2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
1	Aditi Bhattamishra	Design and Characterization of a Hydraulic Soft Kinesthetic Haptic Force Feedback for Teleoperated Robotic Manipulation	EREE: Early Research Experience in E-Term	Robotics Engineering	Cagdas Onal
2	Kayah Jadczak, Vaansh Mansharamani	Self Healing Wireless Networks: Implementing Agentic AI for Autonomous Link Recovery Using SIONNA	EREE: Early Research Experience in E-Term	Electrical & Computer Engineering	Christo K. Thomas
3	Lilith Thompson	Investigating Ecosystem Supports of the New England Medicinal Leech	Charles O. Thompson Fellowship	Environmental & Sustainability Studies	Elisabeth Stoddard
4	Ilia Yashchenko	Regulatory development for Industrial testing of Stented Bioprosthetic valves	EREE: Early Research Experience in E-Term	Biomedical Engineering	Ivan Nepomnyashchikh, Zhenglun Alan Wei
5	Nathaniel Johnston	Performance Simulation of a Novel Hybrid Multi-Rotor Drone	EREE: Early Research Experience in E-Term	Aerospace Engineering	Jielong Cai
6	Stephen He	Improving an Existing Automated Circuit Designer and Code Generator (ADArC)	EREE: Early Research Experience in E-Term	Computer Science	Pradeep Radhakrishnan, David Brown
7	Mahitha Bodicherla, Fevin Doshi, Priya Hungund	EdTech Sector Analysis – Entrepreneurial & Market Trends	EREE: Early Research Experience in E-Term	Data Science	Sandhya Balasubramanian

2026 WPI Summer Research Showcase Table of Contents

2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
15	Hudson Markin, Uma Mandapati, Daniel Baranov	ToMVerse of Madness: Benchmarking and Explaining Theory of Mind Reasoning in LLMs	REU: Applied Artificial Intelligence for Advanced Applications	Data Science	Raha Moraffah
16	Ojal Prasad, Corey Verkouteren, Deeya Rawat, Dennis Hofmann, Lei Ma	Can Multi Agent System Reasoning Errors Be Identified By Cheap Detectors?	REU: Applied Artificial Intelligence for Advanced Applications	Data Science, Artificial Intelligence	Elke Rundensteiner
17	Aman Siddiqi, Niara Marwah	Auditing Fairness of Healthcare Vision-Language Models with Test Time Debiasing	REU: Data Science Research for Healthy Communities in the Digital Age	Data Science	Walter Gerych
18	Skhaina Florian	RNA Expression Analysis: Unlocking Pathogenesis of M. abscessus through Colony Morphology	Research in Shell Lab	Bioinformatics & Computational Biology	Scarlet Shell
19	Carys Evans, Dominic Radcliffe-Hines, Ruben Bonilla-Santiago, Alexander J.B. Reading, Brian S. Hercyk	Cofilin controls the sorting of tropomyosin to distinct actin networks	LaPre Fellowship	Biology & Biotechnology	Shane G. McInally
20	Isaac Huynh	Synthesis and Characterization of an Aminobenzodifuranone: A Solvatochromic Dye	LaPre Fellowship	Chemistry & Biochemistry	Christopher R. Lambert, Anita E. Mattson
21	Ryan Cohen	Exploration of Polyester Dendrimer Capping of MOF-5	LaPre Fellowship	Chemistry & Biochemistry	Shawn Burdette, Ronald L. Grimm

2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
22	Victoria Pan	Developing ML Models for Predicting HIV Drug Resistance	Manning/Lesser Fellowship	Bioinformatics & Computational Biology, Data Science	Xiangnan Kong
23	Jill Cavener	Deciphering splicing mutations in human disease: An integrative, literature-derived mechanism dataset	Manning/Lesser Fellowship	Bioinformatics & Computational Biology	Dmitry Korkin
24	Grace Chagnon	Causal Effects of Mindfulness On Chronic Low Back Pain	Neuroscience Fellowship	Data Science	Charlotte Fowler
25	Shuling Lin	Knockout of indiscriminate terminal-nucleotidyl transferase, GLDR-2, compromises male fertility in C. elegans	STAR Fellowship: Summer Training in Arts & Sciences Research	Biology & Biotechnology	Karl-Frédéric Vieux
26	Vanya Malik, Shruti Shastry, Racheal Asaolu	Machines Learn the Worm: Classifying C. elegans from Swimming Behavior	Spencer Fellowship	Biology & Biotechnology	Jagan Srinivasan
27	Alexander Teymurazyan, Evan Johnson, Mattan Mohel, Collin Shuff, Thomas Peters, Ronald Premo, Tianqi Jin, Geoffrey Tompsett, Kristie Koski	Zero-Valent Transition-Metal Intercalation Alters the Optical Properties in Two-Dimensional SnS_2	STAR Fellowship: Summer Training in Arts & Sciences Research	Chemistry & Biochemistry, Chemical Engineering	Lyubov V. Titova, Ronald L. Grimm
28	Brandon Proteau	Variable Projection for Neural Network-based Parameter Estimation	STAR Fellowship: Summer Training in Arts & Sciences Research	Computer Science	Andrea Arnold

2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
29	Natalie Hannoush	Investigating Binary Black Hole Mergers via Gravitational Waves	STAR Fellowship: Summer Training in Arts & Sciences Research	Physics	Padmanabhan K. Aravind, Rudra P. Kafle
30	Christopher Wittekind	f-block Metal Sequestration Through Surface Tethered Schiff Base Ligands	STAR Fellowship: Summer Training in Arts & Sciences Research	Chemistry	Ronald L. Grimm
31	Ágata Romero, Abigail J. Sullivan, Paige Turcotte,	The Effects of Shared Awe Experiences on Neural Synchrony and Mental Health Stigma Reduction	STAR Fellowship: Summer Training in Arts & Sciences Research	Psychological Sciences	Richard Lopez
32	Samuel Harris	Signal Activation by Caveolae Viral Entry	STAR Fellowship: Summer Training in Arts & Sciences Research	Chemistry & Biochemistry	Suzanne Scarlata
33	Remy Kaplinsky	An Experimental Technique for Measuring Flow Rate in Branching Microchannels	STAR Fellowship: Summer Training in Arts & Sciences Research	Applied Physics	Francesca Bernardi
34	Lana Acevedo	A Study on Blind and Low Vision (BLV) Gamer Experiences and Preferences	STAR Fellowship: Summer Training in Arts & Sciences Research	Interactive Media & Game Development	Rodney Duplessis
35	Brayden Little, Caleb Warzocha	Benchmarking and Generalizing the Bounce Allocator	STAR Fellowship: Summer Training in Arts & Sciences Research	Computer Science	Robert Walls

2026 WPI Summer Research Showcase Table of Contents

2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
43	Meghana Kesavan, Jarin Maisha, Ankita Paul, Zephyr Paxton, Antonia Pelteku, Rachael Speckhard, Ivan Baginskiy, Serhii Dukhnovsky, Veronika Zahorodna, Oleksiy Gogotsi	Influence of MXene to Silk Ratio on Near IR (800 nm) Laser Exposure: Photothermal Properties and Drug Release	REU: Functional Materials	Biomedical Engineering	Kateryna Friedman Kushnir, Lyubov V. Titova, Jeannine M. Coburn
44	Jarek Michalak, Gary DeVilbiss	Highly Stretchable Sensor Arrays for Soft Robotics	REU: Functional Materials	Mechanical & Materials Engineering	Pratap Rao
45	Eleni M. Papadopoulos, Timothy E. Lopes	Tetra(benzyl)Zn-cyclen converts CO_2 to Bicarbonate faster than Zn-Cyclen	REU: Functional Materials	Chemistry & Biochemistry	Ronald L. Grimm
46	Eleni M. Papadopoulos, Alireza Nikbakht, Daniel Pinto	The Effects of N-acetylglucosamine: Glucose Ratio on the Production and Properties of Bacterial Cellulose	REU: Integrated Bioengineering Research	Biomedical Engineering	Jeannine M. Coburn
47	Daniel Zlatanov, Jarin Maisha	Ultrafast dynamics of Anthracycline binding and release with Chondroitin Sulfate for Cancer treatment	REU: Functional Materials	Physics	Kateryna Kushnir Friedman, Lyubov V. Titova, Jeannine M. Coburn
48	James Nellis, Jacob Feinstein, Jacob Myers, Natalie Frey	Autonomous Measurement Optimization for Quantum Sensing of Magnetic Fields	REU: Functional Materials	Physics	Raisa Trubko
49	Peter Olszak, Dawei Liu, Mattan Mohel	Terahertz Probes of Carrier Dynamics and Disorder in Cr:ZnSe	REU: Functional Materials	Physics	Kateryna Kushnir Friedman, Lyubov V. Titova

