomedical engineering and with my graduate degree, I will be able to obtain more challenging and higher-level jobs within these regenerative medicine companies.

Jada Jackson

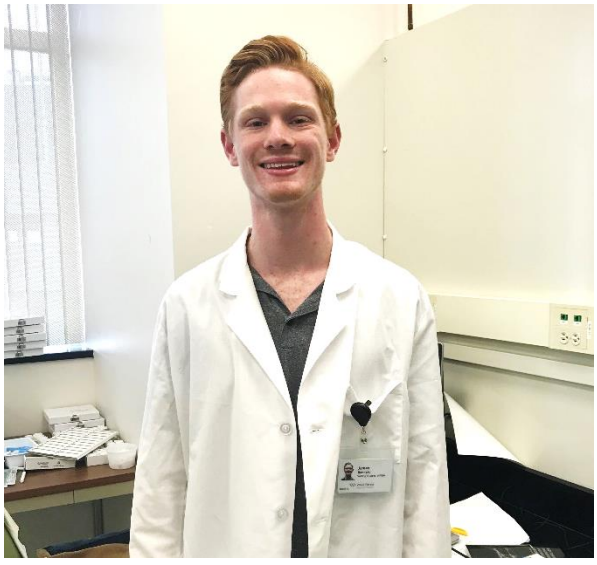
Tuskegee University, Chemical Engineering

Faculty Advisor: *Giuseppe Orlando, MD, PhD, Marie Curie Fellow and Assistant Professor*

I am Jada Jackson, a rising junior from St. Louis, majoring in chemical engineering at Tuskegee University. Most of my time is spent practicing for track, studying, and listening to music. I've loved science for as far as I can remember. As a child, my brother and I would mix up things to attempt to create new lotions or perfumes. In elementary school I participated in science fairs and loved the process. Around my freshman year of college is when I realized I want to work with, improve, and create new medicine. I decided to take the pharmaceutical option of my major. I didn't know about the term "regenerative medicine". I felt like the WFIRM Scholars Program was perfect for me because I could explore new methods of helping people which is what I want my career to be based on. This is also my first research experience so, I get a chance to learn what I like and don't like about it. So far, I l am loving it!

This Summer I have the pleasure to work in Giuseppe Orlando's lab, under the instruction of Deborah Chaimov and Riccardo Tamburrini. We are working to help patients with Type 1 Diabetes. Islets are found in the pancreas and contain Beta cells. With extracellular matrix (ECM), the cells can produce insulin so. The current procedure is flawed because after islet transplantation, patients deal with the side effects of immunosuppressants, the cells can't get enough oxygen, or the ECM is damaged during transplantation. In the lab, we are experimenting different environments for the pancreatic cells to determine which one best supports the health of the cells.

My goal for the future is to be able to work with medicine or food and hopefully, work towards improving them. I've been looking into pharmacy school and careers with the FDA. I think this experience at WFIRM will be very helpful in reaching my goal.



James Bennett

Bucknell University, Biomedical Engineering

Faculty Advisor*: Anthony Atala, MD, Professor, Director of WFIRM*

My name is James Bennett and I am a rising senior biomedical engineering major with a mathematics minor at Bucknell University. My interest in regenerative medicine stems from its ability to apply biomedical techniques to regrow and regain function of lost tissue. I use similar techniques to artificially restore the function of missing limbs to people, through prosthetics, in a biomedical club e-NABLE, where I am the president of Bucknell University's chapter. From this I have gained extensive knowledge and experience with 3D design, fabrication, and manufacturing, which helps me contribute to my project. I also have experience in conducting medical research studies, data analytics, and statistics as I previously interned at the LeBauer Cardiovascular Research Foundation where I conducted multiple comparative studies that analyzed how surgical and lifestyle choices impact the probability of recurrent Atrial Fibrillation. At Bucknell University, a team of engineers and myself developed a wearable biomedical device that incorporated electrical stimulation and compression to the calf muscle during inactivity to prevent the formation of blood clots. From this, I developed my

teamwork, communication, project management, and scheduling skills which will help my research group. My experience in cell culturing and biological labs is limited but I do have exposure pipetting and passing cells and working with biohazardous materials in a laminar flow hood using proper sterile techniques in a level 2 biosafety lab. I was able to work in a team to maintain HeLa cell line by observing, feeding, and splitting cells as needed which has helped me assist in cell culturing at the WFIRM.

