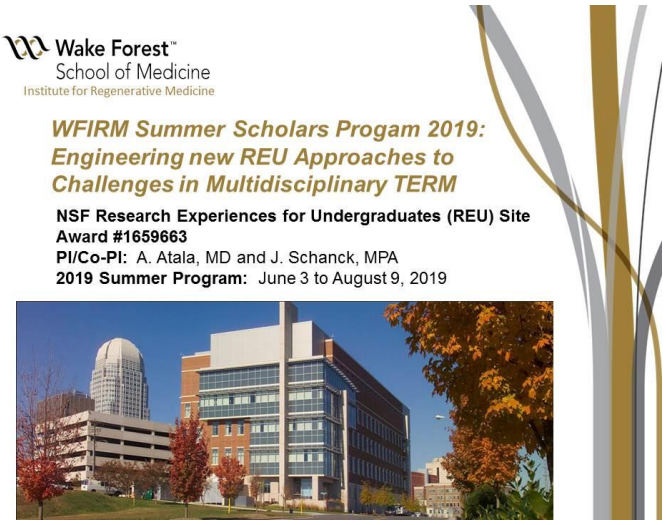
Overview of the Wake Forest Institute for Regenerative Medicine Faculty Mentors/Training Team, Research, Philosophy & Infrastructure



The current faculty roster at the Wake Forest Institute for Regenerative Medicine (WFIRM) contains a mixture of established faculty and junior faculty with outstanding promise and collaborative expertise in the field of tissue engineering and regenerative medicine (TERM). Overall, our team of faculty mentors have successfully been awarded over $34 million in funding, including areas of translation of TERM technologies, along with DOD priority research programs (Armed Forces Institute for Regenerative Medicine and Body-on-a-Chip technologies) and the new Advancing TERM Biofabrication and Manufacturing. Roughly 20-25 undergraduate research projects are available each summer. There is an eligible mentor pool of 22 research faculty, from early-stage through senior faculty with fully funded research programs and decades of mentoring experience (see **Figures 1 and 2** below).

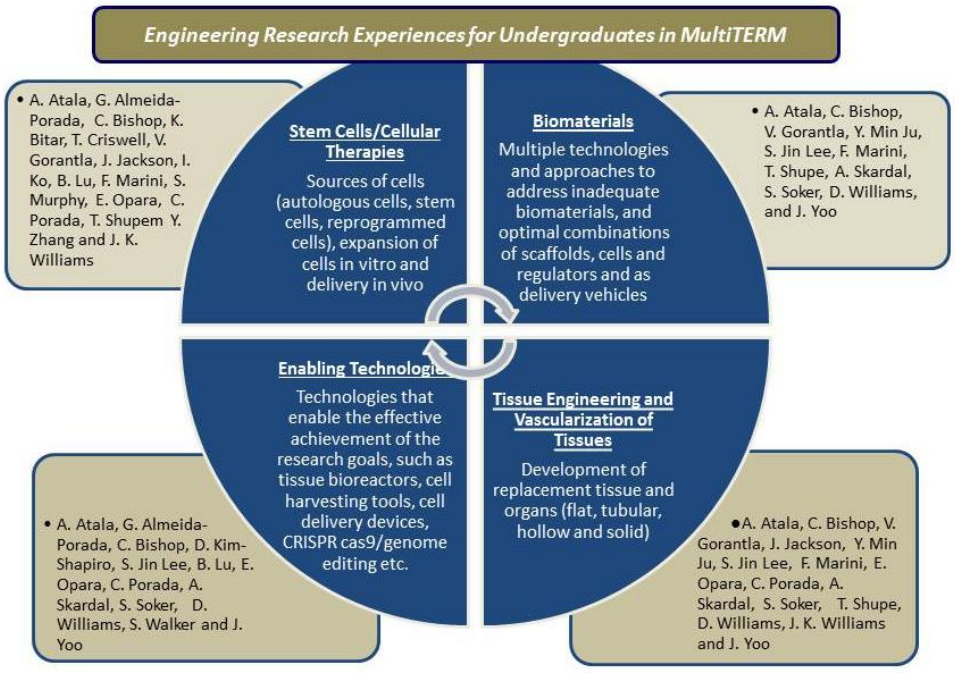


Figure 1: WFIRM MultiTERM Focus Areas

Training Team, Philosophy & Infrastructure (cont.)