2026 WPI Summer Research Showcase Table of Contents

Poster Number	Authors	Poster Title	Summer Program	Department	Advisors
50	Alejandra Tello	Impact of CT-Derived Myocardial Scar on Ventricular Activation and Body-Surface Potentials in a Personalized Computational Heart Model	CARDIO4U Supported by the AHA	Biomedical Engineering	Shijie Zhou, Artin Elhamirad, Zhen Qi
51	Simone Chapman, Reyla Williams	Designing a leak-proof flow system for 3D printed blood vessel models	CARDIO4U Supported by the AHA	Biomedical Engineering	Yonhgui Ding
52	Madisen McLeod, Yihong Olivia Song	Automated Optimization Equipped with GPUs For Fontan Surgery	CARDIO4U Supported by the AHA	Biomedical Engineering	Zhenglun Alan Wei
53	Arya Shahane, Zoe Vittum, Camden Holm	Quantifying CD44 Expression to Understand Remodeling in Atheroprone Environments	CARDIO4U Supported by the AHA	Biomedical Engineering	Solomon Mensah
54	Luke A. Morrow, Bridgette M. Bowyer, Ian M. Anderson, Bryanna L. Samolyk	Characterization of Porous Anisotropic Fibrin Scaffolds with Tunable Mechanics and Degradation	CARDIO4U Supported by the AHA	Biomedical Engineering	George D. Pins, Kristen L. Billiar
55	Melissa Vieira Rodrigues Domingues, Julia Nicolescu	Foot Kinematics and Dynamic Arch Behavior During Barefoot and Shod Running	CLIMB	Biomedical Engineering	Karen L. Troy
56	Samantha Wheatley, Alireza Nikbakht	Investigating Curcumin Loaded Bacterial Cellulose Membrane for Slow-Release Antimicrobial Wound Dressing	Summer Volunteer Independent Research Project	Biomedical Engineering	Jeannine M. Coburn

2026 WPI Summer Research Showcase Table of Contents

2026 WPI Summer Research Showcase Table of Contents

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Design and Characterization of a Hydraulic Soft Kinesthetic Haptic Force Feedback for Teleoperated Robotic Manipulation
1	Authors	Aditi Bhattamishra
	Advisors	Cagdas Onal
	Department	Robotics Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Haptic force feedback is a crucial component of human-robot interaction in teleoperation systems. Established methods of providing haptic force feedback rely on mechanically generated resistive forces on the fingers, utilizing pneumatically actuated soft bellow actuators, motor-driven tendons, or electromagnetic braking. Comparatively, hydraulically actuated systems are underexplored. This work presents the proof-of-concept of a miniaturized standalone digital hydraulic powerpack replacing a previously developed pneumatic system and compares the differences in haptic feedback between air (compressible) and water (incompressible) as mediums. Both systems use soft silicon-fabric inflatable actuators, called "haptic muscles," to provide lateral force feedback on individual fingers based on the force experienced by the end effector. An off-the-shelf miniature 6V DC geared motor-driven peristaltic pump is adopted for proof-of-concept validation, resulting in a hydraulic system with fewer unique components than the pneumatic system, and complete elimination of valves. The hydraulic system has a smaller form factor, an adaptable design, and a fixed, enclosed amount of water that requires no refilling, and introduces a novel method of high-precision active inflation and deflation control, which is lacking in the pneumatic system. In comparison to the pneumatic system, the hydraulic system utilizes 44% less fluid by transfer volume and produces an 11% higher restorative force max internal pressure. The hydraulic system’s compressive force profile matches the pneumatics, but results in higher compressive forces at max internal pressure, which can be attributed to the compressibility of air. Notably, the hydraulic system latency is above the ideal 100ms, that of the pneumatic system; further improvements can be made by further modifications to the peristaltic pump and using a higher-speed motor. The findings of this study can better guide the exploration and incorporation of hydraulic systems for haptic feedback and, broadly, wearables.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Self Healing Wireless Networks: Implementing Agentic AI for Autonomous Link Recovery Using SIONNA
2	Authors	Kayah Jadczak, Vaansh Mansharamani
	Advisors	Christo K. Thomas
	Department	Electrical & Computer Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Future wireless networks, including 6G, are expected to operate at a scale and complexity that make continuous human management impractical. This project develops a simulation framework for an agentic AI-based self-healing wireless network designed to autonomously detect, diagnose, and recover from communication failures. The envisioned framework consists of three agents, where one monitors link quality and detects degradation; another diagnoses the root cause of the degradation, and a third selects and executes an appropriate recovery action. As a first step, our goal is to build a simulation platform that integrates NVIDIA Isaac Sim with Sionna RT. Isaac Sim models a mobile robot and provides its position to Sionna RT, which uses a shared representation of the robot environment to calculate radio-propagation paths between the robot and a base station and generate the corresponding channel impulse response (CIR). This integration provides the data and simulation foundation needed to implement the three agents. In future work, the agents will use symbolic machine learning methods to analyze CIR-derived features to detect link degradation, identify its likely cause, and initiate a suitable recovery strategy. The resulting framework will provide a platform for investigating autonomous self-healing mechanisms in future wireless networks.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Investigating Ecosystem Supports of the New England Medicinal Leech
3	Authors	Lilith Thompson
	Advisors	Elisabeth Stoddard
	Department	Environmental & Sustainability Studies
	Summer Program	Charles O. Thompson Fellowship

Abstract

Due to its rarity and sporadic range, the preferred habitat of the New England Medicinal Leech, Macrobdella sestertia, is poorly understood. Yet, the variety of blood it consumes and stores might make M. sestertia instrumental for studying biodiversity and conservation. This study investigates environmental factors, including human activity, that may be supporting a newly discovered population of M. sestertia for the purpose of informing further identification and conservation efforts. The population was observed throughout June and July of 2026 at the beaver pond of the Turn Back Time (TBT) nature-based education center in Paxton, MA. Its behavior and abiotic habitat were characterized, nearby flora and fauna species were catalogued, and TBT staff was interviewed about land management practices. The pond was observed to be a breeding ground for multiple types of amphibians and abundant in aquatic plants that served as potential interaction sites between M. sestertia and its prey. By preserving the pond's aquatic plants and 50 acres of forest surrounding the pond, TBT protects critical breeding grounds and migration paths for M. sestertia's amphibious prey sources, thereby supporting the leeches as well. Forested corridors between waterbodies and the presence of aquatic plants are easily visible indicators that may suggest M. sestertia's residence in an area and should be conservation goals for those concerned with M. sesteria's preservation.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

<table>
<tr><td colspan="3"></td></tr>
<tr><td>Poster Number</td><td>Poster Title</td><td>Regulatory development for Industrial testing of Stented Bioprosthetic valves</td></tr>
<tr><td rowspan="4">4</td><td>Authors</td><td>Ilia Yashchenko</td></tr>
<tr><td>Advisors</td><td>Ivan Nepomnyashchikh, Zhenglun Alan Wei</td></tr>
<tr><td>Department</td><td>Biomedical Engineering</td></tr>
<tr><td>Summer Program</td><td>EREE: Early Research Experience in E-Term</td></tr>
<tr><td colspan="3">Abstract</td></tr>
<tr><td colspan="3">Heart valve disease affects up to 2.5% of the USA population and causes over 28000 deaths annually. Treatment strategies involve surgical heart valve replacement in many cases. Regulatory guidelines given in ISO 5840 require preclinical testing of all prosthetic heart valves in a mock circulatory flow loop. However, the standard does not specify the design of the the flow loop, potentially, leading to inconsistent testing between prosthetic heart valve manufacturers. In particular, the design of the valve holder – a piece of the flow loop that holds the valve in place – may affect the flow field past the valve and, consequently, lead to inaccurate estimates of the valve's blood damage potential. This project aimes to identify a research direction for developing an anatomically consistent ISO valve holder design. Literature review is performed, research direction is developed, and a mock circulatory flow loop is designed. It is proposed to use effective orifice area as a criterion for anatomical consistency of the valve holder. Real patients' MRI data will be used to 3D print and test different anatomical models. Particle image velocimetry with simultaneous valve operation visualization will be used to calculate effective orifice area and turbulent shear stress among the tested anatomies. Statistical analysis will be used to identify the influence of the effective orifice area on the turbulent shear stress. This work will inform the ISO committee on guidelines creation for standardized prosthetic heart valve testing.</td></tr>
</table>

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Performance Simulation of a Novel Hybrid Multi-Rotor Drone
5	Authors	Nathaniel Johnston
	Advisors	Jielong Cai
	Department	Aerospace Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

This study presents power consumption analysis for three distinct VTOL drone designs with the goal to investigate their efficiencies under different application scenarios. Power consumption was modeled and analyzed in MATLAB using wind tunnel experimental data for the aerodynamic performance of the propeller and drone fuselage. The novel drone design is then modeled with a force balance solver under different mission conditions. With force data, power consumption of each mission is then determined using propeller efficiencies and theoretical coefficients of lift and drag. Results show that an autogyro design has potential to out-perform the traditional drone at speeds above 12 m/s for mid range missions. It was also shown that for high-distance travel, a quadcopter with a wing and pusher propeller out performs other designs. Therefore, the autogyro technology, with appropriate design, can provide power savings over the traditional quadcopter design with the drawback of a larger overall footprint. For future work, gathering experimental data for lift and drag on an autogyrating blade is required to determine if traditional autogyro lift and drag models apply at these lower scales. It is also recommended that a hybrid Wing-Autogyro design as well as a Traditional-Autogyro hybrid design be investigated to reduce the drawbacks of the Autogyro while still capitalizing on its benefits.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Improving an Existing Automated Circuit Designer and Code Generator (ADArC)
6	Authors	Stephen He
	Advisors	Pradeep Radhakrishnan, David Brown
	Department	Computer Science
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Web-based automated circuit design platforms provide an accessible environment for designing, generating, and validating Arduino-based systems without requiring physical hardware. However, the usefulness of such platforms is limited by incomplete peripheral support, insufficient hardware simulation, and user interface limitations that reduce the efficiency of circuit development and debugging. This project extends an existing automated Arduino circuit design and code generation platform by expanding its virtual hardware capabilities, improving simulation behavior, and enhancing the overall user experience. New virtual peripheral controllers were implemented to emulate additional digital, I^2C, and SPI devices with behavior consistent with their physical counterparts, allowing existing Arduino libraries and user programs to execute without modification while interacting with simulated hardware. The platform was further improved through multiple interface enhancements, new visualization features, and numerous bug fixes that increased simulation stability, usability, and workflow efficiency. Together, these improvements expand the functionality of the platform and provide a more capable environment for embedded systems prototyping, simulation, and engineering education.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	EdTech Sector Analysis – Entrepreneurial & Market Trends
7	Authors	Mahitha Bodicherla, Fevin Doshi, Priya Hungund
	Advisors	Sandhya Balasubramanian
	Department	Data Science
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