I desired the WFIRM internship because I seek to enter the field of regenerative medicine, and the internship provided the unique opportunity of hands-on experience and development of professional communication skills. Regenerative medicine is one of the specialties I am considering for a master's degree and the WFIRM Summer Scholars internship provides unparalleled experience into the field as well as strong mentors and incredible networking opportunities.

My summer scholar research project at the WFIRM focuses on skin bioprinting with my faculty advisor being Dr. Anthony Atala and my PI being Adam Jorgenson. The goal of my project is focused on bioprinted skin healing full thickness wounds and validating it as potential treatment option. The overall objective is to determine if full thickness wounds treated with bioprinted skin significantly reduces scar formation and promotes the development of healthy normal skin during wound healing. I will accomplish this by using several image analysis programs to study if the collagen in the bioprinted skin is aligned more in a random orientation similar to healthy skin or more parallel aligned similar to scar tissue.

After graduating Bucknell University I plan on attending graduate school to obtain a Masters of Engineering degree specializing in biomedical engineering with a focus in either regenerative medicine or biomedical device design. After completing graduate school, my career goal is to work for a regenerative medicine biomedical device company which will best allow me to combine my understanding of biomedical devices and mechanics with my passion for regenerative medicine.

James Harper Day

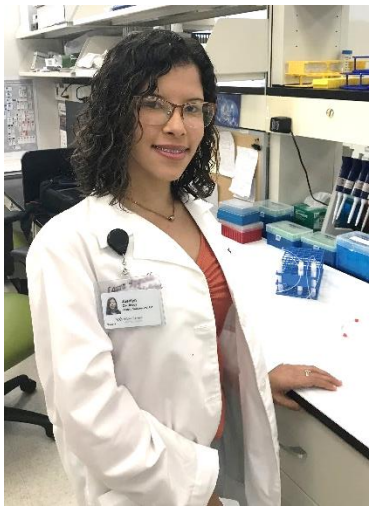
North Carolina State University, Chemical Engineering
Faculty Advisor: *Thomas Shupe, PhD, Assistant Professor*

My name is James Harper Day, and I am currently a rising junior at North Carolina State University currently studying to receive my undergraduate degree in Chemical Engineering with a Biochemical concentration. As a Goodnight Scholar and Honors Student at NC State, STEM research, particularly research with medical applications, has been something that I have always been interested in and have been trying to do. Prior to becoming a WFIRM Summer Scholar, I had limited experience with performing research, only having taken a course in my freshman year of college as part of the SEAPHAGES program studying bacteriophages. Now that I am researching regenerative medicine here at WFIRM as part of the Summer Scholars program, I finally have a chance to research something that I care deeply about.

While here at WFIRM, my research this summer will consist of performing analysis of human primary cell culture samples by examining the concentrations of specific metabolites within the cell culture media. This is done as part of the RegenMed Development Organization (ReMDO) Universal Media Project, a project developing a growth media for human cells that is not only free of animal-derived products but also is completely defined in its composition; by contrast, most commercial growth media products which use fetal bovine serum (FBS) and other animal derived components and are not chemically defined. Additionally, the effect that FBS has on the growth and differentiation of human cells may not be representative of their behavior in the body because of the presence of hormones and other compounds not natively present within their typical growth conditions. For my research, I will be looking at the levels

of glucose, ammonia, and lactate within samples of complete media held under different storage conditions and within samples from diverse cell cultures to monitor their growth and development; as part of this project, I will also be analyzing and interpreting the trends in the data to determine biological causes for the trends.

After I am finished here at WFIRM, I plan to continue through my undergraduate degree, after which I hope to either pursue a graduate degree in Genetic Engineering or Bioengineering or enter Medical School. If I am fortunate, I might be able to do both. Regardless, I want to pursue a career that will allow me to make meaningful contributions to society through the field of medicine, whatever that may be.



