

2023

The First-Year Innovation & Research Experience

FIRE

Annual Review



FIRE: THE FIRST-YEAR INNOVATION & RESEARCH EXPERIENCE

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MISSION

FIRE provides first-year UMD students with an inclusive, faculty-mentored research experience that drives accelerated career readiness and opportunity.

VISION:

FIRE forever changes professional trajectory.

VALUES:

CAREER READINESS

Fearless research drives fearless career readiness: FIRE students develop communication, critical thinking, equity and inclusion, leadership, professionalism, and teamwork traits that employers are seeking.

RESEARCH EXPERIENCE

FIRE students use authentic, discipline specific tools to address the challenges of our time. Outcomes are uncertain in a manner that allows students to thrive through challenges.

OPPORTUNITY

The research experience and career readiness FIRE provides help students have experience and qualifications to pursue internships and at-graduation opportunities with confidence.

SUPPORTING OTHERS

Students experience a professional culture where they internalize the value of helping and supporting others while they grow as individuals.

FIRE SEMESTER 1

FIRE Semester 1 (FIRE120)

Students develop initial capacities in selecting and evaluating literature, critical thinking and problem-solving, collaboration with teams, communication, and professional management of research projects.

FIRE SEMESTER 2

FIRE Semester 2 (FIRE198)

Students start at square-zero training, deep immersion, and research mentorship within the research stream chosen by the student. Students will come to understand the research mission and group components of their stream.

FIRE SUMMER OPPORTUNITIES

FIRE Summer Opportunities

The mid-point of the FIRE sequence is the summer between a student's first and second year. FIRE students can apply during their first year to be a part of the Office of Undergraduate Research's Summer Research Internship Program.

FIRE SEMESTER 3

FIRE Semester 3 (FIRE298)

Students transition from trainee to experienced practitioner during FIRE Semester 3. Students drive their research projects to completion and communicate the results to a broad audience and potentially national conferences.

FIRE LEADERSHIP OPPORTUNITIES

FIRE Leadership Opportunities

FIRE-participating students who complete all three semesters of the FIRE experience are eligible to continue with FIRE as a Peer Research Mentor and on the Student Leadership Council.

OVERVIEW & HIGHLIGHTS

UNDERGRADUATE RESEARCH DAY

105 FIRE Students presented at **Undergraduate Research Day** representing 12 FIRE streams.



MORE ON PAGE 6

FIRE STUDENT AWARDED 2023 NSF GRADUATE RESEARCH FELLOWSHIP



FIRE Alumni **Harrison Lee** was awarded the **National Science Foundation Graduate Research Fellowship** in April, 2023. His research proposal was based on research he worked on in his FIRE stream **Host-Pathogen Interactions** and in a research lab at the Institute for Bioscience and Biotechnology Research. This fellowship will help support his graduate studies in Biochemistry at Texas A&M University, which he began in Fall 2023.

NEW PODCAST FROM VISUALIZING SOCIAL JUSTICE

During the summer semester, **Visualizing Social Justice** Summer Research Interns produced seven episodes of a podcast featured in **Maryland Today**.

With Love & Struggle explores the 1970's radical, feminist news journal "off our backs." Episodes are available wherever you get your podcasts!



FIRE ALUMNI AWARDED GILMAN SCHOLARSHIP

FIRE alumna **Jennifer Tabet** spent two months as a research assistant at Tokyo Medical University after being awarded a **Gilman Scholarship**.



FIRE ALUMNI MOVED TO GERMANY TO CONTINUE NOVEL BACTERIA RESEARCH

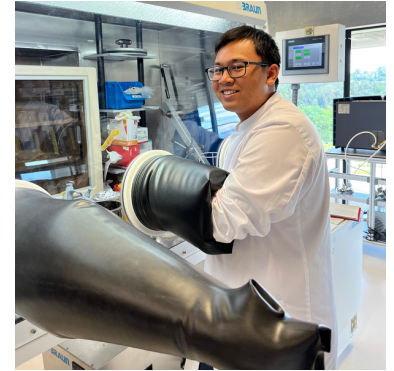


Photo courtesy of CMNS and Garmani Thein

FIRE alumni and Peer Research Mentor of the **Molecular Diagnostics** stream **Garmani Thein** helped to discover two novel species of bacteria while working in the Angenent research lab at the University of Tübingen in Germany during the summer of 2022. After graduating in May 2023, Thein returned to the Angenent Lab as a lab technician to help characterize and classify the species of bacteria.

THE FIRE SUMMIT

FIRE Semester 3 students and Peer Research Mentors spent the evening sharing their research with the campus at the **2023 FIRE Summit**.



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QUANTUM MACHINE LEARNING POSTER SESSION

QML Semester 3 students and Peer Research Mentors presented research posters highlighting the research projects they developed across the spring and fall semesters to peers, colleagues, and industry professionals in the Physical Sciences Complex in late December.



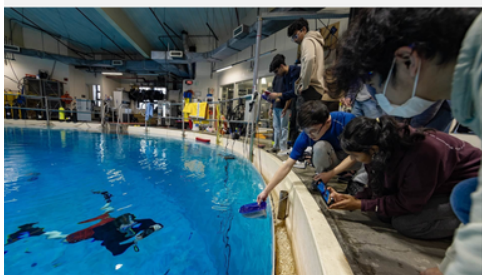
BIOINSPIRED ROBOTICS TESTING FEATURED IN MARYLAND TODAY

In December, **BioInspired Robotics** students had the opportunity to test robots they designed and built during the fall semester at UMD's neutral buoyancy tank. Featured in **Maryland Today**, students experienced the successes and failures of research, learning to "fail forward."

MarylandToday

Produced by the Office of Marketing and Communications

FRIDAY, DECEMBER 08, 2023



CAMPUS & COMMUNITY

Floating With Disaster

Undergraduate Research in Robotics Teaches Students to Fail Forward

FIRE NEXT STEPS PAGE UPDATE

NEXT STEPS

FIRE prepares you to take fearless next steps after you complete our experience.

What happens after I complete FIRE?

FIRE students are strongly positioned to transition to next steps in their professional development after completing the FIRE 3 semester experience. In addition to the technical skills you have gained, FIRE students are career ready.

Use these resources as a guide for thinking about your next step.

During the Fall 2023 semester, the **FIRE Next Steps** webpage was redesigned to provide FIRE Semester 3 students and FIRE alumni with more comprehensive guidance on considering steps to take after completing FIRE. This guidance includes reflective prompts, guidance on finding research and internship opportunities, and suggestions for staying connected to the FIRE community. The updated page also offers samples of resumes, CVs, and cover letters from FIRE alumni where they describe their FIRE experience. In addition, several FIRE alumni who made notable next steps post-FIRE are featured on the page to provide students with near-peer examples of the various opportunities available at UMD and beyond after completing FIRE.

FIRE HOSTED 135 STUDENTS DURING SUMMER RESEARCH INTERNSHIP



The Summer Research Internship engaged 135 FIRE and non-FIRE UMD students during summer 2023.

THE OFFICE OF UNDERGRADUATE RESEARCH LAUNCHES



In November 2023, **The Office of Undergraduate Research (OUR)** was officially announced to the UMD campus and community. OUR, led by Director Patrick/Patricia Killion, aims to broaden the campus culture and community around undergraduate research and scholarly activities.