The EdTech industry has grown significantly over the past decade, driven by emerging technologies and rising demand for workforce upskilling. The global EdTech market reached $214.58 billion in 2026 and is projected to grow to $588.72 billion by 2034, a 13.45% CAGR. The sector is shifting focus from virtual reality and remote lab tools toward student-centered, adaptive technologies that personalize learning at scale. The EREE project examines how AI and emerging technologies are reshaping digital learning, educational administration, and operational efficiency across the EdTech landscape. Using the PitchBook dataset of 18,000+ EdTech companies, we conducted longitudinal analysis of startup trends and built dynamic Power BI visualizations to surface structural patterns and strategic insights. We also applied hierarchical classification to map sector concentration against the digital capabilities needed in higher education. This draws on the open-source Higher Education Digital Capability (HEDC) Framework, which spans 4 dimensions, 16 domains, and 68 capabilities. A 300-company training sample was independently coded by multiple raters, with consensus grouping used to resolve disagreements and establish inter-rater reliability; this coded sample now informs an AI-assisted classification model (in progress) designed to scale coding across the full dataset. Preliminary results show Digital Design as the dominant dimension, pointing to a focus on how content is delivered, not just what is delivered. Lifelong learning and workforce upskilling startups form the second most concentrated segment, reflecting sustained employer demand for reskilling. Next steps include refining the AI model for prediction accuracy, extending classification to non-PitchBook startups for a fuller industry map, and launching primary research: surveys and interviews with both supply-side (founders, investors) and demand-side (administrators, faculty, procurement/IT leaders) stakeholders.

Poster Number	Poster Title	Soft architecture: shifting shapes with pre-stretched fabric and form finding methods
8	Authors	Erin DiStefano
	Advisors	Soroush Farzin
	Department	Architectural Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

The PEACE Room is an interactive architectural environment designed to respond to a user's emotional state to help alleviate mental stress by adapting its lighting, sound, and physical configuration. To reduce the complexity and energy demands of conventional mechanical actuation, this project explores soft architectural systems capable of achieving significant geometric transformations with minimal mechanical input. The proposed wall system consists of a flexible fabric membrane integrated with 3D-printed patterns across its surface. These patterns influence how the membrane stretches, contracts, and deforms, allowing the wall to produce different spatial configurations. The goal of this project is to develop a form-finding method for identifying patterns that maximize flexibility and enable a wide range of shape transformations. A physical soap-film model is used to explore and evaluate these patterns before fabrication. The setup consists of a 3D-printed base, adjustable pins positioned at 45° relative to the geometry's center, and strings. The assembly is dipped into a soap solution, allowing the resulting soap film to simulate the behavior of the pre-stretched fabric. The strings represent the embedded 3D-printed pattern and constrain the membrane as it changes shape. By repositioning the pins from their angled configuration to a vertical position, the model simulates the transition from a stretched membrane to a relaxed condition. The resulting geometry provides a physical prediction of how the fabricated wall system may deform when tension is released. This low-cost form-finding method enables rapid generation, testing, and comparison of multiple geometries before committing to full-scale 3D printing. It therefore supports iterative design while reducing fabrication time, material waste, and unnecessary prototyping. Ultimately, the method can help identify optimized patterns for flexible, responsive wall systems within the PEACE Room.

Poster Number	Poster Title	Improving Human-Robot Interaction Through Interface Design: ARBot
9	Authors	Hailey Reed
	Advisors	Tian Guo
	Department	Computer Science
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Interfaces that visually display robotic data heavily impact human-robot interactions. Poorly designed interfaces for robotic systems can result in information being misinterpreted by humans during operation. This project's main objective is to design an easy-to-understand and efficient web interface for the framework ARBot, improving users' interpretation of the robot's environment and augmented reality (AR) data during teleoperation. Since modifying the existing ARCADE framework was outside the project's purview and timeline, a standalone web-based interface was developed from scratch using HTML, CSS, and JavaScript. The interface visualizes two robot-mounted camera feeds and one AR feed, along with camera labels, control modes, system metadata, and an interactive control panel. The design choices implemented in the web interface were steered by the UI/UX methods in Nielsen Norman Group's 10 Usability Heuristics for User Interface Design and Visual Hierarchy in UX. Features such as automatic active camera switching, disabling inactive controls, and a structured layout were designed to help users quickly identify the most significant information while reducing unnecessary interactions. Overall, the web interface creates a clear foundation for ARBot’s human-centered AR evaluation. Future work includes integrating the interface with live ARBot data, improving usability, and enhancing visual data comprehension.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Development of a Microstructure-Informed Dataset for Machine-Learning-Guided Alloy Design
10	Authors	Nicolas Adrian, Yangyang Fan
	Advisors	Yu Zhong
	Department	Mechanical Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Aluminum alloys are widely used in the automotive and aerospace industries because of their high strength-to-weight ratios. However, conventional alloy design relies heavily on iterative experimental processing and testing, which require substantial time, cost, and material resources and may also contribute to increased carbon emissions. This work supports a more computationally driven approach to alloy development aimed at accelerating the identification of compositions and processing conditions that produce desirable properties. A microstructure-image-based framework using generative machine learning was applied to the Al-Si alloy system. Because reliable model performance depends on the quality and breadth of the training data, a curated dataset containing more than 250 literature-derived microstructure records and associated metadata was developed. The metadata include alloy composition, cooling conditions, post-processing information, and available microstructural and mechanical properties. In parallel, a secure, versioned data-processing and transfer pipeline was implemented, together with a PyTorch-based training workflow that converts the curated records into model-ready tensors for training, validation, and testing. At its current stage, the framework can generate a range of Al-Si microstructures under different cooling conditions. More broadly, this work establishes a scalable foundation for microstructure-informed alloy design by connecting published experimental data, automated dataset preparation, and generative modeling within a unified workflow. Continued expansion and validation of the dataset will support more reliable predictions and may ultimately reduce the experimental burden associated with developing new aluminum alloys.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Elastically-Coupled Leg Exoskeleton
11	Authors	Sophia Caramanica
	Advisors	Connor McCann
	Department	Biomedical Engineering
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

According to the CDC, around 2 million Americans need to wear some form of leg orthotic. One type used is an actuated leg orthotic, which uses motors to help propel AND guide the wearer along the traditional gait path. However, since motors are traditionally used to provide both types of actuation, these orthotics tend to be bulky, heavy, and expensive, limiting their effectiveness and their accessibility. If the motors used to correct the person's gait could be replaced with a spring-pulley system that passively guides the wearer's gait towards their natural gait cycle, that could greatly reduce the cost and bulkiness of such an important device. The goal of this project is to design a non-uniform-spool and spring system to create an energy field that passively guides the wearer of a leg orthosis towards the typical gait cycle. By simulating different profiles in MatLab, a spool arrangement was found which stored 0.54J, 0.28J, 0.11J, 0.07J, and 0.16J at the respective hip angles, knee angles: -24, 0; 0, 10; 20, 30; 40, 50; 55, 65. When tested with a real-world model, that same spool arrangement stored 0.67J, 0.42J, 0.32J, 0.28J, 0.36J at the same respective angles. Since the simulation outputs follow the same trend as the real-world model outputs, the main reason for their differences is a compounding measurement error. However, this experiment shows that with the right profiles and the proper spring set-up, the desired energy field could be achieved.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Seeing is believing: AI Literacy, Synthetic Media, & Engagement
12	Authors	Isa Cooper, Deep Sanghvi, Khushali Shah
	Advisors	Adrienne Hall-Phillips
	Department	Business School
	Summer Program	EREE: Early Research Experience in E-Term

Abstract

Increasingly realistic synthetic media, like deepfakes, can exploit snap judgments on social media to deceive and cause harm, making AI literacy ever more critical. Yet little is known about how users form visual trust in images, particularly those without accompanying text. This study examines how perceived visual credibility influences visual trust in caption-free Instagram posts. It also investigates whether AI literacy helps users adjust these judgments when images are AI-generated rather than authentic. A survey experiment (N = 216) exposed participants to a 2×2 factorial design manipulating content origin (AI-generated vs. human-created) and content veracity (true vs. false). Structural equation modeling (SEM) provided support for the proposed mediation model confirming that trust is essential mechanism for linking perceived credibility to consumers' engagement intentions. Findings also suggest that AI literacy influences this process challenging the assumption that greater AI literacy necessarily makes consumers more skeptical of AI-generated visual content.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Predicting Food Spoilage with Machine Learning
13	Authors	Sam Phillips, Amaya Keys, Sahana Gokulakrishnan, Tom Arnold, Pavan Antala
	Advisors	Fabricio Murai
	Department	Data Science
	Summer Program	REU: Data Science Research for Healthy Communities in the Digital Age