Joselyn De Jesús

University of Puerto Rico – Río Piedras, Cellular and Molecular Biology

Faculty Advisors: *Graca Almeida-Porada, MD, PhD, and Chris Porada, PhD, Professor*

My name is Joselyn De Jesús. I am a third-year student at the University of Puerto Rico – Río Piedras majoring in Cellular and Molecular Biology. My interest in scientific research began in my freshman year when Dr. Paul Bayman offered me the opportunity to work in his microbiology lab. Currently, I'm conducting my undergraduate research project in Plant Pathology working under the guidance of Ph.D. student Luz Serrato and Dr. Bayman. The purpose of this research project is to investigate if the coffee berry borer (an insect) is a vector of the Fusarium spp. These fungi cause coffee berry disease and greatly damages the coffee crops. We study the interaction by extracting and sequencing the DNA of the fungi, by their morphological characterization and using Koch's postulates. Although this experience has been very enriching, I wanted to have the opportunity to focus on a research that was more clinically applicable. For this reason, I became intrigued to apply to WFIRM's Summer Scholars Program. I know that regenerative medicine is the future of medicine, therefore I am really enthusiastic about the fact that I have the opportunity to be here and can be part of it.

This summer at WFIRM I am working on the project of Cell and Gene Therapy for Hemophilia A, under the mentorship of Dr. Graca Almeida-Porada and the Ph.D. student Martín Rodriguez. Hemophilia A (HA) is an X-linked disorder caused by the deficiency of functional plasma clotting factor VIII (FVIII), which may be inherited or arise from a spontaneous mutation. Many of the current treatments for hemophilia are lifelong treatments, were the patient's quality of life is hindered and they develop immunological responses against these treatments. The goal of this research is to cure HA with the use of a cell and gene therapy approach delivered during the prenatal period allowing long-term engraftment of donor modified cells and induction of central immune tolerance to both, FVIII and donor cells. The prenatal stem cell therapy consists of the use of placenta cells that modified to express an optimized FVIII transgene.

After graduating from the University of Puerto Rico in the spring of 2021, I plan to attend medical school as the next step in my education. I aspire to become a geriatric doctor with a specialty in endocrinology. I want to be able to study and help the elderly to have a better quality of life during their golden years.

Lauren Drake

University of Pennsylvania, Bioengineering

Faculty Advisor: *Emmanuel Opara, PhD, Professor*

I am a junior from the University of Pennsylvania, majoring in bioengineering and double minoring in creative writing and journalism. I have been interested in regenerative medicine since I was in middle school, where our Future City team studied tissue regeneration as a part of an essay on the future of healthcare and had the opportunity to tour tissue engineering labs. That early exposure to research sparked my interest in STEM and inspired me to study bioengineering. At Penn, I began my scientific research journey in the Shorter Lab, where I study the biochemical mechanisms of neurodegenerative disease during the year. I have been hoping to explore regenerative medicine research in college, and I am very excited to be involved in a biomaterials project at WFIRM!

Under the mentorship of Dr. Emmanuel Opara, I am contributing to the matrix stiffness of a bioartificial pancreas project as a treatment for type 1 diabetes. Type 1 diabetes is an autoimmune disorder that destroys the insulin-producing cells of the pancreas. Current treatment requires patients to monitor their own blood glucose and administer their own insulin. The bioartificial pancreas project aims to eliminate the lifelong burden on patients through islet cell transplantation, in which pancreatic islet cells from a cadaveric donor are isolated and encapsulated in immunoprotective alginate and transplanted into the T1D patient. My project will investigate whether the stiffness of the alginate capsule affects islet cell survival and function. Using a pig model, I will encapsulate islets in alginate with stiffness similar to that of the porcine pancreas and evaluate their viability and glucose-stimulated insulin secretion. By housing islets in capsules that more closely resemble their native environment, we hope to improve long-term transplant function.

I have enjoyed all of my research experiences so far and plan to apply to PhD programs this fall. I hope to combine my studies in biochemistry and neuroscience with regenerative medicine strategies in my future research.

Macaiah Sheffield

Georgia Military College, Sports Medicine

Faculty Advisor: *Tracy Criswell, PhD, Assistant Professor*

Prior to the WFIRM Summer Scholars Program, the only scientific background I had was from taking chemistry, physics, biology, and anatomy classes. I had never done this type of program or research before. So, this was definitely a new experience for me. I was very nervous at first because I thought I would not have enough knowledge or experience to succeed. However, I was wrong. The staff, mentors, and the other summer scholars, were all so welcoming and willing to work with me. They provided their office hours, previous material to reference to, and answered any questions I had.