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OUR & FIRE AWARDED TLTC TEACHING & LEARNING GRANT

In December 2023, OUR and FIRE received a **TLTC Teaching and Learning Grant** to fund their proposal "Multidisciplinary Open Educational Resource Supporting Undergraduate Student Readiness and Success in Research Engagements." FIRE faculty Carinna Ferguson, Catherine Spirito, and Jaclyn Bruner will work alongside Director Killion throughout 2024 to develop and design an open educational resource. The resource will be piloted in FIRE Semester 1 courses during Fall 2024 and will be available to the UMD community in late August 2024.

FIRE ALUMNI TESTIMONIALS

During Fall 2023, an alumni survey was deployed to gather up-to-date testimonials, resources, and source materials from FIRE alumni. This survey informed the redevelopment of the FIRE Next Steps webpage and the FIRE Students page on FIRE's website. Several alumni testimonials are featured here, highlighting FIRE's long-term impact on students across career readiness, research, academic, and interpersonal domains. See the full FIRE Students page at fire.umd.edu/students.



“ FIRE gave me the confidence to believe that I was capable of doing research at a rigorous level. It gave me the basics of research that I now apply to my everyday research in grad school.

BRIANA MERCADO



“ FIRE gave me foundation for everything I knew at UMD. It solidified my love for medicine and wanting to become a physician. It opened doors to more experiences and opportunities that have led me to where I am today.

SOPHIA VU



“ The most impactful aspect of FIRE was the close-knit environment I got to work in. Everyone knew each other and we were all working toward the same goal of learning as much as we could about a topic we knew nothing about initially.

SHASANK PATEL



“ The leadership and teaching skills that I gained through serving as a FIRE Peer Research Mentor helped me secure a post-graduation opportunity as a Fulbright grant recipient in South Korea.

ILANA HEROLD



“ FIRE taught me many valuable skills like managing and using my time wisely, thinking outside of the box, not being afraid to ask questions, and working with people who did not have the same skillset as me.

ROSHNI KAINTHAN



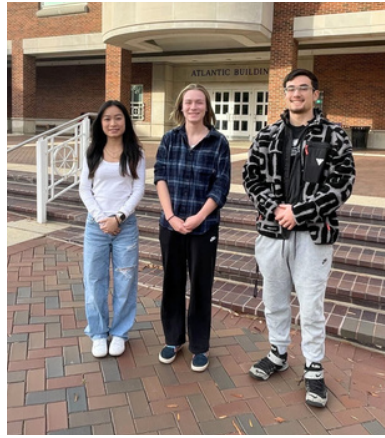
“ A major aspect of FIRE was the improvement of my communication skills; from our annotated bibliography to the FIRE Summit, our abilities to summarize science and communicate effectively were constantly tested.

MATTHEW ADJODHA

PEER RESEARCH MENTORS

Peer Research Mentors serve a critical role in FIRE streams, working to assist faculty with research, mentor FIRE Semester 2 and 3 students, and conduct more advanced research in their respective streams. In addition, Peer Research Mentors serve as senior student researchers and leaders in their streams.

In spring 2023, 132 Peer Research Mentors assisted faculty in their research streams, while 83 Peer Research Mentors served during fall 2023. During the Fall 2023 semester, the FIRE Peer Research Mentorship Committee led the Spring 2024 Peer Research Mentoring Application Cycle. One hundred sixty-five students completed applications to serve as Peer Research Mentors and 157 students accepted positions as Peer Research Mentors in one of the 16 FIRE streams.



STUDENT LEADERSHIP COUNCIL

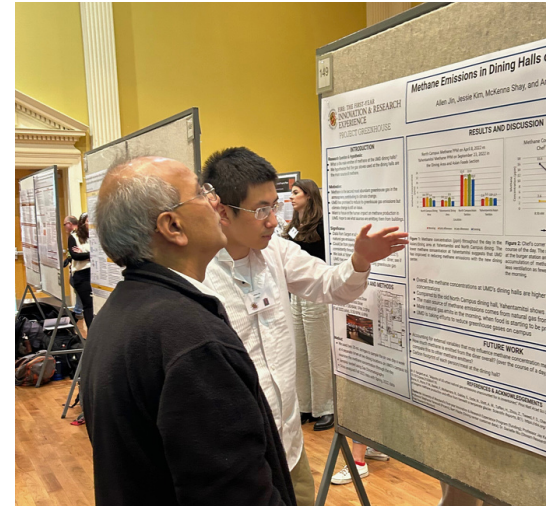
The Student Leadership Council serves an important role for FIRE. This year, 25 students served as members of the Student Leadership Council in the Spring and Fall 2023 semesters. Students provided critical feedback to FIRE leadership on issues of student support, FIRE students next steps, social media usage, and stream organization.

UNDERGRADUATE RESEARCH DAY

APRIL 27, 2023
STAMP GRAND BALLROOM

Undergraduate Research Day provides undergraduate students from the University of Maryland the opportunity to share their research with the campus community. This event showcased student research, scholarship, and creative inquiry in the form of posters, performances, and presentations.

A select number of FIRE students from each stream shared their research at Undergraduate Research Day, with 105 FIRE students from 12 streams presenting research posters.



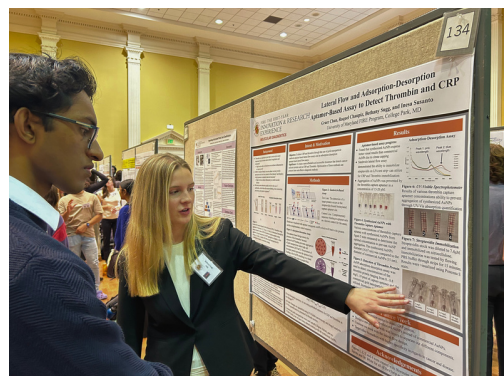
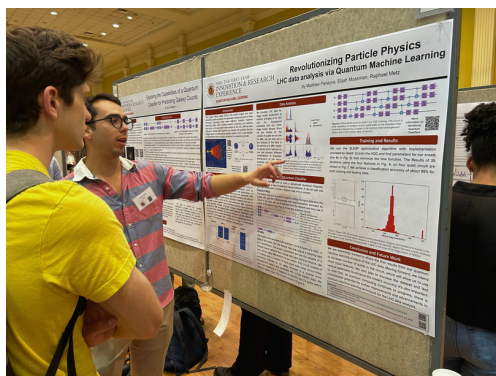
FIRE AT UNDERGRADUATE RESEARCH DAY

105

FIRE students presented at Undergraduate Research Day

12

FIRE streams represented



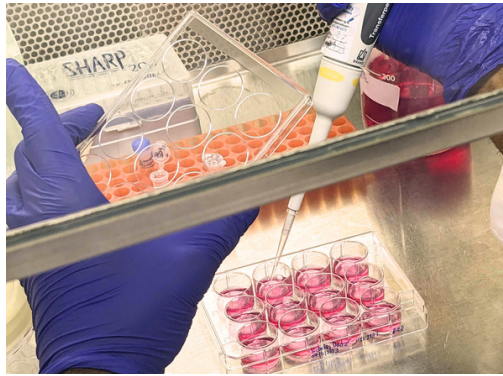
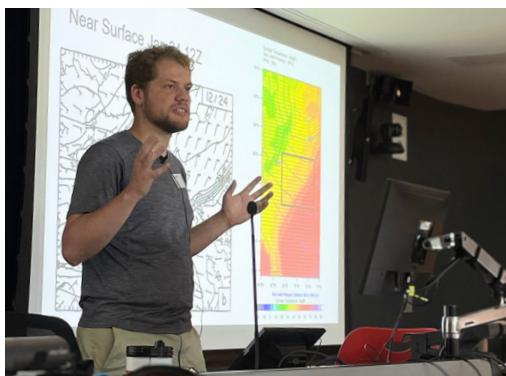
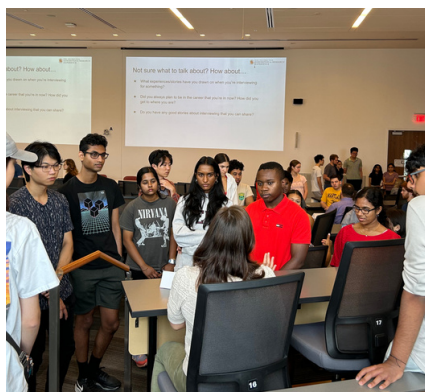
Providing students the opportunity to present “completes the research cycle and builds key communication skills.”