Figure 2: WFIRM Infrastructure enabling STRM Training

WFIRM infrastructure enhances training with teams of in-house personnel (regulatory, legal, commercialization) and the RMCC facilities (GMP) designed and constructed for production of RM products and evaluation of "in-house" Phase I/II human clinical studies in compliance with the current GMP regulations.

Training Faculty - *Some achievements of WFIRM scientists*

► First to demonstrate complex, layered tissue structures can be engineered using cells. **(1994)**

► First to engineer functional, experimental solid organs using a strategy to recycle donor organs. **(2004, with first publication in 2009)**

► Developed first tissue-engineered product to go to the US FDA for Phase 1 approval for clinical applications, consisting of cells and biomaterials for injectable therapy. **(1995)**

► First to use biomaterials alone, without the addition of cells, implanted in patients for the regeneration of organs. **(1996)**

► First to create a laboratory-grown organ that was successfully implanted in patients. **(1999 first implantation; publication 2006)**

► First to create a functional solid organ experimentally, a miniature kidney that secretes urine. **(2003)**

► Led the team that engineered tubular excretory organs and implanted them in patients. **(2004 first implantation; publication 2011)**

► Founded the Regenerative Medicine Foundation, a non-profit organization dedicated to advancement of RM treatments and therapies. **(2005)**

► Identified and characterized a new source of stem cells derived from amniotic fluid and placenta, which show promise for the treatment of many diseases. **(2007)**

► Selected to co-lead the Armed Forces Institute of Regenerative Medicine, an $85 million, federally funded effort to apply RM to battlefield injuries. **(2008)**

► First initiative for RM manufacturing through establishment of a joint industrial engineering program. **(2008)**

► Led the team that successfully implanted engineered vaginas into girls with a rare genetic defect. **(2005 first implantation; publication 2014)**

► Developed a 3D bioprinter (the Integrated Integrated Tissue and Organ Printing System) specifically designed to print living tissue structures to replace injured or diseased tissue in patients. **(2016)**

Summer Scholars Program 2019 – Research Project Areas

Roughly 20-25 projects are available each summer. The section below provides an overview of some of the available faculty mentors and project areas.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Body-on-a-Chip

Position Need: Undergraduate Summer Student Researcher

Advisor:

Anthony Atala, MD
Professor and Director, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 716-5701
Email: aatala@wakehealth.edu
www.wfirm.org

Project Description:

The Body-on-a-Chip project is a federally funded effort to build a miniaturized system of human organs to model the body's responses to harmful agents and to develop potential therapies.

Biomaterial-derived bio-inks are being designed and formulated as an extracellular matrix, and are combined with tissue specific human cells to 3D bio-print the organ structures. Miniature lab-engineered organ-like hearts, lungs, livers and blood vessels are placed on microchips and linked together via a system of circulating artificial blood substitutes through channels and sensors to provide online monitoring of individual organs and the overall organ system.

The goal of the research is to accelerate the development of therapeutic agents by having a technology that better represents the human biological system, as compared to current methods of 2D culture systems or in vivo animal testing that may not accurately replicate the human response. The system can also be used to develop diseased tissue and organ models that can be used to study specific pathology, and can be explored for the advancement of personalized medicine therapeutics.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	3D Bioprinting and Regenerative Medicine
Position Need:	Undergraduate Student Summer Researcher

Advisor:

Anthony Atala, MD
Professor and Director, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 716-5701
Email: aatala@wakehealth.edu
www.wfirm.org

Project Description:

3D bioprinting is being used in our laboratory to print cells, tissues, and organs. Various components are essential in allowing these technologies to move forward, including biomaterial specificity, bio-ink design and manufacturing, cell biology, hardware design and construction, and software development. The goal of this research is to manufacture tissue constructs that can be implanted in patients. We are working on many tissues with the bioprinting technology, including liver, heart, kidney, trachea, lung, muscle, cartilage, blood vessels and bone. This research involves using cells to engineer an implant, with the engineered bio-ink/biomaterials degrading as new tissue builds over time.