I am majoring in Sports Medicine and I enjoy working with skeletal muscle regeneration after injuries. I recently received my Associate's Degree from Georgia Military College while doing dual enrollment. Now, in the fall, I will be attending University of Pittsburgh.

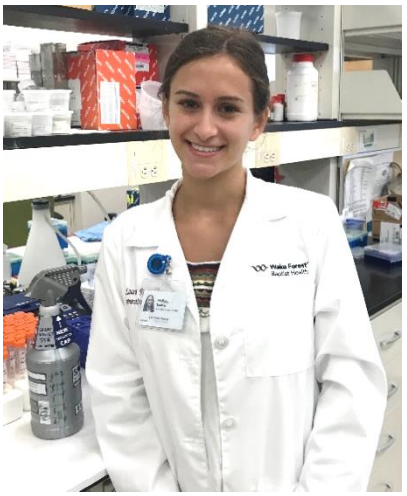
My project is on the effect of the muscadine grape extract (MGE) treatment on macrophage activity and subtype in vitro and in vivo. My mentors are Tracy Criswell, PhD, Joy Zhou, PhD, and James Poteracki, MS. Our goal for the project is to see if MGE treatment will enhance macrophage survival in vitro and affect the M1 to M2 macrophage shift in vivo after an injury.

My future plans are to attend and continue my research at the University of Pittsburgh. After I receive my bachelors in Athletic Training, I will further my education by attending medical school.

Mallory Thomas

North Carolina State University, Biological Sciences

Faculty Advisors: *Graça Almeida-Porada, MD, PhD, Professor and Christopher Porada, PhD, Professor*



I am a rising sophomore at North Carolina State University majoring in biological sciences with a concentration in the human body. I aspire to go to medical school after my undergraduate career, and that same desire sparked my interest for the Summer Scholar program with WFIRM. This program is allowing me to see the academic pursuit for clinical solutions that I hope to see implemented as I enter the field in the future. My exposure to medicine has been largely clinical rather than research or academic, and WFIRM is the perfect place to begin my journey in understanding the analytical processes that go into providing care for patients.

The project I am working on this summer is under the mentorship of Drs. Chris Porada and Graça Almeida-Porada and their graduate student, Brad Kuhlman. We seek to further determine the biological effects of space travel and better define the risk it poses for inducing carcinogenesis within the human hematopoietic and gastrointestinal systems. NASA plans to establish a permanent lunar colony with the goal of manned missions to Mars by the mid 2030's. These missions beyond low-Earth orbit will expose astronauts to types of radiation not present on Earth. Before humans endeavor upon these long voyages, it is imperative that we fully understand the associated health risks. As a representation of these effects, murine models were exposed to Mars mission-relevant doses and species of space radiation. Alterations in radiosensitive tissues will now be characterized via immunohistochemistry and flow cytometry. Specifically, quantification of gross morphological changes and differences in stem cell migration and proliferation will be used as metrics for assessing the effects space radiation exerts on these tissues. This research aims to provide novel insight into the health risks associated with extended space exploration.

I plan to graduate from North Carolina State University in the spring of 2022 and proceed to medical school. Though I am not interested in a specific specialty, I plan to continue researching and shadowing physicians as a way of allowing myself to narrow my interests.

Nikhil Vettikattu

University of Southern California, Human Biology

Faculty Advisor: *Vijay Gorantla, MD, PhD, Associate Professor*

My first experience with laboratory science was at City of Hope National Medical Center at the Center for Gene Therapy, where I spent the summer after my first year culturing hematopoietic stem cells for fluorescence-based cytotoxicity assays. As I tested the effects of various chemotherapeutic agents on my cells, I discovered the amazing potential stem cells had for serving as an in vitro model for disease and drug development. My project was part of a study that sought to treat sickle-cell disease (SCD) by transducing patient bone marrow stem cells to cure them of the point mutation that causes SCD and then autotransplant them back into the patient, in an effort to replace their failing hematopoietic system with the transfected, functional one. Through this experience, I was introduced into the beauty and collaborative nature of biomedical science, as well as the fascinating biology of stem cells.