Abstract

Food safety decisions rely on static shelf-life estimates that ignore real-world variation in storage conditions, a gap that matters most in settings such as disaster relief, where both consuming unsafe food and discarding safe food carry increased costs. Existing mechanistic models require per-condition calibration, while deep learning approaches lack biological grounding. We aimed to predict bacterial spoilage from environmental conditions - such as pH, water content, and temperature - and make those predictions usable by non-experts. Using ComBase, a public database of multi-laboratory growth experiments, we built a preprocessing pipeline that standardized curves into a consistent format, yielding a benchmark of spoilage-growth curves spanning a wide range of foods and organisms. We paired a Baranyi growth model driven by cardinal-parameter kinetics with learned networks that correct its initial population, its growth parameters, and its output residual, evaluated under a shared, replicate-grouped, food-stratified five-fold cross-validation. The corrected model substantially improved curve-fit accuracy and reduced the false-alarm rate relative to the mechanistic baseline, with more modest gains in shelf-life timing prediction. To facilitate use by non-experts, we built a conversational interface returning plain-English explanations of these predictions. Correcting a biologically grounded model with learned components therefore improves spoilage prediction without sacrificing interpretability; future work will expand the dataset to additional foods and organisms. Supported by NSF REU Grant #2349370. We thank the USDA ComBase maintainers.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Advancing Multi-Label Data Extraction and Explainability: Predicting Adverse Events and Identifying Clinically Meaningful Features in Oncology Patients Using U.S. FAERS Data
14	Authors	Matthew Jones, Amruta Soma, Gandhali Sheth
	Advisors	Chun-kit Ngan, Yin-Ting Cheung, Bo Wang
	Department	Data Science
	Summer Program	REU: Applied AI for Practical Applications

Abstract

Adverse events (AEs) in polypharmacy scenarios are common and may lead to adverse health outcomes among patients with cancer. While the impact of drug-drug interactions (DDIs) on AEs has been extensively investigated, interactions between drugs (D) and herbs (H) and/or supplements (S) remain underexplored. This gap limits our ability to accurately understand the impact of DHI/DSI/DHSIs and to predict single or multiple AE(s) (SMAEs), highlighting the need for patient-level clinical data to systematically investigate these interactions. To address this, we propose a multi-label (ML) statistical and machine learning framework for predicting SMAEs and identifying clinically relevant features and DHI/DSI/DHSIs in oncology patients using 1.2 million U.S. FAERS data records. Specifically, the contributions of this work are five-fold: (1) a frequent itemset mining and pharmacovigilance signal detection method to analyze correlations in our dataset and identify commonly co-occurring DHI/DSI/DHSIs and their associated SMAEs; (2) a ML feature selection method, Association Rule Interaction Scoring and Ensemble Selection (ARISES), to identify the most clinically significant features and to uncover their global and local correlations for SMAEs prediction; (3) a patient-level ML eXplainer (MLX) that leverages structured gradient descent as a post-hoc explainability approach to identify the most influential patient-level features driving the predicted SMAEs; (4) a comprehensive evaluation demonstrating that ARISES outperforms the best baselines (in the DH exposure group: average F1 improvement of 4.29% and average Jaccard improvement of 4.19%; in the DHS exposure group: average F1 improvement of 2.06% and average Jaccard improvement of 3.72%), and that MLX can identify counterfactual scenarios to further support clinically meaningful feature analysis; and (5) a web-based proof-of-concept prototype that provides an interactive environment for SMAEs prediction and MLX-driven post-hoc explainability. Our work is supported by the National Science Foundation, Grant 2349370.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	ToMVerse of Madness: Benchmarking and Explaining Theory of Mind Reasoning in LLMs
15	Authors	Hudson Markin, Uma Mandapati, Daniel Baranov
	Advisors	Raha Moraffah
	Department	Data Science
	Summer Program	REU: Applied Artificial Intelligence for Advanced Applications

Abstract

ToMVerse-of-Madness is a public codebase that serves as a unified benchmarking platform for LLM Theory of Mind (ToM). By faithfully standardizing benchmark evaluation and metrics while allowing for easy future task additions, ToMVerse will allow cross-benchmark comparisons that reveal anomalies and trends, expediting future LLM ToM research. We organized 71 papers into a taxonomy of ToM tasks and state-of-the-art methods. Then, we collected codebases for 19 of them, adapting them into custom tasks in the LLM harness lm-eval. Across the 19 benchmarks, evaluations showed <3% aggregate difference between adaptation results and original codebase results, showing the platform's faithfulness. Next, we ran all benchmarks on 5 models from Qwen and Llama families (parameters ranging from 4B-70B). By comparing these results and underlying reasoning traces, we were able to find patterns behind certain anomalies such as unsolicited reasoning, showcasing the utility of a unified, standardized ToM benchmarking platform. Our work is supported by the National Science Foundation, Grant 2349370.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Can Multi Agent System Reasoning Errors Be Identified By Cheap Detectors?
16	Authors	Ojal Prasad, Corey Verkouteren, Deeya Rawat, Dennis Hofmann, Lei Ma
	Advisors	Elke Rundensteiner
	Department	Data Science, Artificial Intelligence
	Summer Program	REU: Applied Artificial Intelligence for Advanced Applications

Abstract

Multi Agent Systems (MAS), composed of specialized agents that coordinate to complete complex tasks, have seen rapid adoption across domains such as cybersecurity, software engineering, Internet of Things, and beyond. Despite a market valued in the billions of dollars, these systems exhibit failure rates of 41%-87%. These extreme failure rates highlight the need for reliable anomaly detection (AD). We show that trace data of agent communications in MAS naturally clusters by agent action type and that no single AD method performs best across all clusters. Motivated by this heterogeneity, we propose a fully unsupervised ensemble that combines predictions across methods, allowing each detector to contribute where it performs best. Our ensemble (AUC = 0.831) substantially outperforms the best individual unsupervised method (AUC = 0.60) and approaches fully supervised baselines (best AUC = 0.87) without requiring labeled data. These results suggest that lightweight, label-free anomaly detection can improve MAS reliability in settings where labeled data is scarce.

Our work is supported by the National Science Foundation, Grant 2349370.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Auditing Fairness of Healthcare Vision-Language Models with Test Time Debiasing
17	Authors	Aman Siddiqi, Niara Marwah
	Advisors	Walter Gerych
	Department	Data Science
	Summer Program	REU: Data Science Research for Healthy Communities in the Digital Age

Abstract

Healthcare systems are increasingly adopting vision-language models (VLMs) trained on clinical image and text data to assist in disease classification. However, past audits show that VLMs are prone to encode demographic information, yielding biased performance and misallocation of treatment resources for underdiagnosed groups. Many methods resolve this bias with computationally expensive finetuning procedures that retrain model weights, which may be infeasible in constrained healthcare environments. On that end, we apply more efficient test-time debiasing methods in a comprehensive fairness audit of various healthcare vision-language models, evaluation datasets, and health domains. Using four state-of-the-art evaluation datasets, we evaluate to what extent demographic information is encoded in these models with probes. Leveraging this insight, we apply three test-time debiasing methods to assess whether model fairness improves. We find that healthcare VLMs can accurately predict demographic information across all conditions while test-time debiasing significantly improved fairness between age groups. Our audit can be used as a benchmark for future work in evaluating efficient debiasing of VLMs in medical applications. Our work is supported by the National Science Foundation Grant 2349370.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	RNA Expression Analysis: Unlocking Pathogenesis of M. abscessus through Colony Morphology
18	Authors	Skhaina Florian
	Advisors	Scarlet Shell
	Department	Bioinformatics & Computational Biology
	Summer Program	Research in Shell Lab

Abstract

The ESX-4 secretion system is a highly conserved mycobacterial operon linked to pathogenesis in Mycobacterium abscessus (Mabs), an opportunistic pathogen that causes severe abscesses and lung infections with under 50% treatment success. Poor understanding of Mabs virulence factors remains a major barrier to new therapeutics, particularly how colony morphology relates to virulence. This study aimed to determine whether knocking out ESX-4 or its substrates U + T produces transcriptional changes that explain this morphology-virulence relationship. RNA-sequencing was performed across wild-type, whole ESX-4 knockout, and substrates U + T knockout conditions. Expression counts were compared using differential expression analysis, then gene set and pathway enrichment analyses were performed to determine statistically significant pathways. Genes previously linked to colony morphology showed little to no differential expression, and both knockouts had highly similar expression profiles. Enrichment analyses instead consistently implicated ribosome-related genes. These results suggest morphology differences are not primarily driven by transcription of known morphology genes. Further exploration of differentially expressed genes, guided by bioinformatics, will help focus future work on the most promising leads.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Cofilin controls the sorting of tropomyosin to distinct actin networks
19	Authors	Carys Evans, Dominic Radcliffe-Hines, Ruben Bonilla-Santiago, Alexander J.B. Reading, Brian S. Hercyk
	Advisors	Shane G. McInally
	Department	Biology & Biotechnology
	Summer Program	LaPre Fellowship

Abstract

Eukaryotic cells simultaneously build multiple functionally distinct types of actin networks within the same cytoplasm. To control the functions of these networks, cells decorate them with specific actin-binding proteins (ABPs) that tune their sizes, shapes, and dynamics. Proper cell physiology requires the co-assembly of multiple actin cytoskeletal networks that are tailored for specific functions. To distinguish between these networks, cells decorate them with distinct sets of ABPs. While various models have been proposed to explain this selective sorting of ABPs, the role of actin disassembly factors is less well understood. Here, we used inducible CRISPR interference and quantitative live-cell imaging to test how disassembly factors control the size and ABP composition of different networks. We found that knockdown of cofilin (Cof1), a potent and highly conserved disassembly factor, disrupts the size, organization, and ABP composition of actin networks. Specifically, defects in Cof1-mediated disassembly promote the assembly of overgrown and disordered branched actin networks that are inappropriately decorated by tropomyosin (Tpm1). Contrary to prevailing models of ABP sorting, these networks are co-decorated by Tpm1 and fimbrin (Sac6), and their assembly is independent of formin activity. Finally, we evaluated the effects of cofilin knockdown combined with the overexpression of disassembly factors. Crn1 and Aim7 overexpression were found to partially rescue cofilin knockdown effects. Together, our findings demonstrate a critical role for actin disassembly factors in maintaining cytoskeletal structure and function by regulating ABP sorting across distinct networks.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Synthesis and Characterization of an Aminobenzodifuranone: A Solvatochromic Dye
20	Authors	Isaac Huynh
	Advisors	Christopher R. Lambert, Anita E. Mattson
	Department	Chemistry & Biochemistry
	Summer Program	LaPre Fellowship