We are currently building on our prior research where human tissues and organs have been engineered and implanted in patients, in an effort to expand the number of tissues available, and to scale up the technology through 3D printing. The various aspects of this project include:

- To develop novel bio-inks and bio-materials
- To develop novel hardware and software for bioprinting
- To standardize cell culture and expansion conditions
- To define the optimal bioprinting parameters
- To bioprint tissues for in-vivo implantation

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	Regenerative Medicine for the Wounded Warrior
Position Need:	Undergraduate Student Summer Researcher

Advisor:

Anthony Atala, MD
Professor and Director, Wake Forest Institute for Regenerative Medicine
Wake Forest University
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Winston-Salem, NC 27157
Phone: (336) 716-5701
Email: aatala@wakehealth.edu
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Project Description:

The Wake Forest Institute for Regenerative Medicine (WFIRM) has over A dozen projects in the development pipeline for our wounded warriors. Under a $75 Million federally funded program, the Armed Forces Institute of Regenerative Medicine, directed by Dr. Atala, aims to translate regenerative medicine technologies to our wounded warriors. Many technologies are under development affecting 5 major focus areas: Craniofacial, Extremities, Composite Tissue Allo-transplantation, Skin, and Genitourinary. These technologies include the development of biomaterials, cells, or both together, to achieve therapeutic targets in patients. A multi-disciplinary approach involving biomaterial sciences, nanotechnology, molecular and cell biology, physiology and pharmacology, is needed to create therapy constructs that could be developed or tissue engineered. This program has projects that cover the entire spectrum of technology development, including idea conception, experimental design, basic and applied sciences, in-vitro and in-vivo testing, proof-of-principle research, pre-clinical studies, process development, FDA regulatory filings, GMP manufacturing, quality assurance, and clinical trial design and execution.

Other Notes:

There is an opportunity to be involved in various areas, involving different tissue and organ targets, with a wide range of research projects.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Stem Cells, their Niches and the Systemic Environment

Position Need: Undergraduate Summer Student Researcher

Advisor:

Graca Almeida-Porada, MD, PhD
Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-1630
Email: galmeida@wakehealth.edu
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Project Description: Dr. Almeida-Porada's work is focused on delineating pathways and factors that govern stem cell expansion and differentiation into specific fates by studying stem cells in their microenvironment, at the niche level, and upon transplantation. She also focuses on understanding the mechanisms and devising techniques to improve engraftment of transplanted cells. REU projects will elucidate: 1) ways to obtain and expand non-immunogenic tissue-specific progenitor cells for TE and cell transplantation using TE constructs, bioreactors and microfluidic devices; and 2) new and safer approaches to cell therapy, including manipulation of stem cell niches to stimulate proliferation of endogenous stem cells, and/or facilitate engraftment, decrease inflammation, and accelerate recovery after stem cell transplantation. Research performed by students has been fundamental in the development of new projects and grant applications, resulting in publications and presentations at meetings. REU students learn concepts in stem cell biology, immunology, and techniques to perform work on stem cell maintenance, differentiation, expansion, and immunological assessment including use of bioreactors and 3D culture systems. Her work provides opportunities for a number of REU projects. For example: 1) Students will isolate and expand stem cells derived from bone marrow and amniotic fluid. They will learn techniques to perform work on stem cell maintenance, differentiation, expansion and immunological assessment through use of bioreactors and 3D culture systems. Students may also learn how to produce and assess viral vectors and how to transduce cells expressing a therapeutic protein. 2) Students will also learn immunostaining, flow cytometry, DNA and RNA isolation, Q-PCR, ELISA techniques, and microscopy. Students will also use CRISPR/Cas9 technology to insert therapeutic genes and/or correct mutations present in cells.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Bioengineering Functional GI Constructs

Position Need: Undergraduate Summer Student Researcher

Advisor:

Khalil Bitar, PhD
Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-7266
Email: kbitar@wakehealth.edu
www.wfirm.org

Project Description:

Dr. Bitar's program applies basic science information to the bioengineering and implantation of functional gastrointestinal constructs generated from autologous cells. Dr. Bitar has trained 23 undergraduates. The students have been incorporated into the broader ongoing research, with individual student projects collaboratively designed, such as replenishing decellularized intestine as a method of regenerating functional tubular structures. Another example is a project from this past summer where a sophomore isolated and co-cultured interstitial cells with smooth muscle. The project received the TERMIS junior investigator award. Another student project was selected to be "in the news" and also received a junior investigator award during Digestive Disease Week. Another participant gained hands-on experience with a technology that co-cultures smooth muscle cells with enteric progenitor neural cells. This student had a direct impact on advancement in the field of regeneration of the gut. The student's work was presented as an abstract and a poster at the WFIRM summer scholar final research day, and will be part of a manuscript we intend to submit for publication with the undergraduate student as coauthor.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	Bioartificial Organs and iPSC-Derived Organoids
Position Need:	Undergraduate Summer Student Researcher

Advisor:

Colin Bishop, PhD
Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-7273
Email: cbishop@wakehealth.edu
www.wfirm.org

Project Description:

Dr. Bishop has trained > 20 graduate students and mentored 1-3 undergraduate scholars each year over his 25-year career. In a DoD study, he is designing a functional 3D human testis starting with cells derived from small testicular fragments. In another DoD program, Dr. Bishop is creating a human, multi-organ bioprinted "body-on-a-chip" to be used for rapid testing of agents to counteract terrorist threats. For this study, Dr. Bishop is constructing several human, multicellular 3D organoids such as liver, heart, lung and brain. Potential REU projects may involve students in the construction of human brain organoids starting with an induced pluripotent stem cell line (iPSC). As exemplar, a recent summer undergraduate student's project utilized an integration-free, episomal derived iPSC line modified to carry an ultra-fast fluorescent calcium flux indicator (GCaMP6f) integrated into the AAVS1 site by talen mediated homologous recombination. Cerebral organoids were generated by first culturing the cells as embryoid bodies (6 days) then transferred to neural induction media (5 days). Organoids were then encapsulated in matrigel droplets and cultured in neural differentiation medium in static 3D culture for (4 days) before being transferred to a spinning bioreactor containing neural differentiation medium plus retinoic acid for several more weeks. To characterize the brain organoid, quantitative reverse transcriptase polymerase chain reaction (qPCR) and immunohistologic methods were used to analyze the general morphology and expression of various neuronal, forebrain, hindbrain, and progenitor markers. In addition, the presence of the GCaMP6f IPSC-derived cells allowed for live imaging of neural calcium signaling. Successful brain characterization of a cerebral organoid derived from human iPSCs has tremendous implications in bioengineering and biomedical research, and would allow cell replacement therapies, preliminary drug testing, and disease modeling, bypassing ethical issues surrounding ESC testing and human trials.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Sex and Gender Differences in Aging, Wound Healing and Regenerative Medicine

Position Need: Undergraduate Summer Student Researcher

Advisor:

Tracy Criswell, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
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www.wfirm.org

Project Description:

Our sex is determined early during embryogenesis by the XX or XY chromosomes contained in the DNA in each of our cells of which we are made. Therefore, men and women are different at the DNA level and it should not be assumed that men and women age and heal in a similar manner.

This research examines the differences in wound healing and tissue regeneration in men and women at different stages of life. Skeletal muscle is necessary for movement, but also maintenance of body temperature, glucose metabolism and vascular flow and is very sensitive in changes to sex hormones such as estrogen and testosterone. Moreover, skeletal muscle mass and function decreases during the aging process (sarcopenia). Thus, skeletal muscle is an ideal tissue to examine sex and gender differences in tissue regeneration.

Rat models of aging and injury are used in this research as well as the development of microfluid systems that mimic hormonal changes that occur during aging.

Wake Forest School of Medicine
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2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Position Need: Undergraduate Summer Student Researcher

Advisor:

Vijay Gorantla, MD, PhD
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Phone: (336) 713-1494
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www.wfirm.org

Research Focus Areas:

Dr. Gorantla is Director of the Vascularized Composite Allotransplantation program at WFIRM. He played a key role in the Nation's first and second hand transplant programs at the University of Louisville and University of Pittsburgh before being recruited to WFIRM. Dr. Gorantla is lead Investigator on multiple translational and clinical studies funded by the DOD totaling over $10M dollars in funding. Over the last decade, he has been active in basic and translational research in the restoration or rehabilitation of disabilities secondary to complex limb loss, traumatic brain injury, or vision loss. These include complex microvascular models to study limb or eye transplantation, non-invasive high resolution vascular imaging strategies with ultrahigh field MRI and ultrasound biomicroscopy, adipose and mesenchymal stem cell therapies for immunomodulation and neuromuscular regeneration, and novel strategies for bone healing and regeneration using bioresorbable and biocompatible materials.

