FALL 2024

NEWS AND RESEARCH:
FERGUSON LABORATORY FOR ORTHOPAEDIC AND SPINE RESEARCH

Bethel Musculoskeletal Research Center (BMRC) Summer Student Research Program: *Inaugural Class 2024*

The Bethel Musculoskeletal Research Center (BMRC) launched its first-ever Summer Student Research Program (SSRP) in 2024, a competitive program designed to foster the next generation of musculoskeletal researchers. The program was created to provide undergraduate and medical students with immersive research experiences while developing the basic skill sets necessary for a successful career in biomedical research.

"One of the main missions of BMRC is to safeguard the next generation of researchers, giving them the same opportunities that more established researchers have," says Katie Morris, research communications specialist at the Bethel Musculoskeletal Research Center.

Leading many of the efforts of the program's development and coordination, including program curriculum are **Allison Bean, MD, PhD**, assistant professor physical medicine and rehabilitation, and **Laurie Dearolf, PhD**, operations manager of the BMRC.

Structure and Goals of the Program

The SSRP is a nine-week intensive program held on-site in Pittsburgh. It is open to students from any university in the U.S., with the only requirement being their ability to be present in the lab throughout the duration of the program. This inaugural year featured five students, primarily from the University of Pittsburgh, with one participant from the University of Miami.

The Ferguson Lab is the flagship of our department's research identity and longstanding commitment to high-impact orthopaedic and musculoskeletal research.

MaCalus V. Hogan, MD, MBA
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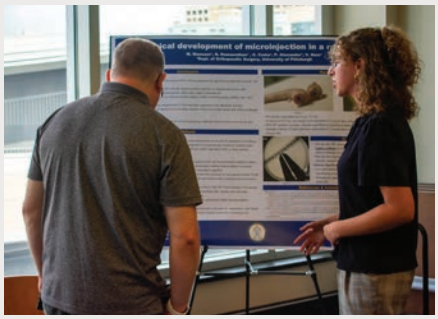
The focus of the program is not solely on conducting original research, but also on cultivating essential skills for a successful research career. The program features weekly seminars that teach students how to critically evaluate journal articles, present research findings, and communicate their work effectively to both academic and lay audiences. They also learn how to keep a lab notebook, read a scientific paper, and how to give a research presentation.



"The program is about conducting hands-on research, but also about teaching them how to be a researcher and function successfully in that challenging world — how to talk about their research, network, and prepare for future opportunities in graduate school or medical school," says Ms. Morris.

SSRP students are paired with a faculty mentor before the program begins, ensuring that their research interests align with the lab's ongoing work. While the preference is for students to identify a mentor and lab ahead of time, the BMRC also helps match accepted students based on their academic backgrounds and research interests. This hands-on experience allows students to participate in meaningful research projects while also learning the behind-the-scenes fundamentals of collaboration and presenting one's work.

Participants and Their Research

At the conclusion of the program, each participant presented a research poster summarizing their summer project. Below is a brief overview of the students and their respective research projects:

Marissa Mansour

Mentor: Nam Vo, PhD

Project: Technical Development of Microinjection in a Rat Tail Disc

Marissa's research focused on developing a reproducible technique for injecting small volumes of fluid into the rat tail disc nucleus pulposus without leakage. Her work has important implications for pre-clinical models studying intervertebral disc degeneration (IDD) and its treatment.

Joseph Garzia

Mentor: Hang Lin, PhD

Project: Use of Human Serum as a Method for Inducing Age-related Changes in Human Mesenchymal Stem Cell Derived Cells

Joseph explored how human serum from elderly donors affects the behavior of synovial-like fibroblasts and chondrocytes. His project aimed to better understand the relationship between aging and osteoarthritis progression.

Lorin Planinsic

Mentor: Kurt Weiss, MD

Project: Differences in AR and ALDH1A1 Expression and Drug Response in Primary and Metastatic Osteosarcoma

Lorin's research investigated the phenotypic differences between primary and metastatic osteosarcoma cells and their respective responses to drug treatments, focusing on androgen receptors and aldehyde .

Anneka Gernert

Mentor: Allison Bean, MD, PhD

Project: Optimizing Biologics for Tendon Regeneration: Effect of Extracellular Vesicle Origin

Anneka's work compared extracellular vesicles (EVs) derived from serum, plasma, and adipose stem cells to evaluate their potential for promoting tendon healing.

Matthew Bardos

Mentor: Peter Alexander, PhD

Project: Modulation of Ligamentum Flavum Hypertrophy by microRNA-29a In Vitro

Matthew focused on the role of miRNA-29a in modulating collagen and elastin production in ligamentum flavum cells. His findings may contribute to the development of non-surgical treatments for lumbar spinal stenosis.

Looking Ahead

The success of the inaugural SSRP has created the framework for future iterations of the program, with plans to expand in scope and possibly include outreach to high school students. The BMRC aims to continue supporting young researchers by providing them with opportunities to work directly with faculty mentors on cutting-edge orthopaedic and musculoskeletal research. The 2025 program is expected to open for applications in early spring, with interested students encouraged to visit the BMRC website or contact the program administrators for more information or to discuss the application process.

To learn more, visit bethel.pitt.edu/education.

Ferguson Lab Trainee Spotlight: *Rahul Ramanathan, MD*

Rahul Ramanathan, MD, clinical research fellow in the Ferguson Laboratory for Orthopaedic and Spine Research, is an orthopaedic surgery research track resident in the Department of Orthopaedic Surgery.