Abstract

Environmentally sensitive organic pigments which exhibit absorption and fluorescence solvatochromic shifts are of special interest in bioimaging, optoelectronics, and materials research due to their responsivity to environmental conditions (e.g., polarity, acidity, temperature). One such pigment, an aminobenzodifuranone (BDF), synthesized by Dr. Michael G. Hutchings and Dr. Anthony A. Gorman in 1996, was found to have the largest positive solvatochromic shift. Since then, little work has been done with the compound, due to the synthetic pathway being covered by a now-expired ICI patent. The total synthetic pathway from a half-condensed intermediate to a benzodifurantrione to BDF was carried out and optimized (40.9% pure yield). Photophysical properties of BDF were studied in a variety of solvents using UV-Vis and fluorescence spectroscopy. In the solvents studied, it was found that BDF exhibits a positive solvatochromic shift of 153 nm, a molar absorptivity of >40,000 per mole per centimeter in select solvents, and maximum a quantum yield of 45.7% in hexane. Based on the photophysical properties and large positive solvatochromic shift of BDF, we are interested in a diverse array of potential applications, including differential staining of biological samples, photovoltaic electrodes, and smart window materials.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Exploration of Polyester Dendrimer Capping of MOF-5
21	Authors	Ryan Cohen
	Advisors	Shawn Burdette, Ronald L. Grimm
	Department	Chemistry & Biochemistry
	Summer Program	LaPre Fellowship

Abstract

Metal-organic frameworks (MOFs) are crystalline, three-dimensional frameworks composed of metal-centered clusters, held together by organic linkers. Our previous research on these frameworks focuses on their post-synthetically tunable nature. These studies utilized MOF-5, a cubic crystal with octahedral Zn4O clusters with benzene dicarboxylic acid linkers, the dye Crystal Violet as a guest compound, and a sterically bulky ligand post-synthetically added to the surface of MOF-5 to attempt to cap the pores. Ongoing research using MOF-5 has explored using poly(benzyl) ether dendrimers to control MOF stability in humid conditions. Dendrimers are globular, branched macromolecules that are grown stepwise iteratively. The branches are symmetric and highly customizable, where the core and the branches can be separately modified. Combining dendrimers with MOFs can lead to new methods of drug delivery. Polyester dendrimers are susceptible to hydrolysis, and customizing the composition of the dendrimer means customizing the hydrolysis of the dendrimer itself. Biological necessities can be met where the hydrolysis products are nontoxic, and the rate of release is controlled. Through UV-Vis and XPS experiments, it is observed that the first and second generation (G1 and G2) capping the surface of MOF-5 slows leakage of Crystal Violet. Ongoing research using capped MOF-5 will examine acid degradation of the dendrimer and its impact on dye leakage.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Developing ML Models for Predicting HIV Drug Resistance
22	Authors	Victoria Pan
	Advisors	Xiangnan Kong
	Department	Bioinformatics & Computational Biology, Data Science
	Summer Program	Manning/Lesser Fellowship

Abstract

Drug resistance is a major barrier in treating diseases such as Human Immunodeficiency Virus (HIV), and experimental screening of all possible mutations is costly and time-consuming. This study aims to develop and evaluate a Multi-Output Logistic Regression (MOLR) classification model and a Convolutional Neural Network (CNN) to predict phenotypic resistance to nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs): lamivudine (3TC), abacavir (ABC), zidovudine (AZT), and non-nucleoside reverse transcriptase inhibitors (NNRTIs): efavirenz (EFV), etravirine (ETR), and nevirapine (NVP) directly from HIV-1 genotypic sequence data. Curated NRTI and NNRTI datasets from the Stanford HIV Drug Resistance Database were utilized, which contained amino acid substitutions across reverse transcriptase positions and phenotypic fold-resistance values. The models were validated using 5-fold cross-validation and benchmarked against known drug resistance mutation (DRM) lists. The MOLR model achieved strong and consistent drug resistance classification performance across both drug classes, with macro-averaged AUC-ROC of 0.944 (NNRTI) and 0.969 (NRTI) on cross-validation, confirmed by closely matching hold-out test scores of 0.952 and 0.974, respectively. The CNN modestly outperformed the MLP baseline on NNRTI drugs, most notably EFV (ΔAUC-ROC +0.018, ΔAUC-PR +0.015), while both models performed comparably on NRTIs, suggesting convolutional feature detection offers a meaningful but narrow advantage where resistance is driven by combinatorial mutation patterns rather than independent point mutations.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Deciphering splicing mutations in human disease: An integrative, literature-derived mechanism dataset
23	Authors	Jill Cavener
	Advisors	Dmitry Korkin
	Department	Bioinformatics & Computational Biology
	Summer Program	Manning/Lesser Fellowship

Abstract

More than 95% of human genes undergo alternative splicing: a cellular process that allows one gene to produce multiple mRNA transcripts, which are translated into different proteins. Splicing research is critical to the study of human disease; 50% of pathogenic mutations affect alternative splicing. While current splicing datasets describe variant type, location, and disease association, most lack information on HOW the mutation affects splicing outcomes. Mechanism data is buried in thousands of individual research papers. The goal of this project is to develop a pipeline using Large Language Models (LLMs) to extract mechanism data from literature, building an atlas of mechanistically annotated splice variants. Genes of interest were selected from preliminary ClinVar research. Semantic Scholar and Entrez APIs were used to select relevant papers for each gene. Three LLMs; Anthropic, OpenAI, and Gemini; were prompted to extract splicing variants from each paper. The same LLMs were used to rate each response for accuracy and completeness. Anthropic selected the best response for each paper based on these ratings. Finally, the results were compiled into a final dataset, including ratings and confidence levels from the evaluation steps. The results were derived from 12 papers, and a total of 59 variants were extracted. 11 variants were excluded for lack of data. The variants were sorted by gene (MLH1 and CFTR). Important splicing characteristics were graphed across both genes. The results demonstrate that the current LLM pipeline is capable of producing variant-mechanism datasets for research use. However, several limitations must be addressed before large-scale usage. The literature-search process is not fully automated and requires manual review before extraction. Additionally, hallucinations/inaccuracies can slip through the evaluation phase. Future work will include improvement of the current pipeline for the development of a large-scale mechanism dataset, and implementation of a machine-learning model for pattern recognition.

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Causal Effects of Mindfulness On Chronic Low Back Pain
24	Authors	Grace Chagnon
	Advisors	Charlotte Fowler
	Department	Data Science
	Summer Program	Neuroscience Fellowship

Abstract

This project estimates the impact of mindfulness-based stress reduction (MBSR) on chronic lower back pain (cLBP). Amidst the growing opioid crisis and pharmaceutical inflation, there is a pressing need for alternative cLBP treatments. This study follows 46 participants enrolled in an MBSR program, tracking changes in pain outcomes and biopsychosocial markers over time. A linear mixed-effects model was used to assess the relationship between session attendance and multiple pain outcome scores. This model controls for within-participant variation using random intercepts while adjusting for confounders, or baseline participant characteristics that may affect program adherence. Two causal inference approaches were used: regression adjustment and inverse propensity weighting. Both approaches found that high attendance was associated with increased self-efficacy and reduced pain catastrophizing at the 4- to 6-month follow-up. By identifying predictors of attendance, individuals can optimize their adherence to MBSR and achieve better outcomes.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Knockout of indiscriminate terminal-nucleotidyl transferase, GLDR-2, compromises male fertility in C. elegans
25	Authors	Shuling Lin
	Advisors	Karl-Frédéric Vieux
	Department	Biology & Biotechnology
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

GLDR-2 is a terminal nucleotidyl transferase (TNT) in Caenorhabditis elegans that adds mono-A tails to microRNA precursors, and poly-A, poly-U, or mixed tails to other coding and non-coding RNAs. It is robustly expressed in head and tail neurons and in the hermaphrodite germline, making it a TNT of interest for reproductive biology. While prior research has shown that the loss of GLDR-2 alone does not affect hermaphrodite fertility, it may play a role in the fertility of male worms. Qualitative observations suggest that the absence of GLDR-2 in male nematodes may impact fertility due to difficulty in generating and maintaining a population of gldr-2-null males. GFP-tagged GLDR-2 males were imaged using confocal microscopy, revealing nuclear expression of GLDR-2 throughout the male germline. GLDR-2 expression decreases after pachytene and is absent during the later stages of meiosis and spermiogenesis. We also observed a robust nuclear expression in somatic cells, including intestinal and neuronal cells. The offspring produced by gldr-2-null males were assessed in a 5-day brood count. Either wild-type or gldr-2-null males were crossed with wild-type hermaphrodites. On average, offspring generated from crosses with gldr-2-null males decrease about 33% in comparison to crosses with wild-type males. Brood counts were repeated with feminized, temperature-sensitive mutants, which cease to produce sperm when incubated at 25°C. Crosses using gldr-2-null males produced 23% fewer viable offspring than wild-type males, confirming that this sub-fertility phenotype is male-specific. Together, these results implicate the role of GLDR-2 in male C. elegans fertility. Future work involving the generation of auxin-inducible degron (AID) strains will allow for tissue-specific depletion of GLDR-2. These tissue-specific depletions will identify if the male sub-fertility phenotype is due to defects in mating behaviors or spermatogenesis.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Machines Learn the Worm: Classifying C. elegans from Swimming Behavior
26	Authors	Vanya Malik, Shruti Shastry, Racheal Asaolu
	Advisors	Jagan Srinivasan
	Department	Biology & Biotechnology
	Summer Program	Spencer Fellowship