SUMMER RESEARCH INTERNSHIP

The **Summer Research Internship** presents a unique opportunity for students and faculty to dedicate eight weeks during the summer to research. FIRE and non-FIRE students may engage in the Summer Research Internship. Students work closely with FIRE faculty, attend professional development workshops, present their research at the end of the summer, and earn 3 credits of FIRE 199 - FIRE Research Internship.

During spring 2023, FIRE invited 140 students to participate. 73 FIRE or FIRE alumni and 67 non-FIRE students made up the Summer 2023 Cohort.

During the summer, students attended several workshops led by FIRE faculty members with the summer workshop theme of “Mapping Your Journey with FIRE: Ideas, Resources, and Opportunities.” Workshops covered topics like “The Perfect Pitch” and “The Idea Workshop,” in which students developed research communication and ideation skills. Additional workshops hosted guests from a range of professions during seminars “On the Path,” “Gathering Resources,” and “Preparing for the Interview.” Students finished their summer by presenting their research at the Summer Research Internship Symposium. Student research teams delivered oral presentations on their research to peers and FIRE faculty members.



THE FIRST ANNUAL

FIRE FALL WELCOME



The first annual **FIRE Fall Welcome** event was held for FIRE Semester 1 students in the STAMP Grand Ballroom on August 28, 2023. The event served as an **official welcome to FIRE** and the **FIRE community**.

454 FIRE Semester 1 students, Peer Research Mentors, the Student Leadership Council, faculty, and staff participated in icebreaker activities hosted by Playfair, and students received their FIRE t-shirts. A highlight of the night was the Rock-Paper-Scissors tournament, with the champion receiving a FIRE prize bag and an Amazon Fire HD 10 Tablet. The icebreaker activities were followed by an ice cream social with ice cream from the Maryland Dairy.



THE FIRE SUMMIT

The FIRE Summit provides FIRE Semester 3 students and Peer Research Mentors the opportunity to present their research to the broader university community. The Summit also provides FIRE Semester 1 students the opportunity to learn about research occurring in each FIRE stream and meet FIRE Faculty.

This year, the Summit was held on November 1, 2023, in the Stamp Grand Ballroom. FIRE Students presented their research on mini-posters and computers. In addition, students from several streams brought 3D-printed representations to provide hands-on models of their research. Students from the Fertility Science stream brought a microscope for visitors to use for an up-close look at their research.

In addition to students presenting their research from each of the 16 FIRE streams, new FIRE faculty members presented the new streams launching in 2024.



NATURAL SCIENCE



Dr. Cherisse Hall
Assistant Clinical Professor
Bacterial Pathogenesis



Dr. Quira Zeidan
Assistant Clinical Professor
CellEx



Dr. Halli Weiner
Assistant Clinical Professor
Fertility Science



Dr. Jessica O'Hara
Assistant Clinical Professor
Host-Pathogen Interactions



Dr. Catherine Spirito
Associate Clinical Professor
Molecular Diagnostics



Dr. Danielle Niu
Assistant Clinical Professor
Project Greenhouse

TECH & APPLIED SCIENCE



Dr. Thanica Ruangmas
Assistant Clinical Professor
Sustainability Analytics



Dr. Sara Strey
Assistant Clinical Professor
Climate Computing



Dr. Robert Young
Assistant Clinical Professor
Genome Computing



Dr. Shabnam Jabeen
Associate Clinical Professor
Quantum Machine Learning



Dr. Lena Johnson
Assistant Clinical Professor
BioInspired Robotics



Dr. Randall Kania
Assistant Clinical Professor
Design Engineering

SOCIAL SCIENCE & HUMANITIES



Dr. Jaclyn Bruner
Assistant Clinical Professor
Visualizing Social Justice



Dr. Benjamin Huffman
Assistant Clinical Professor
Global Development & Design



Dr. Patrick McGurrin
Assistant Clinical Professor
Addiction Science



Dr. Marissa Hartwig
Assistant Clinical Professor
Human Learning, Memory & Cognition

LEADERSHIP



Dr. Patrick/Patricia Killion
FIRE Director
OUR Director



Dr. Carol Vieira
Assistant Program Director



Tameka Jones
Assistant Program Director



Dr. Catherine Spirito
Associate Clinical Professor
Assistant Director



Dr. Carinna Ferguson
Assistant Clinical Professor
Assistant Director

FIRE STREAMS

FIRE streams consist of around 40 FIRE students, a Full Time Faculty Leader, and Peer Research Mentors.

Streams share similarities and differences in discipline and methods used to produce research outcomes. As such, each FIRE stream is organized into one of three clusters: **Natural Science**, **Social Science & Humanities**, or **Tech & Applied Science**. Streams in each cluster use related research tools and methodologies.

In January 2023, four new streams launched: **Climate Computing**, **Design Engineering**, **Genome Computing**, and **Visualizing Social Justice**. In addition, in August 2023 FIRE welcomed **BioInspired Robotics** as a stream.

Each year, a small number of streams end as new FIRE streams launch. This process allow FIRE to provide continually renewed streams and maintain research relevant to the challenges of our times. As such, four streams ended in 2023, and four new streams launched in January 2024.

FIRE Stream	Faculty Leader	FIRE Cluster
Addiction Science (Ending in 2023)	Dr. Patrick McGurrin	Social Science & Humanities
Bacterial Pathogenesis	Dr. Cherisse Hall	Natural Science
BioInspired Robotics	Dr. Lena Johnson	Tech & Applied Science
CellEx	Dr. Quira Zeidan	Natural Science
Climate Computing	Dr. Sara Strey	Tech & Applied Science
Design Engineering (Ending in 2023)	Dr. Randall Kania	Tech & Applied Science
Fertility Science	Dr. Halli Weiner	Natural Science
Genome Computing (Ending in 2023)	Dr. Robert Young	Tech & Applied Science
Global Development & Design	Dr. Ben Huffman	Social Science & Humanities
Host-Pathogen Interactions	Dr. Jessica O'Hara	Natural Science
Human Learning, Memory, & Cognition (Ending in 2023)	Dr. Marissa Hartwig	Tech & Applied Science
Molecular Diagnostics	Dr. Catherine Spirito	Natural Science
Project Greenhouse	Dr. Danielle Niu	Natural Science
Quantum Machine Learning	Dr. Shabnam Jabeen	Tech & Applied Science
Sustainability Analytics	Dr. Thanicha Ruangmas	Tech & Applied Science
Visualizing Social Justice	Dr. Jaclyn Bruner	Social Science & Humanities

FIRE STREAMS LAUNCHED IN 2024

In Fall 2023, “**Humanities**” was added to the **Social Science & Humanities** cluster as FIRE works to expand its reach to additional disciplines and provide opportunities for FIRE students to engage in humanities research.