Wake Forest School of Medicine
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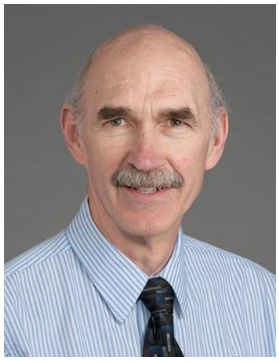
2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Position Need: Undergraduate Summer Student Researcher

Advisor:



John Jackson, PhD
Associate Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-1490
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www.wfirm.org

Research Focus Areas: Dr. Jackson has directed his research toward the effects of cytokines and other agents on hematopoietic mobilization for transplantation as well as hematopoietic and immunological recovery following hematopoietic stem cell transplantation. More recently, he has broadened his interest in tissue engineering using stem cells, primary tissue cells and small molecules for repair and regeneration of skin, inner ear hair cells, ovary and corporal cavernosum.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Skeletal muscle tissue regeneration

Position Need: Undergraduate Summer Student Researcher

Advisor:

Ji Hyun Kim, PhD
Instructor, Wake Forest Institute for Regenerative Medicine
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Winston-Salem, NC 27157
Phone: (336) 713-1327
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www.wfirm.org

Project Description:

This project addresses shortage of transplantable organs by providing functional engineered tissues in a clinically relevant manner. The research has focused on establishing novel strategies to efficiently restore tissue function for treating critical size defects using tissue-engineering technologies and cell-based therapies. This project has two different approaches to create clinically feasible engineered tissues, particularly for skeletal muscle tissue regeneration. One is a novel fabrication approach for creating volumetric and biomimetic skeletal muscle constructs using 3D bioprinting technology. In vitro and in vivo results demonstrate the potential of the use of the 3D bioprinted skeletal muscle constructs with biomimetic features that can reconstruct volumetric large-scale muscle defects. The other is to establish novel platform technologies for in situ tissue regeneration. This project can provide an efficient and useful tool for regenerating functional organ in situ by utilizing body's own regeneration capacity.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	3D Biomaterial Systems for TERM
Position Need:	Undergraduate Summer Student Researcher

Advisor:

Sang Jin Lee, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-7288
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www.wfirm.org

Project Description:

Dr. Lee focuses on the design of 3D microenvironments for TERM applications (bone, cartilage, muscle, tendon, blood vessel, heart, and kidney), utility of 3D integrated organ printing (IOP) system for fabricating complex, composite tissues or organs, understanding of interactions between biomaterials and cell/tissue, and development of enabling technologies (e.g. bioreactor, bioimaging, etc.). He developed various biomaterial systems that improve cellular interactions by providing appropriate environmental cues. As an established investigator on NIH- and DOD-funded grants, he has successfully developed functional vascular scaffolds that are biocompatible, possess biomechanical properties that resist high degrees of pressurized flow over long-term, and provide a favorable environment to support the growth of vascular cells. As an example, one REU project focuses on smart biomaterials for TERM, which will introduce REU students to 3D biomaterial systems through learning about bioprinting numerous tissues or organs and how they are used for tissue regeneration following implantation. They will conduct experiments using cell cultures, biomaterial fabrication and characterizations, biochemical assays, and histology and immunohistochemistry tests.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: CRISPR/Cas9 genome editing

Position Need: Undergraduate Summer Student Researcher

Advisor:

Baisong Lu, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
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Project Description: We are working on developing novel delivery technologies for the CRISPR/Cas9 machinery. We use the novel delivery system to examine strategies to treat genetic diseases by CRISPR/Cas9 facilitated gene therapy. One disease we are working on is spinal muscular atrophy.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	Imaging in TERM
Position Need:	Undergraduate Summer Student Researcher

Advisor:

Frank Marini, PhD
Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
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Winston-Salem, NC 27157
Phone: (336) 713-1471
Email: fmarini@wakehealth.edu
www.wfirm.org

Project Description:

Dr. Marini investigates interactions between regenerating muscle tissue and participating progenitor populations. His group was first to demonstrate the tropism of MSCs, a tissue resident progenitor population for tumors, and inflammatory/wounding microenvironments. REU students could acquire data from pathological (tumors) normal, and regenerative tissues and learn to apply image analysis software to either deconvolte, spectrally umix and analyze images for quantitative data. A process workflow design ensures acquisition of very large and complex imaging (250 GB to 1 TB of data), from 3D macroscale to subcellular analysis of the cell-to-cell interactions. REU students will be integrated into projects spanning biomedical engineering, cellular and tumor biology, biophysics, optics, and computational analysis to develop novel imaging technologies to enable feasible, accurate, whole organ characterization of biological tissues at the single cell resolution. They can further develop optical tissue clearing technologies invented by the Marini group, engineer software to performing complex image analysis of biological tissues using numerical tools (e.g. MATLAB), 3D visualization suites (e.g. Imaris), and finite-element modeling software (e.g. COMSOL), and then use these tools to study whole tissue microenvironments. In addition, students will use established methods in multi-photon/confocal and multi-spectral imaging to acquire and generate a continuum of detailed, high-resolution macroscale maps of ECM/matrix components, parenchyma, and stromal elements. These projects contribute to better biological microscopy and new ways to evaluate mechanistic phenomena, and design new paradigms in TERM.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Controlled delivery of immunotherapeutic molecules for Type 1 Diabetes