Abstract

Differences in locomotion patterns between wild-type (WT) and mutant Caenorhabditis elegans strains can be subtle, making manual identification difficult. However, machine learning (ML) offers a powerful approach for detecting these patterns in large behavioral datasets. This study aims to identify whether swimming behavior provides sufficient information for an ML model to classify WT, ser-2, and cat-2 strains. Analysis of mean summary statistics from individual worm tracks revealed wave initiation rate and dynamic amplitude as the features that differed most significantly among strains. However, plotting the first two and the first three principal components did not reveal distinct strain clusters. For strain classification, a Linear Discriminant Analysis (LDA) model achieved the best performance, reaching an average classification accuracy of 66% when distinguishing WT from cat-2 strains. Although these results demonstrate the potential of ML for strain classification, accuracy may be improved by incorporating time-series locomotion data and postural embeddings rather than summary statistics.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Zero-Valent Transition-Metal Intercalation Alters the Optical Properties in Two-Dimensional SnS_2
27	Authors	Alexander Teymurazyan, Evan Johnson, Mattan Mohel, Collin Shuff, Thomas Peters, Ronald Premo, Tianqi Jin, Geoffrey Tompsett, Kristie Koski
	Advisors	Lyubov V. Titova, Ronald L. Grimm
	Department	Chemistry & Biochemistry, Chemical Engineering
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Controlled metal intercalation offers a powerful strategy for tuning the structural, optical, and electronic properties of layered two-dimensional van der Waals materials. Particularly, tin disulfide (SnS_2) is a layered semiconductor capable of hosting intercalated metal atom species within its interlayer van der Waals gaps while preserving its layered crystal structure. Such metal-atom intercalation creates opportunities to engineer SnS_2 for optoelectronic and sensing applications; however, questions remain regarding how intercalant concentration and packing geometry affect its optical and electronic properties. In this work, chemical vapor transport yielded single-crystalline 2H-SnS_2 with terraces exceeding 1 mm^2. Raman spectroscopy and powder X-ray diffraction (pXRD) confirmed phase-pure material and established a structural baseline for comparison with intercalated samples. Solution-phase intercalation with bis(cyclooctadiene)nickel(0), $Ni(COD)_2$, was used to introduce zerovalent Ni atoms into SnS_2. Spatially controlled intercalation methods were also investigated to produce partially intercalated crystals working towards concentration gradients, allowing pristine and treated regions to be compared within the same crystal. UV-Vis spectroscopy was used to quantify resulting changes in optical response following intercalation. Raman spectroscopy and pXRD revealed changes in structure, vibrational dynamics, and carrier dynamics due to metal-atom intercalation, while SEM imaging was used to examine surface morphology. Together, these studies establish a framework for correlating intercalant concentration and spatial distribution to changes in layered SnS_2 and provide insight into the design of chemically tunable materials for future optoelectronic, photonic, and sensing technologies.

This work was supported by the grant 288294 funded by the U.S. Department of Energy, Office of Science. EJ was supported by the National Science Foundation Research Experiences for Undergraduates (REU) program under Grant No. 2447096.

<table>
<tr><td>Poster Number</td><td>Poster Title</td><td>Variable Projection for Neural Network-based Parameter Estimation</td></tr>
<tr><td rowspan="4">28</td><td>Authors</td><td>Brandon Proteau</td></tr>
<tr><td>Advisors</td><td>Andrea Arnold</td></tr>
<tr><td>Department</td><td>Computer Science</td></tr>
<tr><td>Summer Program</td><td>STAR Fellowship: Summer Training in Arts & Sciences Research</td></tr>
<tr><td colspan="3">Abstract</td></tr>
<tr><td colspan="3">The goal of parameter estimation algorithms is to recover a system's parameters from observed data when the governing equations for the system are known. Previous work has shown that incorporating classical numerical methods with neural networks is able to obtain promising results. In this work, we propose a method of parameter estimation combined with variable projection to minimize the amount of a priori knowledge necessary to achieve decent parameter estimation. Rather than learning state trajectories and parameters simultaneously, the neural network predicts only the system states, while the parameters are recovered at each iteration by solving a projected least-squares problem. For systems which are affine in their parameters, this can be efficiently done with a linear least-squares solver.</td></tr>
</table>

Poster Number	Poster Title	Investigating Binary Black Hole Mergers via Gravitational Waves
29	Authors	Natalie Hannoush
	Advisors	Padmanabhan K. Aravind, Rudra P. Kafle
	Department	Physics
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Gravitational wave astronomy is a prominent and emerging field in astrophysics, allowing scientists to detect binary black hole and neutron star mergers for the first time. Gravitational waves are caused by the merging of two massive objects—such as black holes or neutron stars. Once emitted, the waves propagate through the fabric of spacetime at light speed, and eventually reach Earth, where they are so weak that spacetime is distorted by a distance smaller than the width of a proton. With such a small distortion, it took scientists decades to build a device sensitive enough. LIGO (Laser Interferometer Gravitational-Wave Observatory) is a Michaelson Interferometer which uses a powerful laser to measure shifts in the distance travelled by light, indicating a possible gravitational wave. The first-ever observed gravitational wave event took place on September 14, 2015. Over the next ten years, the development of Virgo (Italy), KAGRA (Japan), as well as the ongoing project of LIGO-India and updates to LIGO, have enabled scientists to detect over 300 events with a higher level of precision. Successfully detecting gravitational waves has allowed scientist to observe the universe in a completely new way that was that was unavailable 11 years ago, opening the door for exciting discoveries yet to be made.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	f-block Metal Sequestration Through Surface Tethered Schiff Base Ligands
30	Authors	Christopher Wittekind
	Advisors	Ronald L. Grimm
	Department	Chemistry
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Many f-block metals have been labeled by the U.S. Department of energy as critical minerals, these are difficult to mine because they are chemically dispersed rather than concentrated in veins. A surface capable of selectively capturing then releasing f-block metals would enable non-traditional mining technologies. Multiple pathways for creating a larger 'Salen'-like surface tethered Schiff Base ligand were tested, including the creation and tethering of the previously studied "SALDETA" Ligand and the cooperative ligand "DIMPL". The capacity for each of these ligand molecules to ligate lanthanum was tested. The electronic effects of substitution around the aromatic group was also tested with UV-Vis spectrum. The capacity for the surface to abstract lanthanum was verified with the use of X-Ray photoelectron spectroscopy, seeing a significant lanthanum signal on each surface. The signal for the carbonate anion was also seen in the XP Spectra for the SALDETA surface, which is consistent with the ligation model since this complex would have a positive charge balanced out by one carbonate per 2 lanthanum-SALDETA complexes. The lack of the carbonate signal in the DIMPL Surface spectra implies the ligation mechanism involves three individual molecules. The UV-Vis spectra for EWG substituted SALDETA show unique features to each other, showing a change in the electronic environment, exploiting the difference in electronic behavior to improve selectivity will be studied going forward.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	The Effects of Shared Awe Experiences on Neural Synchrony and Mental Health Stigma Reduction
31	Authors	Ágata Romero, Abigail J. Sullivan, Paige Turcotte,
	Advisors	Richard Lopez
	Department	Psychological Sciences
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Awe is a powerful social emotion that can increase feelings of connection, reduce focus on the individual self, and promote empathy. However, most research has examined awe as an individual experience, and little is known about the neural correlates of shared awe experiences or how such experiences may promote mental health and reduce stigma on college campuses. This pilot study establishes a protocol to examine shared awe as pairs of students complete an awe-inducing task while collecting EEG activity from headsets and heart activity from Polar chest bands. The task follows a randomized block design and consists of 2 conditions: an awe condition with four two minute videos of majestic nature scenes and a neutral condition with four two minute videos of non-nature scenes. Preliminary analyses from 5 dyads suggest that, compared with the neutral condition, the awe condition leads to greater positive affect, less negative affect, and less stress. Moreover, self-reported positive affect was associated with higher EEG-derived attention scores during awe-inducing videos but not during the neutral condition. Among participants who completed a mental health stigma attitudes questionnaire pre- and post-task, stigma-related attitudes regarding one's own mental health significantly decreased following the task, while stigma toward others remained stable. Taken together, these findings suggest that shared awe led to behavioral and neurophysiological changes and may reduce self-directed stigma about mental health. Planned follow-up analyses will examine neural synchrony, heart rate variability synchrony, frontal asymmetry indices of positive emotion, and stigma outcomes. If supported by the final results, brief shared experiences of awe may offer a simple way to encourage peer connection and more open attitudes toward mental health.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Signal Activation by Caveolae Viral Entry
32	Authors	Samuel Harris
	Advisors	Suzanne Scarlata
	Department	Chemistry & Biochemistry
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Caveolae are cholesterol- and sphingolipid-rich membrane invaginations that contain the proteins cavin and caveolin 1,2, and 3. We have found that when caveolae are perturbed, cavin-1 dissociates from caveolae and transits to the nucleus, where it can impact gene transcription. Viruses can utilize caveolae for viral entry, resulting in caveolae deformation. This project investigates the signaling and gene expression changes involved in viral entry through caveolae. Initial experiments study how hypoosmotic stress (lowered salts in solution) deforms caveolae, resulting in caveolin delocalization, using caveolin-1-green fluorescent protein (Cav1-GFP) transfection to visualize caveolin. Cavin is shown to delocalize from the cell membrane in WKO-3M22 smooth muscle cells that have a lot of caveolae and high cavin and caveolin expression levels. To understand the impact of caveolae integrity on gene expression of these proteins, we used a reagent that labels newly synthesized ribonucleic acid (RNA). Caveolae were disrupted by hypoosmotic stress, which disrupts their structure, or by viral entry. Fluorescence intensity of labeled RNA showed that hypoosmotic stress produces the greatest amount of new RNA synthesis compared to baseline synthesis. Viral entry did not increase gene expression, suggesting that cavin-1 remains localized to caveolae. Future work will optimize RNA labeling experimental parameters and determine whether higher amounts of viral particles infecting each cell will produce changes in caveolae structure.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	An Experimental Technique for Measuring Flow Rate in Branching Microchannels
33	Authors	Remy Kaplinsky
	Advisors	Francesca Bernardi
	Department	Applied Physics
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Mathematical modeling of wave and flow rate propagation through quantum graph networks serves applications in many fields such as water waves and electrical circuits. However, no simple, accessible experimental methods currently exist for verification of model predictions. While enclosed microchannels cannot be used to run wave experiments, the microfluidic scale offers desirable characteristics for verification of flow rate propagation due to the relatively controlled experimental conditions, laminar flow, and ease of manufacture on inexpensive consumer craft cutters. Building on previous work developing a method of measuring the flow rate in straight microchannels by tracking the progression of bubbles, we developed a method of manufacturing branching microchannels and measuring the flow rate in two channels simultaneously. Future work includes extending this method to measure the flow rate in branching channels when varying branching angle and branches' width. Such experiments could be used to benchmark and guide mathematical models of propagation of flow rates through quantum graphs.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	A Study on Blind and Low Vision (BLV) Gamer Experiences and Preferences
34	Authors	Lana Acevedo
	Advisors	Rodney Duplessis
	Department	Interactive Media & Game Development
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Blindness and visual impairments are disabilities that are often misunderstood and overlooked within the mainstream game development community. SINE Lab is a WPI research group that is interested in developing games that are accessible for blind and low vision (BLV) gamers. In order to aid SINE Lab in this endeavor, this study includes a literature review focused on understanding what blindness and visual impairment is, what barriers BLV gamers face, and what accessibility features and current technology there is to help overcome those barriers. Two surveys were conducted, one to BLV gamers at Perkins School for the Blind and one to WPI IMGD student developers. It was found that student developers tended to express greater interest in accessibility when exposed to the topic. All exposure and education on accessibility came from personal or extracurricular means, not from courses. Due to the Perkins school year structure, the survey responses from BLV gamers are scheduled to be received this fall. This research will be concluded in a paper detailing the literature review and a guide of best practices for SINE Lab and the wider IMGD community to use.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Benchmarking and Generalizing the Bounce Allocator
35	Authors	Brayden Little, Caleb Warzocha
	Advisors	Robert Walls
	Department	Computer Science
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Temporal memory vulnerabilities like use-after-free remain a persistent source of exploits in the Linux kernel. While the Bounce Allocator protects against use-after-free, we ask the question of how the performance of the Bounce Allocator compares with that of other security-focused memory allocators? To answer this question, we implemented the Bounce Allocator on the Radxa Orion O6 to test and compare the performance of the Bounce Allocator to other, similar memory allocators. For testing, we selected the SPEC CPU 2026 suite of benchmarks. The Bounce Allocator has a 0.05% memory overhead compared to the 5-8% of similar memory allocators. The Bounce Allocator strikes a balance between performance and security, while being able to instrument on top of existing memory allocators. Going forwards, the Bounce Allocator could be tested with memory allocators other than glibc’s malloc.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Monocular 3D Tissue Surface Reconstruction for Surgical Laser Focus Control
36	Authors	Andrea Travagliante, Callahan Henry, Kang Zhang
	Advisors	Loris Fichera
	Department	Robotics Engineering
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Laser surgery requires the laser to remain properly focused in order to make precise cuts while avoiding damage to surrounding tissue. However, because tissue surfaces are uneven, maintaining the correct focus throughout a procedure is challenging. This project investigates whether a single camera and the surgical laser can be used to reconstruct the three-dimensional shape of tissue and support automatic laser focus adjustment. To accomplish this, a laser beam was scanned across the surface while an RGB camera tracked the position of the laser spot. Changes in the laser spot location were used to estimate the surface height, and the method was tested on five 3D-printed specimens with known shapes. The system achieved average surface reconstruction errors between 0.16 mm and 0.32 mm, demonstrating sub-millimeter accuracy across all test specimens. These results show that the proposed approach can accurately estimate tissue geometry using simple imaging hardware and has the potential to improve the precision and automation of future laser-assisted surgical systems.