This change came at an opportune moment, as FIRE welcomed an additional humanities-based stream, **Music & Social Identity**, in 2024. In addition, January 2024 saw the launch of two additional Tech & Applied Science streams, **Computing & Society** and **Rapid Diagnostics** as well as one additional Natural Science stream, **Gene Silencing**.

FIRE Stream	Faculty Leader	FIRE Cluster
Computing & Society	Dr. Kristina Kramarczuk	Tech & Applied Science
Gene Silencing	Dr. Mary Chey	Natural Science
Music & Social Identity	Dr. Elizabeth Massey	Social Science & Humanities
Rapid Diagnostics	Dr. Shannon Hilton	Tech & Applied Science



KEYWORDS

qualitative analysis, data analysis, programming, social science



Dr. Kristina Kramarczuk
CS Faculty Leader



KEYWORDS

transgenerational effects, gene silencing, molecular biology, genetics, computational modeling, programming



Dr. Mary Chey
GS Faculty Leader

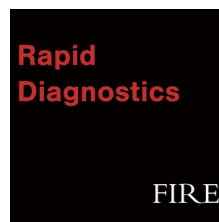


KEYWORDS

music history, social power structures, digital humanities, archival research, social justice



Dr. Elizabeth Massey
MSI Faculty Leader



KEYWORDS

bioengineering, biotechnology, diagnostics, fabrication, analytical chemistry



Dr. Shannon Hilton
RD Faculty Leader

ADDICTION SCIENCE

Why do people use drugs and alcohol despite the risks? Why do some people develop problems with drugs and alcohol while others do not? How might socio-cultural factors impact problematic substance use? Do treatments for problematic substance use really work?

The **Addiction Science (AS)** stream, led by **Dr. Patrick McGurrin**, addresses questions like these using many approaches ranging from basic studies of neurobehavioral and psychological processes that underlie addictive behavior to research on the treatment of addictive behavior and psychological conditions that often co-occur. Moreover, a primary focus of the stream is the unique vulnerabilities and health disparities experienced by racial/ethnic minorities and lower socioeconomic status communities. Based in the Clinical and Cognitive Neuroscience Laboratory, students gain exposure to the full range of



Dr. Pat McGurrin
AS Faculty Leader

approaches to discovery in addiction science.

In 2023, Addiction Science students worked in the Clinical and Cognitive Neuroscience laboratory, where they had the opportunity to participate in hands-on training related to electroencephalography human research studies. Students also gained skills in communicating with mock human participants as well as learned how to run experimental procedures. In addition, students learned data management techniques consistent with standards set for human subjects research.

Students in AS also developed data analysis skills and analyzed two datasets. Students ran descriptive statistics and correlations and wrote their results in a short paper format. Students used this paper to develop research posters and presented at URD. During fall 2023 finalized their work and explored their next steps post-FIRE.



Addiction
Science

FIRE

KEYWORDS

psychology,
neuroscience,
health disparities,
human-subjects
research, data
analysis

BACTERIAL PATHOGENESIS

Organized within the Natural Science Cluster, the FIRE **Bacterial Pathogenesis (BP)** stream led by **Dr. Cherisse Hall** is interested in understanding how the bacterial opportunistic pathogen *Pseudomonas aeruginosa* causes a specific type of hospital-acquired infections (HAIs) called catheter-associated urinary tract infections, or CAUTIs, in humans.

HAIs can complicate healthcare, are linked with high morbidity and mortality, and increase financial burden on the U.S. healthcare system. Patients most often get HAIs when receiving healthcare for another condition, and can get an HAI in any healthcare facility, including hospitals, surgical centers, and long-term care facilities. In 2009, there were an estimated 1.7 million reported HAIs with estimated direct medical costs of \$28 to \$45 billion. BP focuses on beginning to solve some of these healthcare issues in their lab.

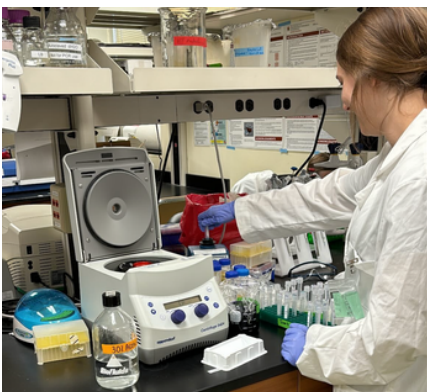
Students in BP work to identify genes in *P. aeruginosa* that are important for the bacteria to cause CAUTI. Students utilize a range of research methods to address this issue. BP students utilize the scientific method to read and understand scholarly literature and learn to use general microbiology aseptic techniques like streaking bacterial cultures for isolation, starting bacterial cultures, and micro pipetting. In addition, students learn to use molecular cloning tools such as PCR and CRISPR-based gene silencing.

Bacterial Pathogenesis

FIRE

KEYWORDS

microbiology,
molecular biology,
bacteriology,
biochemistry,
cellular biology



Dr. Cherisse Hall
BP Faculty Leader

BIOINSPIRED ROBOTICS

Launching in August 2023, the **BioInspired Robotics (BR)** stream is a new stream to FIRE led by **Dr. Lena Johnson**. BioInspired Robotics recognizes that the natural world is full of living creatures that possess incredible adaptations suited to their environment. As such, bioinspired robotic systems are robots, materials, sensors, and coding structures informed by the natural advantages of natural forms. Bioinspired robots are suited to a natural environment and have the potential to advance robot-assisted exploration, environmental monitoring, and protection.

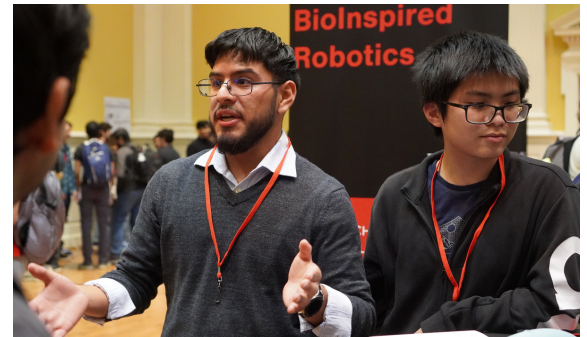
In BR, students learn how to combine biological research and robotic fabrication techniques, informing robotic design by analyzing biomechanisms using engineering methods. Robotic projects developed by BR students are tailored to a field-specific application and are

BioInspired
Robotics

FIRE

KEYWORDS

robotics,
biomechanics,
programming,
electronics



Dr. Lena Johnson
BR Faculty Leader

expected to produce a result capable of operating in non-laboratory environments.

Students in BR develop skills in biological research, bioform, and biomechanical characterization and analysis. They also develop skills in robotic fabrication, electric circuit development, and sensor integration and utilize design and programming tools like CAD.

During 2023, BR students developed bio-inspired models. Students combined the fundamentals of biology and biomechanics to develop background knowledge, informing the development of four bioinspired field robots. Students engaged in end-to-end production of their robotic platform from concept to development to testing. BR's model testing day at UMD's neutral buoyancy tank in December 2023 was featured in Maryland Today.

CELLEX

Mutations in ribosomal proteins cause rare genetic diseases and promote cancer development, especially leukemia. Bone marrow failure, congenital disabilities, and severe immune alterations characterize rare ribosomal disorders. Most ribosomal diseases have no known cure and are often fatal. Developing biomedical approaches targeting ribosomal protein activity could benefit patients with rare congenital diseases and cancer.