I used this experience to find a position at a lab at my undergraduate institution, the University of Southern California. At the laboratory there, I assisted in experiments that studied the development of bone and its responses to mechanical stressors in the environment. This laboratory was an amazing way to work with a small animal model and learn about experimental design and sophisticated computational methods.

These experiences have shaped my interest in biomedical science and have demonstrated to me that laboratory investigation will be an important part of my future because of its rewarding nature and the potential to influence large populations through the development of novel curative therapies.

This summer, I will be tracking macrophages using near-infrared imaging (NIR), a method that allows in-vivo monitoring of macrophages in the laboratory of Professor Vijay Gorantla, MD, PhD. Under the guidance of my co-mentors, Drs. Fatih Zor and Husseyin Karagoz, I will be inducing acute inflammation in a rat model using Complete Freund's Adjuvant (CFA) which should attract macrophages and activate them. We will monitor macrophage movement using a custom-made nanoemulsion that is selectively phagocytosed by macrophages and is visible under NIR, as well as a probe that fluoresces under NIR when cleaved by matrix metalloproteinases, enzymes secreted by macrophages in response to inflammation. This will be the first attempt to monitor macrophages in acute inflammation using this method and will provide evidence that we can use this strategy in the setting of composite tissue allotransplants, the main focus of the Gorantla laboratory.

After graduation next year, I will be applying to medical school. I hope to become a physician-scientist who combines clinical practice with laboratory investigation, a drive that seems highly compatible to the principles of WFIRM. I am using this program in part to decide whether or not I want to apply directly to medical school or to an MD/PhD program, as well as to contribute to a research project with powerful translational potential.

Olivia Cain

Spelman College, Biology

Faculty Advisor: *Steve J. Walker, PhD, Associate Professor*

Hi all! My name is Olivia Cain and I am a rising sophomore Biology major, Spanish minor at Spelman College. I was interested in engaging in regenerative medicine at WFIRM because I think that this field is one of the most innovative and ambitious fields that one can involve themselves in. At WFIRM, people are actively creating things that one hundred years ago were nothing more than science fiction. WFIRM is also a unique institute with a collaborative, not competitive, environment where everyone is working towards one goal: to improve the everyday lives of patients. I am a Winston Salem native, so I had heard about the incredible work being done at the lab and I am grateful to have the opportunity to work at this institute.

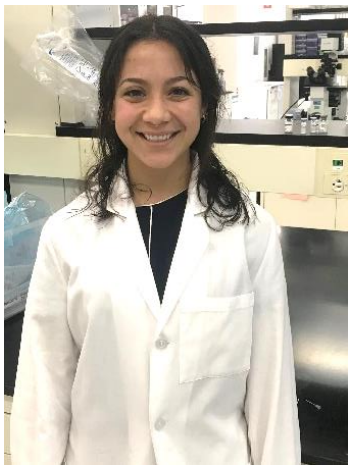
This summer I was working in Dr. Steven Walker's lab where we had the goal of determining if there is a subgroup of Interstitial Cystitis/Bladder Pain Syndrome patients that can be characterized by low bladder capacity. IC/BPS is a condition that is diagnosed when a patient has bladder pain and it is not found to be one of the common bladder conditions such as a Urinary Tract Infection or bladder cancer. As a result of this catch all approach, researchers find it increasingly difficult to come up with medications and treatments for IC/BPS patients because the results are often variable. Our lab hypothesized that this variability is due to there being two primary types of IC/BPS, one caused by a bladder specific disease and another being associated with a chronic pain syndrome. My work is a continuation of Dr. Walker's previous work which provided evidence that low bladder capacity is a sign of the bladder specific subgroup of IC/BPS.

I hope to receive either an MD or an MD-PhD and I plan on becoming either an OBGYN or a Pediatric Surgeon. Future research that I would like to conduct are potential treatments for people with chronic pain syndromes or creating an artificial womb that can sustain an embryo to a fully grown fetus.