Position Need: Undergraduate Summer Student Researcher

Advisor:

Emmanuel C. Opara, PhD
Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-1297
Email: eopara@wakehealth.edu
www.wfirm.org

Project Description: The goal of this project is to regenerate the destroyed insulin-producing pancreatic β-cell in autoimmune Type 1 diabetes (T1D). We are engineering mesenchymal stromal cells (MSC) to produce therapeutic levels of immunomodulatory molecules and subsequently encapsulating the MSC in immunoisolatory alginate-PLO-alginate microbeads for site-specific immobilization of the MSC and localized delivery of the molecules to achieve sustained efficacy after tissue implantation. We have recently developed a microfluidic approach for microencapsulation of the MSC in microbeads measuring <150 µM in diameter, which we have found to be safe for implantation in the parenchyma of the rat pancreas. We are performing *in vitro* experiments to study the secretory profile of specific therapeutic proteins from encapsulated MSC incubated in long-term cultures. We will also be studying the ability of the released proteins to suppress cytotoxic T-cells effects *in vitro* prior to *in vivo* experiments in valid rat models of autoimmune T1D.

Other Notes: This research effort is being performed at the Wake Forest Institute for Regenerative Medicine (WFIRM) and you will have the opportunity to work on a range of projects that focus on the applications of biomaterials and tissue engineering in diabetes and development of bioartificial organs.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Bioengineering a bioartificial pancreas

Position Need: Undergraduate Summer Student Researcher

Advisor:

Emmanuel C. Opara, PhD
Professor, Wake Forest Institute for Regenerative Medicine
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Project Description: The objective in this research is to design a bioengineered functional endocrine pancreas that is made with an encapsulation matrix that mimics the native microenvironment in which pancreatic islet cells are housed. The approach is to fabricate an alginate-based matrix whose stiffness resembles that of the native pancreatic scaffold and to embed in this matrix extracellular membrane (ECM) proteins that will provide all the biochemical and biological cues (collagen, laminin, fibronectin, integrins, and growth factors) that will support the encapsulated cells for long-term viability and function. This project involves both in vitro and in vivo experiments to test the viability of the engineered tissue.

Other Notes: This research effort is being performed at the Wake Forest Institute for Regenerative Medicine (WFIRM) and you will have the opportunity to work on a range of projects that focus on the applications of biomaterials and tissue engineering in diabetes and development of bioartificial organs.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Bioartificial Ovary for Cell-based Hormone Therapy

Position Need: Undergraduate Summer Student Researcher

Advisor:

Emmanuel C. Opara, PhD
Professor, Wake Forest Institute for Regenerative Medicine
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Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-1297
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Project Description: Although medications under the umbrella of hormone replacement therapy can compensate for the loss of ovarian hormone production, this treatment modality can result in higher-than-normal hormone levels and complications. My laboratory is working on a cell-based hormone therapy – essentially a bioartificial ovary to deliver sex hormones in a more natural manner than drugs. The project involves using donor ovarian cells that are "encapsulated" in the same fashion as the natural architecture of follicular cells with thin membranes that allow oxygen and nutrients to enter the tissue construct, but prevent immune factors that would cause the patient to reject the cells. In in vitro studies, we showed that the encapsulated cells secreted sex hormones, demonstrating for the first time that the hormone-producing units of ovaries can be engineered outside the body. In preliminary in vivo studies published recently, we have tested the encapsulated cells and shown high efficacy of the tissue constructs in the restoration of physiological levels of sex hormones as well as prevention of co-morbidities associated with ovarian failure.

