



Institute for Regenerative Medicine

Summer 2019 Program Call for Applications New NSF Research Experiences for Undergraduates (REU) Site At The Interface of Engineering and Biology = WFIRM REU Program

Engineering New REU Approaches to Challenges in MultiTERM NSF REU Award #1659663; PI: Anthony Atala, MD; Co-PI: Joan F. Schanck, MPA E-APPLICATIONS OPEN: November 30, 2018 APPLICATION DEADLINE: January 4, 2019 \$5,000 stipend and housing allowance

<u>Overview:</u> This new REU program at the Wake Forest Institute for Regenerative Medicine (WFIRM) engages 10 undergraduate students each summer (2018-2020) in highly collaborative, team-based research at the interface of engineering and biology all focused on challenging areas of tissue engineering and regenerative medicine (TERM). With focus toward enhancing participation and interest of under-represented minority (URM) groups, women and non-traditional students attending 2- and 4-year universities with limited research, first generation and veterans, REU students engage in TERM research simultaneously identified as high priority by NSF and DOD.

Undergraduate students will be engaged in highly collaborative, team-based research at the interface of engineering and biology in challenging areas of tissue engineering and regenerative medicine (TERM). The NSF and the Department of Defense have both identified TERM research as high priority. Scholars will focus on four challenging areas: 1) biomaterials, 2) cell sources, 3) vascularization and 4) enabling technologies such as cell delivery devices, 3D bioprinting and tissue bioreactors.

Unique Aspects of the MultiTERM REU Program:

- Interdisciplinary mentored research with prominent TERM researchers addressing real-world clinical needs
- Students are placed within an interdisciplinary, team-based research environment
- Collaboration with primary faculty mentors, co-near peer secondary faculty mentors, graduate and post-doctoral fellows and the entire WFIRM research team
- Exposure to TERM research projects beyond the students' own research focus
- Exposure to Biofabrication Technologies and Introduction to Translation (cGMP/GTP Cell Process, etc.)
- Opportunity for oral and poster presentations throughout the summer, culminating in a final Research Day Podium and Poster presentations
- Attendance to and presentation opportunities at local and national meetings
- Robust track record of publications/presentations with undergraduate co-authors

Student Experience Highlights:

- Additional program elements and education on the research process
- Skill transference/hands-on exposure to modern instrumentation and techniques
- Workshops on bioethics, responsible conduct of research, effective oral and written communication, professional development and other career opportunities
- Social and Community-Building activities to highlight STEM advances
- Networking with students, prominent scientists, engineers, industry and government collaborators, educators and community leaders.

"A significant challenge in TERM is developing the next generation of science and engineering experts, who are cognizant of the interdisciplinary challenges and approaches needed to solve TERM problems," said Joan Schanck, MPA, WFIRM Academic Research Program Officer who oversees educational programming.

Applications accepted at: http://wfirm.org

Deadline: January 4, 2019

Questions? Email summerscholar@wakehealth.edu or contact Joan Schanck, 336-713-1201



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WFIRM NSF REU MultiTERM Program Summer 2018 Highlighted Profiles



Rawdah Elbahrawi

University of Alabama at Birmingham, Biomedical Engineering Faculty Advisor: Ji Hyun Kim, PhD, Instructor

I joined the NSF REU program at WFIRM as a sophomore studying Biomedical Engineering at the University of Alabama at Birmingham (UAB). I have been interested in the scientific and medical field since I can remember. In high school, I was given the opportunity to attend an International Baccalaureate program and it changed my perspective on how I can contribute to an ever-changing world. I learned that I

wanted to be "hands on" in making a change. Furthermore, after attending the 5th Annual Regenerative Medicine course at WFIRM, a component of the NSF REU program that I was exposed to, I have become more certain that I am interested in a scientific or medical career. Through the program, I have learned from scientists, engineers and physician scientists I've met about the many changing tools, machines, and methods that are truly groundbreaking. The exciting stuff of the future is at the interface of many disciplines and this program both excited me and exposed me to the fantastic opportunities team-based approaches represent.