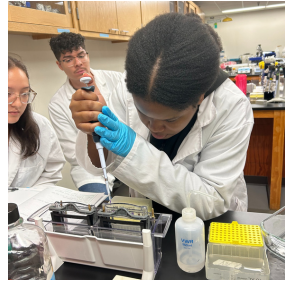
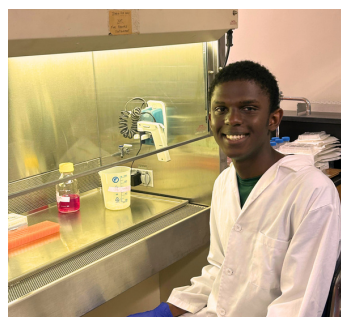
The research in **CellEx (CX)**, led by **Dr. Quira Zeidan**, analyzes the ribosome assembly landscape, identifying steps susceptible to their therapeutic interventions and providing insights into potential disease treatments. Specifically, CX investigates the chemical modifications and molecular interactions each ribosomal protein encounters during its transport inside the cell before being incorporated into a ribosome.

CellEx

FIRE

KEYWORDS

molecular biology,
cellular biology,
biochemistry,
microscopy



Students in CX learn to dissect the ribosomal protein transport roadmap using cell biology, biochemistry, and molecular biology techniques. CX's experimental strategy includes *in vitro* and *in vivo* approaches to follow the dynamics of individual ribosomal proteins as they integrate into molecular assemblies. Students also learn to apply the scientific method and communication skills.

In 2023, students in CX worked on projects ranging from constructing recombinant DNA molecules to producing proteins in cell-free systems. CX Semester 1 and Semester 2 students collaborated to successfully clone 15 human ribosomal proteins from the small subunit into bacterial expression vectors with 100% sequence accuracy. Students used the resulting recombinant plasmids to optimize conditions for protein expression in bacteria with high solubility in enough quantities. These proteins will be isolated and purified from complex mixtures and used for biochemical and structural *in vitro* analyses. In addition to lab work, several CX students presented their research at Undergraduate Research Day.



Dr. Quira Zeidan
CX Faculty Leader

CLIMATE COMPUTING

Weather and climate impact nearly every aspect of society, including transportation, food supply, renewable energy tourism, infrastructure standards, natural resource availability, and national security.

The **Climate Computing (CC)** stream, led by **Dr. Sara Strey**, launched in January 2023. The stream focuses on weather, climate, and climate system modeling, exploring the interactions between the ocean, atmosphere, and cryosphere systems in a changing climate. Students in CC gather and analyze input data and use state-of-the-art climate system models and supercomputing clusters to answer questions about how our climate system works and will work as anthropogenic climate change evolves.

Supported by the National Centers for Atmospheric Research (NCAR) and the Computational and Information Systems Lab (CISL), CC used the Cheyenne Supercomputer to conduct topical earth systems modeling research.

In CC, students learn basic principles of earth systems and atmospheric science. They explore climate change, polar climate, and earth systems interactions. Students learn to employ weather and climate system models to investigate research questions and use a Linux environment navigation and programming for pre and post-processing of data and model output. CC students develop experience with computing and analysis applicable to a broad range of disciplines and develop valuable skills in the ever-growing field of data science.

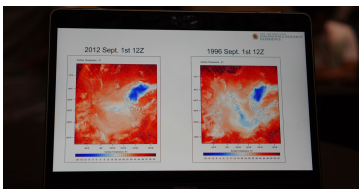
During 2023, students successfully ran simulations using The Weather Research and Forecast Model and the Community Earth System Model. Students worked in groups to investigate climate-related research questions, including investigating how increased sea surface temperatures may have increased the strength of a storm like Superstorm Sandy, the sea ice albedo feedback phenomenon, and the impacts of mass deforestation on local climate change.

Climate
Computing

FIRE

KEYWORDS

climate system
modeling,
programming, data
analysis, high-
performance computing



Dr. Sara Strey
CC Faculty Leader

DESIGN ENGINEERING

Often when a new part or product is designed, precise operating conditions are assumed. The real world, however, is messy, random, and chaotic: manufacturing equipment has errors, human operators err, and the weather is never quite how we predict.

Design is present in many different fields, particularly engineering, but the concept of making something better to solve a problem is ubiquitous. In the same way, there is uncertainty in everything we do. Sometimes it can be ignored, and sometimes it can be avoided in a generalized way (e.g. making parts “twice as strong as they need to be”). As we push for greater performance (faster planes, more fuel-efficient cars, lower waste products), uncertainties must be more carefully identified, studied, and incorporated into the design process, minimizing the impact.

Design Engineering (DE), launched in 2023 and led by **Dr. Randall Kania**, explored techniques that combine analytical and numerical design methodologies with prototyping and experimentation. Students learned how to parametrize a design, optimize, prototype, and manufacture while examining how uncertainty and randomness appear.

In DE, students developed a range of research skills. These included proficiency in technological environments such as Python and Matlab. These also included skills in physical methods like 3D printing, laser cutting, and manufacturing.

During the Spring 2023 semester, students in DE were introduced to rapid prototyping techniques emphasizing iterative design improvement. Students worked in teams to complete the “biggest challenge,” in which students learned design engineering principles. Students also designed a capsule required to meet specific objectives while being limited to a specific budget and materials. In addition, students learned about relevant algorithms via literature. During Fall 2023, DE students worked on teams on independent research projects and developed research communication skills. DE teams created written reports and presented their projects at the FIRE Summit at the end of the semester.

Design
Engineering

FIRE

KEYWORDS

design
optimization,
prototype
construction,
programming,
modeling &
simulation



Dr. Randall Kania
DE Faculty Leader

FERTILITY SCIENCE

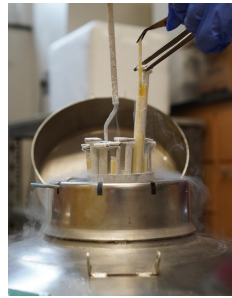
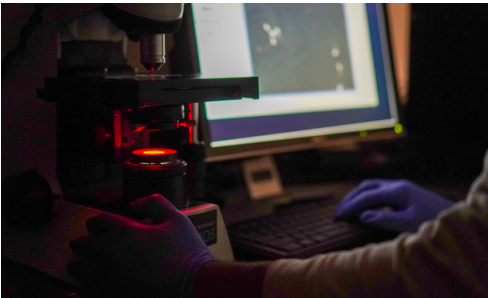
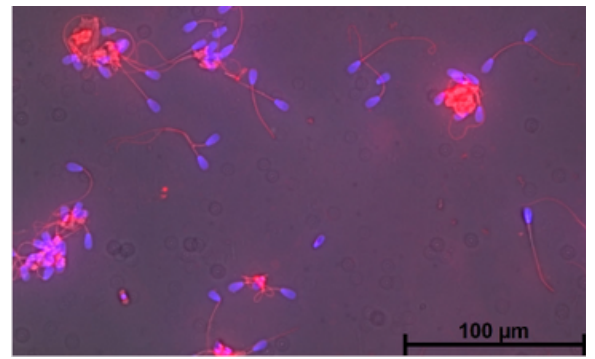
The **Fertility Science (FS)** stream, led by **Dr. Halli Weiner**, investigates how cellular processes contribute to fertility challenges. When endangered wildlife is brought into captivity, reproductive efforts are centered around the successful production of offspring. In livestock species, techniques like *in vitro* fertilization and embryo culture are common and possible because of the knowledge gained from extensive husbandry practices. In wildlife species that would benefit from these procedures, we still do not know enough about their reproductive biology to implement them successfully. Instead, assisted reproduction relies on the cryopreservation of sperm cells and artificial insemination, but more *in vitro* techniques could be possible with a greater understanding of the internal workings of gametic cells.