Other Notes: This research effort is being performed at the Wake Forest Institute for Regenerative Medicine (WFIRM) and you will have the opportunity to work on a range of projects that focus on the applications of biomaterials and tissue engineering in diabetes and development of bioartificial organs.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Position Need: Undergraduate Summer Student Researcher

Advisor:

Chris Porada, PhD
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Winston-Salem, NC 27157
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Email: cporada@wakehealth.edu
www.wfirm.org

Research Focus Areas:

Dr. Porada's research focus is to develop safer and more efficient means of accomplishing gene transfer into clinically relevant cell types in vivo and achieving immunological tolerance to the therapeutic transgene. The ultimate goal is to use this knowledge to develop safe, effective treatments for monogenic diseases such as hemophilia which could be administered shortly after, or prior to, birth. In addition to his studies on direct *in vivo* gene delivery, Dr. Porada has spent over 10 years studying stem cell-based gene therapy, employing hematopoietic stem cells and mesenchymal stem cells as delivery vehicles for a variety of marker and therapeutic transgene cassettes. As such, he has a great deal of experience transducing bone marrow-derived stem cells with a variety of viral vectors, and with tracking/characterizing stem cell engraftment after transplantation. More recently, as a NASA investigator, he has been applying his knowledge of hematopoiesis and stem cell assay systems to define the effects of solar particle event and galactic cosmic ray radiation on the human hematopoietic system, with ultimate goal of defining the risk of leukemogenesis astronauts will face during long-duration missions in deep space.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Fertility Preservation in Klinefelter Syndrome Using Spermatogonia Stem Cell Technology

Position Need: Undergraduate Summer Student Researcher

Advisor:

Hooman Sadri-Ardekani, MD, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-7290
Email: hsadri@wakehealth.edu
www.wfirm.org

Project Description:

This project is a close collaboration of basic scientists and clinicians who have focused on Spermatogonia Stem Cell (SSCs) culture and Klinefelter syndrome (47XXY males) over past 10 years. Although half of Klinefelter patients have a chance to be a biological father a healthy child, new technology utilizing spermatogonia stem cells therapy can open new avenue for infertility treatment of KS patients. In Vitro and In Vivo study from mouse to human SSCs culture and transplantation can reveal many questions about germ cells depletion in KS patients. Establishment of 2D and 3D testicular cells culture in mouse and human provides new fundamental studies in stem cell biology of extra X chromosome.

The goal of the research is to step forward to clinical application of spermatogonia stem cell technology to preserve fertility in Klinefelter patients.

Other Notes:

The project involves various aspects of research, including characterization of in vitro propagated cells, 2D and 3D culture system, genetics and epigenetics evaluation, microchip construction, and optimization, and bio-sensing design and analyses.

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Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title(s):

1. Tracking Cell Metabolism using the Roche Cedex Bioanalyzer
2. Tracking Morphology, Viability, and Average Diameter of Human Primary Cells Supported in Varying Culture Media
3. Evaluation of the viability of human organoids systems supported in ReMDO Media

Position Need(s): Undergraduate Summer Student Researchers

Advisor:

Tom Shupe, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
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Winston-Salem, NC 27157
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Email: tshupe@wakehealth.edu
www.wfirm.org

Project Description:

1. This project would use an automated system to evaluate human primary cells, in vitro. The system provides both physical and metabolic characterization of cell cultures, and will be used to optimize cell culture media for the expansion of human primary cells intended for regenerative medicine therapies.
2. Determine in vitro stability of human primary cell phenotype through several passages under our recently developed universal human primary cell culture medium.
3. Determine the performance of our recently developed universal human primary cell culture medium for the support of advanced and integrated microphysiological systems (Body-on-a-Chip).

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2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location: Richard H. Dean Building
391 Technology Way
Winston-Salem, NC 27101

Project Title: Tumor Organoid/Tumor-on-a-Chip

Position Need: Undergraduate Summer Student Researcher

Advisor:

Aleksander Skardal, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
Medical Center Blvd.
Winston-Salem, NC 27157
Phone: (336) 713-1649
Email: askardal@wakehealth.edu
www.wfirm.org

Project Description and Funding:

The Tumor Organoid/Tumor-on-a-Chip project is an ongoing effort funded through a variety of sources, including NIH, focused on developing in vitro tumor models from patient tumor biospecimens and biopsies that are deployed in anti-cancer drug screening studies. The vision is that the empirical drug response data in organoids and tumor-on-a-chip systems could help inform treatment decisions for the patients from which the tumor tissue came from.

To date we have shown that we can create such models and perform drug screens in organoids derived from a variety of tumor types, including colorectal, lung, glioma/glioblastoma, melanoma, mesothelioma, appendiceal, myeloma, and sarcoma tumors. One very new effort in the lab is to immune-enhance these organoids using immune cells from the same patient to facilitate screening of immunotherapies.