Acknowledgements: I would like to acknowledge the contributions of Callahan Henry, Kang Zhang, and Loris Fichera to this project, as well as the support of the National Science Foundation (NSF).

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Micro-Optics for Photonic Integrated Circuit Packaging
37	Authors	Nicholas Holbrook
	Advisors	Doug Petkie
	Department	Physics
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Photonic Integrated Circuits (PICs) are an emerging technology with applications in fields from biosensing to quantum computing. However, widespread deployment of PICs is limited by the precise fiber alignment required for efficient edge-coupling, making packaging a critical challenge. This work investigates micro-optic systems designed to increase alignment tolerances of fiber-coupled PIC packaging. Experimental results demonstrated the viability of micro-optics in fiber-to-fiber coupling by confirming simulated results, and simulations predicted similar improvements for fiber-to-PIC coupling. Additional simulations of meta-lenses and Bragg reflectors identified promising designs that will be validated in future experimental work. These results demonstrate the potential of integrated micro-optic components to simplify PIC packaging and enable more reliable deployment outside laboratory environments.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	MXene Chemistry-Dependent Electronic and Photothermal Properties of Silk Fibroin Composite Films
38	Authors	Dawei Liu, Jarin Maisha, Meghana Kesavan, Ivan Baginskiy, Serhii Dukhnovsky, Veronika Zahorodna, Oleksiy Gogotsi
	Advisors	Ronald L. Grimm, Kateryna Kushnir Friedman, Jeannine M. Coburn, Lyubov V.
	Department	Physics, Biomedical Engineering
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Transitional metal carbides and nitrides, known collectively as MXenes, are a family of 2D materials discovered in the last decade. It has the general formula M(n+1)XnTx, where M is an early transition metal, X is carbon and/or nitrogen, and Tx represents surface terminations such as -OH, =O, and -F. A wide range of MXene compositions have been synthesized and investigated; each exhibiting distinct electrical, optical, and thermal properties that make them attractive for applications in energy storage, electronics, sensing, and biomedicine. The surface terminations render MXenes hydrophilic, which enables the possibility to be combined with water-processable biopolymers such as silk fibroin to form composite films. In these composites, MXenes impart desirable functionalities including electrical conductivity, broadband optical and terahertz (THz) absorption, and efficient photothermal conversion, making MXene–silk composites promising candidates for biomedical and wearable-device applications. Previous studies have shown that the incorporation of silk fibroin into Ti3C2Tx-based composites greatly reduces long-range DC conductivity while largely preserving the AC conductivity at THz frequencies [1]. The addition of silk also modifies the photothermal response of the composites, allowing tuneable saturation temperature through changing the MXene-to-silk ratio. In this study, we investigate how MXene chemistry influences the optical, electronic, and photothermal properties of MXene–silk fibroin composite films. Particularly, we compare composites with Nb4C3Tx to Ti3C2Tx bases. THz time-domain spectroscopy (THz-TDS) is used to characterize frequency-dependent charge transport. Time-resolved THz spectroscopy (TRTS) is employed to probe photothermal dynamics on picosecond-to-nanosecond timescales, revealing how heat generated within optically excited MXene flakes is transferred to the surrounding silk matrix. An IR camera setup is used to observe the photothermal characteristics of the composite films on the second timescale. By correlating MXene chemistry with charge transport and photothermal behavior, this work provides insight into the design of MXene-silk composites with tailored properties for specific biomedical and optoelectronic applications.

Poster Number	Poster Title	Effects of Injury Severity and Perspective-Taking on Mock Jurors’ Perceptions Within Civil Cases
39	Authors	Keyla Padilla
	Advisors	Jeanine Skorinko
	Department	Social Science & Policy Studies, Psychology
	Summer Program	STAR Fellowship: Summer Training in Arts & Sciences Research

Abstract

Jurors may rely on injury schemas, or expectations about the harm that should result from an event, when evaluating psychological and physical injuries in civil cases (Vallano, 2013; Vallano & McQuiston, 2018). Previous research suggests that severe injuries can increase responsibility and compensation judgments for defendants, while perspective-taking may influence empathy and perceived culpability depending on whose perspective is considered (Bornstein, 1998; Robbennolt, 2000; Skorinko et al., 2014). The current study examined whether injury severity and assigned perspective-taking independently or jointly influenced mock jurors’ perceptions and decisions.