Fertility
Science

FIRE

KEYWORDS

cellular biology,
biochemistry,
microscopy,
reproduction,
conservation biology



The FS stream aims to better understand how culture conditions affect sperm function and metabolism. The purpose of this objective is to inform scientists and fertility specialists who may be using outdated protocols due to a lack of basic knowledge about how sperm quality is affected by metabolism. Our goal is to use this information to improve reproductive efforts for threatened and endangered wildlife species.



Dr. Halli Weiner
FS Faculty Leader

During 2023, FS worked to achieve immunofluorescence in fixed sperm cells for more than just a DNA stain. After testing and revising a protocol several times over the summer, Dr. Weiner and her students successfully stained sperm with both Hoechst (DNA-specific stain) and primary/secondary antibody stains to identify the location of progesterone receptors in bovine sperm. In addition, FS developed a protocol to quantify cellular ATP using a Promega plate reader. FS students worked closely with Dr. Weiner to test and refine this protocol during the Summer and Fall semesters.

GLOBAL DEVELOPMENT & DESIGN

The **Global Development & Design (GDD)** stream, led by **Dr. Benjamin Huffman**, explores what ethical development around the world really means. This stream focuses on understanding values-based differences between “good” and “bad” development and the technological and design tools that can help program designers do their jobs better. Overall, the goal of GDD is to create an interactive, open-access, online toolkit that activists and professionals can use to design social impact projects, where each stage of the design process will be infused with the imperatives of ethical, inclusive development.

With the creation of GDD’s toolkit, the stream aims to address several needs in the field of development ethics and make the tool free to anyone anywhere students in this stream have worked throughout 2023 to develop this toolkit with the guidance of Dr. Huffman.

Global
Development
& Design

FIRE

KEYWORDS

sustainable
development,
design thinking,
web development,
public policy,
qualitative analysis



Students in GDD work in teams clustered by theme, learning and employing different skills through different aspects of the project. These include coding, web design, app development, principles of international development, and best practices in social impact programming; development ethics, moral philosophy, and human rights; and human-centered design and lean start-up.

In 2023, GDD students helped to complete the second iteration of the “Development Ethics Toolkit” and produced seven research articles used to inform “lessons learned” in the Toolkit. Six of the students’ seven articles are being considered for publication. In addition, GDD Summer Research Internship students provided consultancy to the Philippine Government’s Department of Information and Communication Technology and conducted interviews with government officials from all levels of government across multiple sectors.



Dr. Benjamin Huffman
GDD Faculty Leader

GENOME COMPUTING

DNA is an essential molecule in the cells of living organisms and relies on both its encoded base sequence and overall structure for a multitude of uses ranging from organization to expression. Research conducted in **Genome Computing (GC)**, led by **Dr. Robert Young**, focused on creating 3D computational models of DNA from data stored in online databases like the Protein Data Bank. In GC, students create DNA models inspired by research conducted in national labs, exploring interactions used in metabolism and architecture or exploring the presence of circular DNA found in cancer cells.

Students in GC determine and understand the relationship between the sequence and structure of nucleic acids and proteins, explore the interactions between proteins and nucleic acids and the consequences of said interactions, and utilize experimental data in online databases to construct, optimize, and analyze structures.



Dr. Robert Young
GC Faculty Leader

GC bridges the gap between computational modeling and design. Students in GC engage in a range of projects, including comparing protein structures found in the Protein Data Bank, analyzing models differing by DNA sequence, and even creating their own DNA models. Overall, students develop a comprehensive understanding of how to work in a computational environment.

GC students develop familiarity with programming languages like Python and C++, learn how to execute code, utilize supercomputers, and generate figures.

During 2023, students in GC worked on tasks related to structural studies of DNA circles and DNA loops as well as the study of DNA sequence-structure relationships. Students worked to develop a database on microDNA sequences and rotation of the lac Repressor protein headpieces. Students develop analysis and visualization skills utilizing various packages in Python.

Genome
Computing

FIRE

KEYWORDS

programming,
genomics,
bioinformatics,
data analysis,
modeling &
simulation

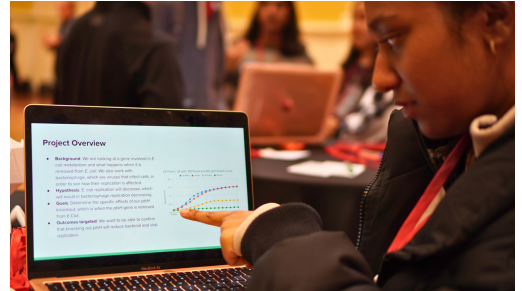
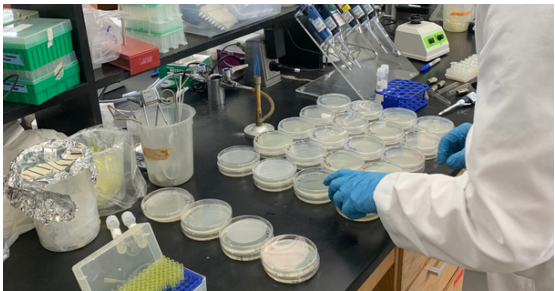


HOST-PATHOGEN INTERACTIONS

Intracellular pathogens need to manipulate the host cell environment in order to maximize conditions favorable to drive their own replication. This often includes hijacking host cell metabolic pathways to scavenge essential resources. High-throughput techniques like those employed in metabolomics are just beginning to allow this complex interplay to be investigated, leading to the identification of new therapeutic targets.

The **Host-Pathogen Interactions (HPI)** stream, led by **Dr. Jessica O'Hara**, is focused on better understanding the cellular changes induced during viral infection using the well-established model organisms of *Escherichia coli* and bacteriophage. Students investigate critical host-pathogen interactions to better understand the mechanisms employed by both the pathogen and the host to ensure their survival.

HPI students learn basic techniques required to work in a standard microbiology lab, including sterile transfer and aseptic culture techniques,

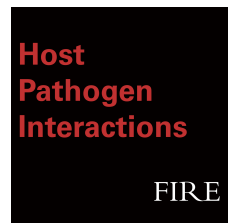


preparation of culture media and plates, spectrophotometry, bacteriophage preparation, plating, and quantification. The independent research projects undertaken in this stream involve the genetic manipulation of both the *E. coli* host cell and different types of bacteriophage, metabolite profiling during infection, and measuring the dynamics of bacterial and viral replication under different conditions.

In 2023, HPI students worked in teams on eight independent projects led by FIRE Semester 2 students and Peer Research Mentors. In addition, Peer Research Mentors worked to develop a one-step growth protocol for phage replication, which may be used in future FIRE Semester 2 trainings and Semester 3 research projects. Additionally, students developed posters and shared their research at Undergraduate Research Day.



Dr. Jessica O'Hara
HPI Faculty Leader



KEYWORDS
microbiology,
virology,
biochemistry,
molecular
biology, genetics

HUMAN LEARNING, MEMORY & COGNITION

Because learning, memory, and cognition affect so many parts of our lives, research in this field can have far-reaching effects – for individuals, organizations, and society as a whole – potentially shaping improvements in schooling, workplace training, marketing, public health initiatives, and any other area that involves communicating information to be learned and remembered.

Students in **Human Learning, Memory, & Cognition (HLMC)** led by **Dr. Marissa Hartwig**, answer questions like, “How can we make learning more effective and engaging?”, “How can we support memory for important information?”, and “Do people have misunderstandings about how to learn and remember?”