Other Notes:

The project involves various aspects of research, including the design and creation of new biomaterials, cell characterization and culture, 3D bioprinting, 3D cell culture, microfluidic device fabrication, and in vitro drug efficacy assessment.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Project Title: Universal Bioink for Bioprinting and Biomanufacturing

Position Need: Undergraduate Summer Student Researcher

Advisor:

Aleksander Skardal, PhD
Assistant Professor, Wake Forest Institute for Regenerative Medicine
Wake Forest University
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Winston-Salem, NC 27157
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www.wfirm.org

Project Description:

The field of 3D bioprinting has grown significantly in the past decade. More and more laboratories are using 3D bioprinting in their research, and this technology holds immense promise for allowing realization of tissue engineered products for use in human patients. However, there is little standardization in the field and there has been little thought in terms of making it easier for tissue engineered products to pass through FDA regulation.

Our Universal Bioink program seeks to change that by developing well-defined hydrogel bioinks that 1) are user-friendly, 2) can be used across a wide variety of bioprinters, and 3) can support a wide variety of tissue types with minor customization by the end user. In the course of this DOD-funded program, we are working with more common extrusion bioprinters, but also developing bioinks for inkjet bioprinting and laser-induced forward transfer bioprinting. Our bioinks are comprised of naturally occurring polysaccharides and proteins that are components of the human extracellular matrix, thereby providing natural, tissue bioinspired microenvironments for cells to reside in.

Other Notes: The project involves various aspects of research, including the design and creation of new biomaterials, chemical syntheses, mechanical characterization of biomaterials, cell characterization and culture, 3D bioprinting, 3D cell culture, and a variety of tissue-specific assays.

Wake Forest School of Medicine
Institute for Regenerative Medicine

2019 Faculty Mentor Request Form for Summer Scholar Program in Multidisciplinary Tissue Engineering and Regenerative Medicine (MultiTERM)

Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101
Project Title:	Molecular and Cellular Biology of the Vascular System, Cells and Scaffolds for TE and Fabrication of Bioengineered Micro-Organs
Position Need:	Undergraduate Summer Student Researcher
Advisor:	Shay Soker, PhD Professor, Wake Forest Institute for Regenerative Medicine Wake Forest University Medical Center Blvd. Winston-Salem, NC 27157 Phone: (336) 713-7295 Email: ssoker@wakehealth.edu www.wfirm.org

Project Description:

Dr. Soker and his group have several interests: 1) Vascular biology and revascularization of bioengineered tissues and organs *in-vivo* and *ex-vivo*; 2) Identification of new sources of cells and scaffolds for TE; 3) Real-time imaging technologies and 4) Fabrication of bioengineered micro-organs. REU students working with Dr. Soker will learn research techniques relevant to these topics, be introduced to the current state of the art of the research and perform guided and independent research. For example, three potential projects include: (1) imaging of bioengineered blood vessels, using a live-cell fluorescent imaging technology to track cells seeded on a scaffold over time; (2) micro-tissue fabrication, a 3D organoid testing system to allow for the early and rapid evaluation of known and unknown drugs. As a major technological leap forward, this system will provide new tissue models and platforms for use in drug discovery and basic research, while supplying the means for the advancement in ex vivo organ systems and (3) mechanism to enhance the supply of pancreatic tissue for transplantation in diabetic patients wherein students will perform research to explore the use of extracellular matrix from decellularized human pancreata in combination with synthetic polymers as a platform technology for pancreatic tissue engineering. The goal is to bioengineer a functional endocrine pancreas from adult pancreatic islet cells and pancreatic extracellular matrix. Dissociated islet cells that become de-differentiated are reseeded on a pancreatic scaffold to enhance the development of functional endocrine pancreas.

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Program Dates: June 3, 2019 to August 9, 2019

Location:	Richard H. Dean Building 391 Technology Way Winston-Salem, NC 27101

Position Need: Undergraduate Summer Student Researcher

Advisor:

James J. Yoo, MD, PhD
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Winston-Salem, NC 27157
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www.wfirm.org

Research Focus Areas: Dr. Yoo's research efforts are directed toward the clinical translation of tissue engineering technologies and cell-based therapies by developing new therapeutic modalities for the functional repair and replacement of diseased tissues and organs. Dr. Yoo's background in cell biology and medicine has facilitated the transfer of numerous cell-based technologies from the bench-top to the bedside. He has been involved in the engineering of applicable tissues and organs, including blood vessels, heart valves, kidney, cartilage, bone, muscle, bladder and urethra for clinical translation. His extensive experience in cell culture, biomaterials design, surgical techniques and animal handling has contributed to achieving functional tissues and organs for successful pre-clinical and clinical studies.