Dr. Ramanathan has a longstanding connection to the Ferguson Laboratory, dating back nearly a decade to his time as an undergraduate student at the University of Pittsburgh. While pursuing his undergraduate degree in bioengineering, Dr. Ramanathan was introduced to the lab by one of his mentors, sparking his interest in orthopaedic research and surgery as a career path.

"The Ferguson Lab was my first introduction to orthopaedics," says Dr. Ramanathan. "I started as a freshman in the lab, working on biomechanical studies with robotics and working on investigations of cervical spine kinematics happening in the lab. That experience really set the stage for my interest in orthopaedics."

During his time as an undergraduate, Dr. Ramanathan worked closely with several mentors, including Patrick Bosch, MD (former pediatric orthopaedic faculty) and orthopaedic spine specialist Joon Lee, MD, who helped to guide his work and who served as his first surgeon-mentor. His first major lab experience was with the Orthopaedic Robotics Lab (ORL), directed by Richard Debski, PhD, and. Volker Musahl, MD, where he collaborated on studies of knee biomechanics, a research area that fascinated him and ultimately led him to pursue a career at the intersection of engineering and medicine: orthopaedic surgery.

"Working with mentors like Dr. Sowa and Dr. Lee as an undergrad helped me gain hands-on experience in cadaveric and molecular studies, which deepened my interest in how things we investigate in the lab can have a real clinical impact for patients," says Dr. Ramanathan.

After completing his bioengineering degree at Pitt, Dr. Ramanathan attended the Carle Illinois College of Medicine, the world's first engineering-based medical school. He was part of only the second class to graduate from the innovative program, which provided a blend of medical education interwoven with engineering principles.

Now between his first and second years of residency in the Department of Orthopaedic Surgery, Dr. Ramanathan is particularly drawn to spine surgery, a discipline that combines his interests in both engineering and clinical practice.

"Seeing Dr. Lee's surgical expertise almost a decade ago for the first time was a transformative experience that profoundly impacted my career path. Witnessing patients regain their mobility and quality of life inspired me to dedicate my career to orthopaedic surgery. Now, with Dr. Lee leading the newly established Bethel Musculoskeletal Research Center (BMRC), I am thrilled to be part of a groundbreaking initiative that has the potential to revolutionize the future of musculoskeletal research."

Dr. Ramanathan's engineering background continues to play a role in his approach to orthopaedic surgery. He is particularly excited about the integration of artificial intelligence (AI) and machine learning into spine surgery.

"I want to be at the forefront of AI integration in surgery," he says. "We're already seeing AI used in preoperative planning and surgical assistance, but I envision a future where AI and surgeons work together more seamlessly."

His current research projects in the Ferguson Lab focus on understanding the origins of chronic lower back pain. He is part of a team working to develop a small animal model to investigate ligamentum flavum hypertrophy (LFH), a key contributor to spinal stenosis. This work, led by Nam Vo, PhD; Gwendolyn Sowa, MD, PhD; Peter Alexander, MD; and Joon Lee, MD, is part of a broader effort to better understand the causes of lower back pain.

"We're surgically inducing instability in the spines of our models to study how LFH develops and leads to nerve impingement," says Dr. Ramanathan. "Our goal is to eventually test therapeutics that could potentially reduce or prevent LFH, offering patients a nonsurgical solution to back pain."

Outside of his research, Dr. Ramanathan emphasizes the importance of patient-centered care, particularly in selecting the right patients for surgery. He sees AI as a tool that could help surgeons make more accurate predictions about surgical outcomes.

"One of the challenges in spine surgery is that it's not always clear which patients will benefit from surgery. AI can help us sift through complex data and identify the patients who are most likely to have successful outcomes based on their characteristics – a truly personalized approach to practicing medicine," says Dr. Ramanathan.

"I've had the honor of working in the Ferguson Lab for a long time with many incredibly skilled researchers and mentors, and I'm grateful for the support and invaluable training I've received here," says Dr. Ramanathan. "Pittsburgh has always felt like home, and UPMC felt like the ideal place for me to continue growing as both a clinician and a researcher."

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ABOUT THE FERGUSON LABORATORY FOR ORTHOPAEDIC AND SPINE RESEARCH

The Ferguson Laboratory for Orthopaedic and Spine Research at the University of Pittsburgh studies the complex developmental mechanisms, etiologies, and basic biology behind intervertebral disc degeneration (IDD), and it works to develop biological, biomechanical, and cell-based therapies for IDD. Another major endeavor of the Ferguson research program is studying the deep phenotype of chronic low back pain through collection and processing of large patient datasets. Leading the laboratory's multidisciplinary research efforts are co-directors Joon Y. Lee, MD, FAOA; Gwendolyn A. Sowa, MD, PhD; and Nam V. Vo, PhD.

The Ferguson Laboratory explores distinct but complementary research areas to dissect and clarify the physiological processes that lead to disc degeneration. Dr. Vo leads the lab's efforts studying the contribution of aging on IDD and loss of disc extracellular matrix (ECM) proteoglycans, with a special focus on cellular senescence and autophagy in regulating aggrecan homeostasis. Dr. Sowa oversees investigations involving the mechanisms of mechanical strain on disc cell metabolism, with an emphasis on how mechanical strain-induced inflammation controls ECM collagen expression and breakdown. As a practicing orthopaedic surgeon, Dr. Lee explores minimally invasive treatment of trauma and conditions in the spine.

The lab is named in honor of Albert B. Ferguson Jr., who held the Silver Chair of Orthopaedic Surgery at the University of Pittsburgh from 1953 until his retirement in 1986. Dr. Ferguson was a visionary force behind the evolution and growth of the clinical, research, and training programs of the University of Pittsburgh Department of Orthopaedic Surgery into the internationally respected program of excellence it is today.

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