Students work with human participants to identify effective learning techniques, improve those techniques, and explore how to translate them into the real world. To accomplish this work, a mix of quantitative research methods

drawn from the psychological sciences are used. Our research questions and findings are relevant and applicable in many different fields as human learning, memory, and cognitive processes are fundamental to most human endeavors.

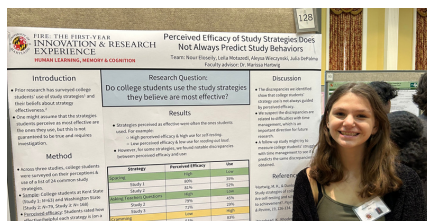
Students in HLMC learn a range of research skills: experimental and survey research design; proficiency with Qualtrics for programming and data collection; participant recruitment and research protocols; human research procedures consistent with Institutional Review Board guidance; data management, quantitative analysis using the Statistical Package for the Social Sciences; and interpretation and communication of results.



KEYWORDS
psychology, data analysis, human-subjects research, knowledge acquisition



Dr. Marissa Hartwig
HLMC Faculty Leader

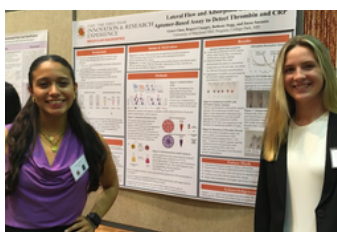
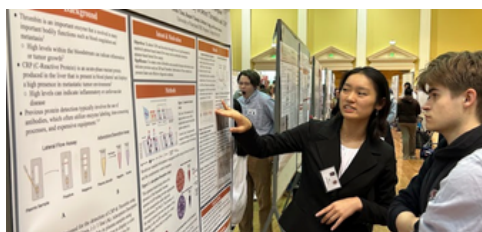


MOLECULAR DIAGNOSTICS

Molecular Diagnostics (MD), led by **Dr. Catherine Spirito**, uses synthetic biology approaches to tackle human and environmental health issues. Synthetic biology is an interdisciplinary field at the interface between biology and engineering. In MD, students design and test biosensors - synthetic DNA or RNA molecules that can detect a target (e.g., bacteria, bacterial signaling molecules, or human disease biomarkers) and emit a detectable signal (e.g., color change or a fluorescent signal). In addition, in vitro selection is used to select for short DNA or RNA sequences (aptamers) that can bind strongly and specifically to target proteins or small molecules. These aptamers can then be used to detect targets in future biosensor designs.

Students in MD learn molecular biology techniques such as PCR, gel electrophoresis, nucleic acid purification and quantification, in vitro transcription, and reverse transcription. Students also learn about biosensor design and develop proposals for their own biosensor design. In the spring, students form small groups and work on research projects related to either aptamer selections or biosensor design and testing. These projects continue throughout the summer and fall and culminate in a final poster presentation.

During spring 2023, MD students completed several comprehensive trainings to learn lab techniques, including lab organization and management, PCR and gel electrophoresis, and DNA cleanup and quantification. Students also worked with Peer Research Mentors to develop a



project relevant to MD's focus and were trained on research skills specific to their projects. MD Peer Research Mentors also led several of their own projects which they shared at Undergraduate Research Day in April 2023.

During fall 2023, MD students worked in small groups to develop research projects under the supervision of Peer Research Mentors. These included projects such as the Mucin Aptamer Selection Project funded by the UMD Grand Challenges Grant, Litigation LAMP Assays to Detect mRNA Biomarkers of Cancer, and Cell-Free Biosensors. As students developed their projects, they also completed weekly reflections, developed a research plan, completed project organization checklists, developed a research poster, and presented their research at the FIRE Summit.



Dr. Catherine Spirito
MD Faculty Leader

**Molecular
Diagnostics**

FIRE

KEYWORDS

molecular biology,
biotechnology,
biochemistry,
microbiology,
genetics

PROJECT GREENHOUSE

Climate change is a crisis multiplier that exacerbates conflict and inequity by stressing food production and water availability, threatening public health, damaging infrastructure, and displacing communities. Methane is sourced from fossil fuels, landfills, agriculture, plants, wastewater, and microbial activity in streams and wetlands. It is also the second most significant driver of greenhouse warming and has a short enough lifetime to be a primary target for mitigation.

The **Project Greenhouse (PG)** stream, led by **Dr. Danielle Niu**, focuses its research on methane outputs of the University of Maryland campus and surrounding regions to generate actionable information about its sources and sinks of methane.

PG students develop a methane budget. Students' collection and analysis of methane combine field, laboratory, and modeling approaches and address diverse research questions. Students use their

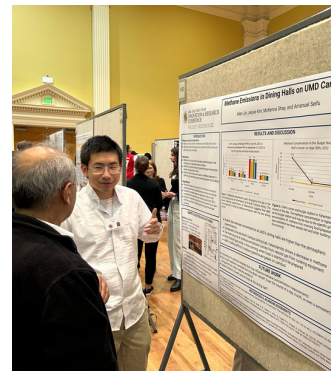
analyses to develop a methane source map that guides effective climate policy.

During 2023, students in PG constructed methane sensors for gathering methane data from a greater geographical area, began work constructing a flux chamber for methane studies, extracted and purified methane from air for clumped isotope analysis, and used a Panorama mass spectrometer to measure clumped isotopes. Students developed skills in field-based observation, gas chromatography, Picarro isotope analysis, gas sample collection, the construction of methane sensors using Arduino boards, and statistics. In December 2023, Dr. Niu gave a conference talk on data gathered in her stream in 2022 and 2023 at the American Geophysical Union's annual conference.



KEYWORDS

biogeochemistry, chromatography, spectrometry, modeling & simulation, data analysis



Dr. Danielle Niu
PG Faculty Leader

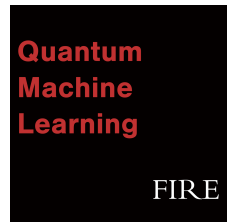


QUANTUM MACHINE LEARNING

Quantum computing represents the future of computing technology. Understanding its principles and potential applications equips students with the knowledge and skills needed to be at the forefront of technological advancements.

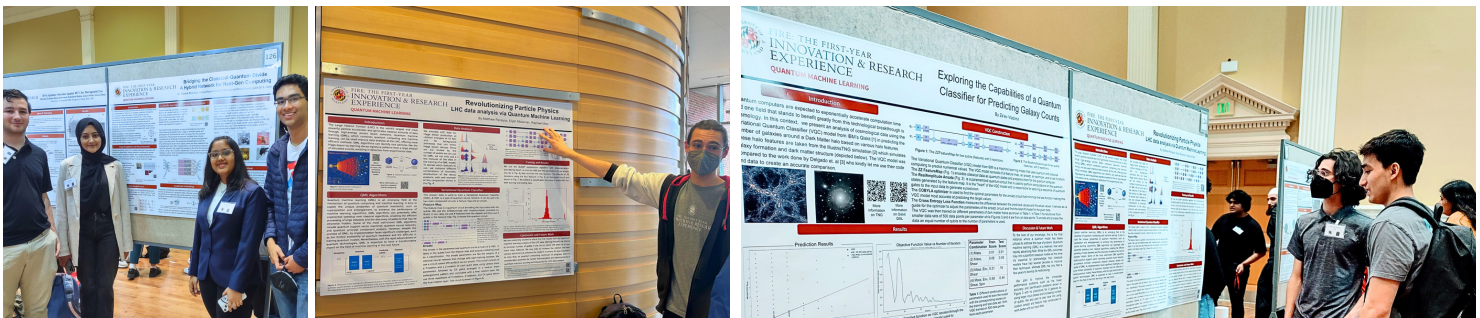
Quantum Machine Learning (QML), led by **Dr. Shabnam Jabeen**, introduces students to the intersection of quantum computing and machine learning. In 2023, the stream began collaborating with the Quantum National Laboratory and one of the world's leading quantum computing hardware and software companies, IonQ. These partnerships allowed students to use real quantum computers.