Olivia Zyniewicz

University of Notre Dame, Neuroscience and Behavior

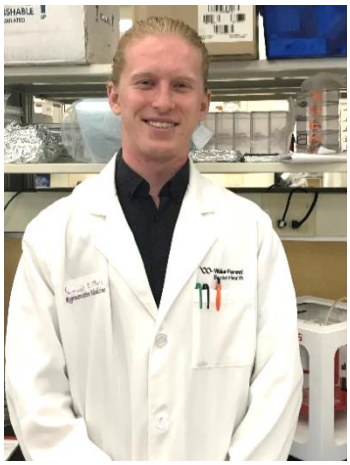
Faculty Advisor*: Young Min Ju, PhD, Instructor*



I am a rising senior at the University of Notre Dame studying Neuroscience and Behavior, pre-medicine. Before my junior year, I was undecided about the pre-medicine track; my decision to pursue this route was solidified by my participation in a study abroad program that was supplemented by an international pre-medicine internship offered by the University of Notre Dame. This experience also ignited an interest in research, an interest in regenerative medicine, as well as my participation in Dr. Matthew Ravosa's lab at the University of Notre Dame studying the interaction of temporal variation in dietary loading and the induction of a saturation response in jaw growth and function in rabbits and primates.

This summer I am excited to work with Drs. Young Min Ju and Ji Hoon Park and their study on targeted angiogenesis. I will be investigating viable concentrations of pro- and anti-angiogenic factors in order to optimize the fabrication of a bioprinted scaffold which can be used to selectively promote angiogenesis in injured areas containing vascularized and nonvascularized tissue. The project aims to discern an effective method for drug and growth factor administration such that process of angiogenesis to sustain tissue regeneration, specifically in osteochondral and similar injuries, may be improved.

After completing the WFIRM Summer Scholars program, I hope to utilize my newly developed skills to broaden my research opportunities during my senior year and beyond. After completing my undergraduate degree, I intend to spend my gap year gaining further experience in the scientific and clinical field. In the future, I plan to pursue an MD so that I may exercise the valuable lessons learned from all of my undergraduate experiences to provide a high quality of care to the best of my abilities.



Samuel Moss

University of Wisconsin – Madison, Biomedical Engineering

Faculty Advisor: *Aleks Skardal, PhD, Assistant Professor*

My name is Samuel P. Moss and I will be entering the fourth year of my bachelor's in biomedical engineering at the University of Wisconsin - Madison. I have spent most of my undergraduate career working in the Microtechnology Core at the University of Wisconsin. At the core I designed and created multiple custom microfluidic devices for various research purposes. I have also spent time creating a custom Langendorff apparatus for the reverse perfusion of guinea pig heart. In my most recent biomedical engineering project I created a dissociation method using hydrogel beads to extract eosinophils from lung tissue samples. My first university scientific experience was in an astro-botanical research lab and I created an automated series of hypoxic chambers to study some of the effects of space flight on different plants.

This summer I will be optimizing the bioprinting of myeloma microenvironments as well as culturing patient tumor samples in organoids to examine the effectiveness of different chemotherapies on them. In simpler terms one half of my summer priorities will be using a bioprinter to place a hydrogel filled with cells in a well plate and then fill up the rest of the well with cell media. This will hopefully automate the process of creating organoids for patient samples. The other half of my summer priorities will be creating organoids from samples of multiple myeloma patients' bone marrow. These organoids will then be cultured with multiple myeloma chemotherapies to determine what therapy may work best for that specific patient.

My future plans are to obtain either my masters or PhD in biomedical engineering and work in the field of regenerative medicine.

recombinant FVIII. However, 75% of people with Hemophilia A do not have access to this treatment, and 30% of people who receive prophylactic treatment develop inhibitory antibodies which can render the treatment ineffective, putting these patients at a tremendous risk. In the Porada Lab, we are developing a cell and gene delivery approach to treat patients prior to birth. Although we expect this approach to be curative, the delivery of FVIII during gestation will induce tolerance to the protein, so if the patients still need treatment after birth, they will not develop inhibitory antibodies. I hope my work during this summer will contribute to developing a novel therapy or even a cure for patients with Hemophilia A.

After my senior year, I will be attending graduate school at the University of Michigan earning a Master's degree in Biomedical Engineering. After that, I plan on attending medical school, so I can help bring new therapies to patients through both clinical and preclinical research.