This summer I worked with the team of Dr. Ji Hyun Kim and Dr. Ilho Park and their study on in situ muscle regeneration. Their main objectives are to develop an ECM scaffold using decellularized muscle fiber fragments, develop muscle fiber fragment scaffold by utilizing growth factors and chemotactic agent loaded forms and to validate this scaffold model.

Two essential components to their study and my work is bioprinting and in situ regeneration. Bioprinting is crucial in that it allows us to mimic the complex architecture of the skeletal muscle tissue, so when used in vivo, its biological cues and functions cooperate with the natural flow of the body. The proteins examined with in situ regeneration in this study are SDF and IGF. SDF and IGF work hand-in-hand in stem cell recruitment and its differentiation. SDF recruits the stem cells through chemotaxis and IGF is responsible for the differentiation of these cells. Furthermore, for an in-situ regeneration process to be successful the recruitment of the host stem cell into the tissue or the tissue construct must be effective for the induction of the incoming cells into cell lineages to occur.

This summer I compared the release kinetics of two different delivery methods of the proteins IGF and SDF. With the success of an effective delivery method, a constant transfer of biological cues and biological functions from the implanted scaffold would guide the host cells to form an integrated functional structure giving the skeletal muscle tissue the reminder that it has the capacity to regenerate, repair and ultimately heal. This work will be beneficial for cases such as volumetric muscle loss where the skeletal muscle is either destroyed or removed and with it its properties of repairing injuries. By introducing an effective delivery system, it will push the muscle to recall its natural regenerative powers.

My experience this summer has confirmed my resolve to continue to pursue my undergraduate degree in Biomedical Engineering at UAB as well as engage in future research. Although I am unsure of the disciplinary advanced degree and disciplinary path I want to pursue post-graduation, my experiences as an REU student at WFIRM will guide my decision-making and future as a scientist. I am thankful for everyone at WFIRM for the opportunity, guidance, and knowledge. I also made life-long friends!

NOTE: Rawdah Elbahrawi has been selected to participate in the **Council on Undergraduate Research's** *Research Experiences for Undergraduates Symposium* taking place on October 28-29, 2018.



Agne Nixon

Washington State University, Biological Sciences Faculty Advisor: John Jackson, PhD, Associate Professor

My name is Agne Nixon and I am a post-baccalaureate student at Washington State University, Tri Cities and a first generation, US college student of immigrant parents. Prior to beginning my foray into biology, I earned a law degree. After much personal reflection, I began to understand I was far more interested in the elegance of science and particularly the intricacies of biology. This epiphany propelled me to return to

school to begin earning pre-requisites for further graduate studies in health care.

While in school, I began to explore opportunities to get involved outside of the classroom and was fortunate enough to be taken on by my anatomy professor as a research assistant in his lab. Currently, I am working under the tutelage of Dr. Cooper to study the evolutionary development of fish with an emphasis on cranial biomechanics, skull morphology, and feeding strategies. We hope to better understand whether certain genetic modifications cause significantly different alterations of cranial morphogenesis. My growing interest in regenerative medicine was fueled by my initial exposure to the regenerative properties of zebrafish that I have seen in my research at Washington State University. The opportunity to expand on my knowledge base and learn more about this field is precisely what propelled me to apply to NSF REU site at the Wake Forest Institute for Regenerative Medicine WFIRM, "Engineering New Approaches to Challenges in Multidisciplinary Tissue Engineering and Regenerative Medicine. I was also drawn by the diversity of the program spanning the research areas, didactic, professional development and social activities as well as the goal to encourage participation of URM students, women, first generation and non-traditional students.

As an undergraduate researcher at WFIRM, I was privileged to be part of the team under the guidance of Drs. Jackson, Sivanandane, and Sequeira working on bioengineering ovarian follicles. Specifically, our work was directed toward the development of ovarian follicles that lead to egg production. We worked with differentiated stem cells to develop a follicle that is most similar to structure and function to live human tissue. This interdisciplinary project at the interface of biology and engineering also introduced me to investigate the type of biomaterials to provide both an environment and a scaffold to allow the follicles to develop. Such a process requires the stepwise aggregation of cell types as the follicle forms and prevention of cell migration, which was my focus in my role at WFIRM this past summer.