In QML, students are provided hands-on exploration, both at the software and hardware levels, of one of today's most intriguing and rapidly evolving



KEYWORDS

climate system modeling, programming, data analysis, high-performance computing



fields of science. Students develop a foundational understanding of fundamental concepts in quantum computing and machine learning, including superposition, entanglement, quantum gates, quantum algorithms, quantum parallelism, quantum decoherence, quantum supremacy, principles of artificial intelligence, deep learning, and classification/ regression problems. In addition, students develop independent projects based on quantum computing software or data analysis.

During 2023, students in QML engaged in a range of projects leveraging the UMD campus's quantum computer as well as the quantum computers at IonQ. Students shared their work at the end of the year at a QML Poster session in the Physical Sciences Center.



Dr. Shabnam Jabeen
QML Faculty Leader

SUSTAINABILITY ANALYTICS

The degradation of the environment stands as one of humanity's most pressing challenges. Policies and actions can yield both intended and unintended consequences. By analyzing the effects of previous environmental events and regulations, more valuable insight may be provided to guide policymakers.

Advancements in computing and increased data accessibility have empowered researchers to establish connections between environmental factors and social outcomes. In **Sustainability Analytics (SA)**, led by **Dr. Thanicha Ruangmas**, students employ techniques from economics, data science, and geography to comprehensively examine the socioeconomic impacts stemming from climate change and environmental regulations.

In SA, students use R programming to perform tasks such as querying large datasets, cleaning and integrating environmental and

socioeconomic data, creating data visualizations in the form of graphs and maps, and utilizing econometrics and machine learning techniques to estimate causal relationships.

In addition, students in SA engage in interdisciplinary teamwork, develop data literacy skills, and develop competencies in spatial and statistical analyses and causal inference.

In 2023, SA students worked on several projects, including studying the impact of light rails on air pollution, the impact of cobalt mining on human conflicts in the Democratic Republic of Congo, the impact of battery recycling plants on air pollution, the impacts of plastic bans on water quality in the Chesapeake Bay, the impact of air pollution on crime in Baltimore City, the correlation between corporate reports and their GHG emissions, and marginal damages of driving electric cars when compared to gasoline cars.

Sustainability
Analytics

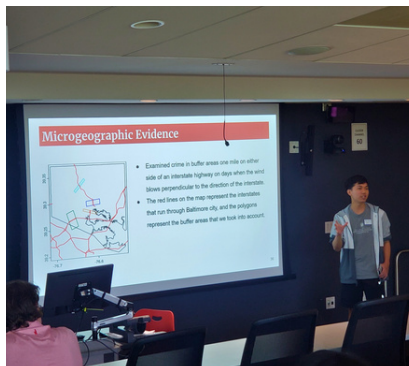
FIRE

KEYWORDS

data analysis,
programming,
environmental
science, public
policy, economics



Dr. Thanicha Ruangmas
SA Faculty Leader



VISUALIZING SOCIAL JUSTICE

What are the missing pieces of our world: the stories that are lost, obscured, or forgotten? When we uncover information about the past (or present), what do we do with it? Our knowledge of injustices and systemic inequalities influences our present, and consequently, our future.

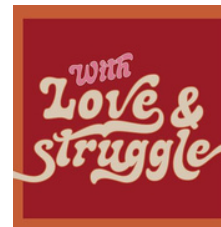
In **Visualizing Social Justice (VSJ)**, students address questions about social justice and public memory by engaging in research that draws from a variety of sources, from archival research to metadata. Guided by **Dr. Jaclyn Bruner**, students interrogate the construction of public memory, engage in research about social justice issues, and collect and tell stories via texts and data.

Students in VSJ develop skills in digital and hands-on archival research methods; gathering, organizing, and managing data and metadata, including creating databases where none yet exists; communicating findings to a public-facing audience; project management; executing data visualization in Tableau/PowerBI; employing strategies for public-facing communication and press interactions; creative problem solving; podcasting.

In 2023, students worked on various social justice-centered projects derived from student interest.



These projects resulted in a set of public-facing research products including the publication of the first volume of an episodic podcast, “With Love & Struggle,” contributions to the public memory project (re)collections.org, and contributions to Wikipedia. Students also began to develop plans for two additional podcasts, assisted in gathering information for filing future FOIA requests and began learning Python and related digital humanities tools.



Dr. Jaclyn Bruner
VSJ Faculty Leader

Visualizing
Social
Justice

FIRE

KEYWORDS

data visualization,
communication,
archival research,
social justice



OFFICE OF UNDERGRADUATE RESEARCH

Launching in November 2023, The Office of Undergraduate Research (OUR) was established to serve UMD students, faculty, and staff across colleges and schools. OUR aims to strengthen and expand research opportunities by advancing equitable and inclusive access for students from all backgrounds and levels of experience. The office will also work to broaden the culture and community around undergraduate research and scholarly activities on UMD’s campus.

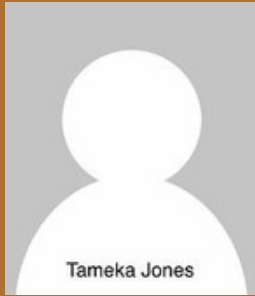
OUR is led by Director Patrick/Patricia Killion, who remains the Director of FIRE. Moving forward, FIRE will be organized within the Office of Undergraduate Research as a foundational program the office maintains and supports. In addition to Director Killion, the office is supported by four staff members: Tameka Jones, Jennifer Lieb, Carol Vieira, and Carinna Ferguson.

OUR is located on the second floor of the Atlantic Building. Members of the OUR staff are available weekly for office hours and are available to students, faculty, staff, and UMD programs to discuss opportunities to support or expand undergraduate research at UMD.

OUR TEAM



Dr. Patrick/Patricia Killion
OUR Director
FIRE Director



Tameka Jones
Assistant Program Director of Business Operations



Dr. Jennifer Lieb
Assistant Program Director of Programs, Services & Academic Operations



Dr. Carol Vieira
Assistant Program Director of FIRE Program Academic Operations



Dr. Carinna Ferguson
Assistant Clinical Professor Assistant Director

MISSION The Office of Undergraduate Research (OUR) empowers students and faculty to equitably and inclusively engage and succeed in inquiry, creative activity, and scholarship.

VISION OUR will empower UMD to enhance its standing as a world-class, preeminent institution of higher education through the transformational impact of student research experiences.

CULTURE & COMMUNITY Broaden culture, presence, and community around undergraduate research and scholarly activities across OUR campus.

EQUITABLE OPPORTUNITY Ensure equitable and inclusive access to undergraduate research opportunities for OUR faculty and students of all backgrounds and levels of experience.

RECOGNITION & CREDIT Supporting opportunities for OUR students to earn degree-advancing academic credit and emerging forms of novel credentialing.

STUDENT SERVICES



- Introduction to Research
- Exploring Research Opportunities at UMD and Beyond
- Opportunities to Share Your Research
- Guidance on Finding and Contacting Faculty Mentors
- Weekly Office Hours to Discuss Research Opportunities

CAMPUS PARTNER SERVICES



- Events, Consultations, & Collaborations
- Research Opportunities Database
- Council on Undergraduate Research Institutional Membership
- Campus Partners Mailing List





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