My experience at WFIRM was outstanding and I value not only the work that I did, but the relationships I built with my colleagues and mentors. Prior to the start of the program, the communication and information I received from WFIRM was perfect. Upon arriving in Winston-Salem, I was warmly welcomed by the WFIRM community and felt like I belonged from the start. This feeling remained with me through the duration of the 10-week program. Part of this was influenced by the open work environment of the lab space which facilitated meaningful discussions. Faculty members and graduate students in the lab were always eager to answer questions and assist with anything I needed help with. Additionally, this paired well with the structured education including the weekly seminars we received and the week-long regenerative medicine course. These allowed for an introduction into the multidisciplinary approach of regenerative medicine. The educational aspect of course continued outside of the lecture hall, and I learned a great deal in the lab through my individually tailored research project. During my time at WFIRM, I built skills related to culturing cells, tissue engineering, microscopy, histology, immunohistochemistry, and imaging software. If I had any questions regarding these lab skills, or really anything, everyone at WFIRM was eager to help, from the lab techs to the program director, to other scholars and graduate students. Additionally, I enjoyed the organized activities arranged for all of us including attending a Dash game, picnics, and hikes. Everything that happened in and outside of the lab made me feel like I was part of the WFIRM family. The whole organization is extraordinarily professional while also allowing for personal growth as a student scientist.

This academic year I will finish my pre-requisites for medical school and apply with the aspiration to matriculate in fall of 2019. My goal is to become a physician scientist involved in academic research that will improve the public's health. I will carry this experience at WFIRM with me as I pursue this dream and I am thankful for this incredible learning opportunity.

NOTE to NSF: This NSF REU is our first year and it is so integral to our ability to engage students in this program. I've also included below some quick facts that attest to the strength of the program that this NSF REU program is associated with and the overall importance of undergraduate research.

About Our Undergraduate Researchers at WFIRM

- Nurturing & keeping future talented scientists

Purpose: To attract young people to TERM, and provide meaningful research opportunities for college students, WFIRM developed the annual Undergraduate Summer Scholars Program.

In 2007, the WFIRM Summer Scholar program became nationally advertised and has been run continuously ever since. Over the past 11 years, a total of 213 undergraduates, 110 male and 103 females, participated in the formal, competitively reviewed WFIRM Summer Scholars program. The interns were studying in institutions across the country. Interns' majors included biology, bio-technology, biomedical engineering, bioinformatics, pre-med, chemistry, biochemistry, psychology, computer science and mathematics.

Quick facts:

- Program active since WFIRM inception
- From 2007-2018, WFIRM hosted nearly 500 undergraduates during both the summer and academic year.
- From 2007-2018, **213 competitively reviewed** Summer Scholars
- Average >250 apps; 19 positions
- > 138 (65%) recruited nationally
- > 75 (35%) from institutes in NC
- > Nearly 80 percent have reported completion of their undergraduate college degree
- 151 (70%) currently attending or completed graduate PhD and/or MD programs in engineering, medicine or related fields
- > 73 (48%) attending MD or PhD programs at Med School
- > 78 (52%) attending Graduate, PhD STEM programs
- > 35% publication rate
- > >60% ongoing collaborative relationships
- Nearly all cite the experience as pivotal in helping them determine next steps in education and career preparation.

Statements regarding what NSF REU student gained most from the program (Note that the surveys are anonymous and that a full comprehensive evaluation summary was provided in the annual report)

- The collaboration I had with my mentor and the entire team was phenomenal. I loved that I could reach out to any member and get the help and support I needed. I felt like I as a contributing part of the group and enjoyed the engagement.
- My biggest gain was an understanding of the knowledge and skills required to carry out an original scientific research project from beginning to end, including communication and publication. I'm hooked!
- I developed many meaningful relationships with both my mentors and peers while at WFIRM. I also learned a great deal about which career I would like to pursue moving forward.
- I had an amazing summer. It was way better than I ever could have imagined. I am incredibly sad it is over, but it will definitely be something I remember forever

Chart 1 below depicts the number of WFIRM Summer Scholars currently attending or completed graduate PhD and/or MD programs in engineering, medicine or related fields.



Chart 2 below depicts the distribution of former alumni attending post-graduate education in NC, at WFU/WFSOM and other institutions in the US and abroad.