Poster Number	Poster Title	Using AI and Machine Learning to Predict Battery Material Properties
40	Authors	Emmanuella Brown, Yiqun Duan
	Advisors	Aaron Deskins
	Department	Computer Science, Mechanical Engineering
	Summer Program	REU: Functional Materials

Abstract

Among the ever-advancing technologies of the modern era, lithium-ion batteries have become an essential battery for green technologies due to their high energy density, long lifespans, and cheap production. In the coming decades, as the need for electrochemical batteries increases and the availability of lithium decreases, more sustainable, energy efficient, and stable designs are necessary. For this study, we developed a machine learning algorithm which could predict the overall quality of reproducible battery designs and compare such designs to determine the best contender. Through the Python language, a random forest algorithm took the material and electrical components of various battery models as input and calculated the max delta voltage, average voltage, gravimetric energy, gravimetric capacity, and stability charge. The results, including the optimal input design, were compared and displayed in interactable graphs. The results of this study will advance the battery market for both the benefit of the environment and human advancement.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Simulating Spin Qubit Dynamics in Two-Dimensional Materials Using the Cluster Correlation Expansion
41	Authors	Northey Cao, Robert Kramer
	Advisors	Sathwik Bharadwaj
	Department	Physics
	Summer Program	REU: Functional Materials

Abstract

Solid-state quantum bits (qubits) have emerged as a powerful platform for quantum sensing, achieving sensitivities well beyond those of classical sensors. Their key advantage lies in encoding weak magnetic fluctuations in the environment into well-defined quantum observables. Here, we develop a coupled cluster expansion method to investigate the dynamics of spin-qubits hosted in two-dimensional (2D) hexagonal Boron Nitride (hBN). We analyze the effects of different isotope concentrations, magnetic field, and pulse protocols on decoherence properties of boron vacancy-based spin qubits in hBN. Our work establishes a quantitative link between noise spectra and observables for hBN-based quantum sensors.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Modeling Photothermal Properties of MXene Composites
42	Authors	Rose Rocket Davis
	Advisors	Sathwik Bharadwaj, Lyubov V. Titova
	Department	Physics
	Summer Program	REU: Functional Materials

Abstract

Two-dimensional (2D) titanium carbide (Ti3C2Tx) has attracted significant recent attention due to its remarkable near-unity light-to-heat conversion efficiency. Hence, Ti3C2Tx and its composites have been widely explored for applications in artificial actuators, solar absorbers, and photothermal and photodynamic therapy agents in medicine. However, the mechanism of broadband light absorption across ultraviolet to near-infrared, ultrafast carrier-to-lattice energy transfer, and heat transfer across the MXene composite interfaces has not been fully understood. Here, we develop a semiclassical two-temperature model combined with interfacial Kapitza conductance to describe the ultrafast heat-transfer mechanism in MXene composites. We validate our model through direct comparison with optical pump–terahertz probe spectroscopy and thermal imaging experiments, demonstrating quantitative agreement across timescales and material composites. Our work provides a pathway for predicting and engineering photothermal performance in MXenes, enabling the design of next-generation high-efficiency photothermal devices.

Acknowledgements: This project was supported by the National Science Foundation Research Experiences for Undergraduates (REU) program under Grant No. 2447069.

Poster Number	Poster Title	Influence of MXene to Silk Ratio on Near IR (800 nm) Laser Exposure: Photothermal Properties and Drug Release
43	Authors	Meghana Kesavan, Jarin Maisha, Ankita Paul, Zephyr Paxton, Antonia Pelteku, Rachael Speckhard, Ivan Baginskiy, Serhii Dukhnovsky, Veronika Zahorodna, Oleksiy Gogotsi
	Advisors	Kateryna Friedman Kushnir, Lyubov V. Titova, Jeannine M. Coburn
	Department	Biomedical Engineering
	Summer Program	REU: Functional Materials

Abstract

MXenes are a class of two-dimensional transition-metal nanomaterials known for their high electrical conductivity and strong interactions with light. Ti3C2Tx, a widely studied MXene, exhibits promising photothermal properties that make it a viable candidate for drug-delivery applications. Ti3C2Tx can also be combined with silk fibroin to form composite films, in which the biocompatible silk protein slows the oxidation of Ti3C2Tx while slightly altering its photothermal behavior (1,2). In prior work, we used a broad-spectrum light source and determined that the presence of silk resulted in heating to higher temperatures when comparing samples with the same amount of MXene (3). In this work, we extend these findings using a NIR laser (808 nm), which is particularly relevant for biomedical applications. We analyze how the MXene to silk ratio in composite film format affects the photothermal properties and compare them with pure MXene samples of equivalent MXene content. Additionally, we investigate how the photothermal response differs when testing films in dry conditions and when testing them in wet conditions that mimic the human body. From these results, we select a single MXene to silk ratio and fabricate films, hydrogels, and porous sponges to understand the impact of form factor on photothermal properties. Finally, we use the findings from the wet photothermal results to determine if light-induced drug release can be achieved, using doxorubicin as a model drug.

Poster Number	Poster Title	Highly Stretchable Sensor Arrays for Soft Robotics
44	Authors	Jarek Michalak, Gary DeVilbiss
	Advisors	Pratap Rao
	Department	Mechanical & Materials Engineering
	Summer Program	REU: Functional Materials

Abstract

As the field of soft robotics and human wearables become more commonplace in industry, traditional strain gauges are unable to handle strains ranging from 10-200%. Stretchable strain gauges seek to remedy this problem by being mechanically compliant and highly stretchable. Using various elastomeric substrates, LMGs (Liquid Metal Gels), and Integrated Circuits, we are examining ways to create a stretchable strain gauge array. The primary goals we seek to achieve are for the array to isolate the strain of individual sensors, scalability of the array, and withstand high-strain repetitive motion without damage to the circuit. By testing multiple manufacturing methods including stencil printing, direct ink writing, and screen printing on elastomeric substrates using LMGs, we are able to print the stretchable circuits using a layer-by-layer approach. These findings look to provide a smoother interface with compliant surfaces allowing freedom of range of movement while translating motion of multiple joints into measurable data which can be sent to a microcontroller to interface with electronic components.

Acknowledgements: JM was supported by the National Science Foundation Research Experiences for Undergraduates (REU) program under Grant No. 2447069. This work was supported in part by Air Force Research Laboratory (AFRL) with SEMI-FlexTech under Agreement Number FA8650-20-2-5506 in support of Army Research Laboratory (ARL).

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Tetra(benzyl)Zn-cyclen converts CO2 to Bicarbonate faster than Zn-Cyclen
45	Authors	Eleni M. Papadopoulos, Timothy E. Lopes
	Advisors	Ronald L. Grimm
	Department	Chemistry & Biochemistry
	Summer Program	REU: Functional Materials

Abstract

Carbon dioxide (CO_2) emissions are a major driver of climate change, motivating carbon capture technologies for industrial materials, particularly building and construction materials. Cementitious materials represent a promising target for carbon capture and mineralization strategies. Elsewhere, researchers employed naturally occurring carbonic anhydrase (CA) to accelerate CO_2 hydration and mineralization in cementitious systems. However, its limited long-term stability motivates efforts to reproduce its high activity in a catalytic system that remains stable under the high temperatures and alkaline conditions encountered in cementitious materials. In our earlier work, Zn(cyclen), a biomimetic zinc-coordination complex based on the macrocyclic ligand cyclen (1,4,7,10-tetraazacyclododecane), catalyzes the hydration of CO_2 to bicarbonate at a Zn^{2+} active site, but at a rate that is orders-of-magnitude slower than the CA enzyme. Presently, we derivatized cyclen at the amine sites with benzyl bromide to yield 1,4,7,10-tetra(benzyl)azacyclododecane and with tert-butyl bromoacetate to yield 1,4,7,10-tetra(2-tert-butoxy-2-oxoethyl)azacyclododecane with the intention of more accurately replicating the CA superstructure beyond just an undercoordinated Zn^{2+} site. In CO_2 bubble tests designed to quantify carbonate production at highly alkaline pH, modifications to the cyclen ligand framework produced substantial changes in catalytic performance. Relative to Zn(cyclen), the benzyl-substituted derivative exhibited approximately 1.5-fold greater activity for the formation of carbonate compared to Zn(cyclen), and the tert-butyl-substituted derivative exhibited substantially lower activity. Furthermore, we used stopped-flow kinetic assays to determine second-order rate constants for the catalytic hydration of CO_2 and concomitant carbonate formation. The resulting kinetic parameters provide a direct, quantitative comparison of substituent effects on catalytic CO_2 hydration and guide the design of improved catalysts for carbon-capturing cementitious materials.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	The Effects of N-acetylglucosamine: Glucose Ratio on the Production and Properties of Bacterial Cellulose
46	Authors	Eleni M. Papadopoulos, Alireza Nikbakht, Daniel Pinto
	Advisors	Jeannine M. Coburn
	Department	Biomedical Engineering
	Summer Program	REU: Integrated Bioengineering Research

Abstract

Bacterial cellulose has grown in popularity in the biomedical field because of its biocompatibility and mechanical properties that allow it to work well in wound dressings among other applications. However, bacterial cellulose is still limited in biomedical use because it will not degrade within the human body and is not inherently antimicrobial. Previous studies have shown that altering the carbon source within the bacteria's media can change the properties of the cellulose. By altering the chemistry of cellulose through substitute carbon sources, hybrid exopolysaccharides that add amine groups could be created, allowing for the possibility of a greater variety of chemical reactions and property alterations. N-acetylglucosamine, particularly as the UDPylated form, could allow for hybrid cellulose-chitin exopolysaccharides with acetylated amine groups. In this study, N-acetylglucosamine was used as a substitute carbon source for glucose for Komagataeibacter hansenii cultures, with varied ratios of N-acetylglucosamine to glucose (0:100, 25:75, 50:50, 75:25, 80:20, 85:15, 90:10, 95:5, 100:0) as well as glucose concentration gradient with no N-acetylglucosamine and N-acetylglucosamine gradient with no glucose, to determine if we could create unique exopolysaccharides for biomedical applications. We calculated the percent yield of cellulose when bacteria were grown under different carbon sources. UV-vis spectroscopy was used to determine the visible optical properties of the resulting exopolysaccharides. Incorporation of N-acetylglucosamine was analyzed by FTIR, and the presence of amine groups, after deacetylation, was detected using a Ninhydrin assay.

Poster Number	Poster Title	Ultrafast dynamics of Anthracycline binding and release with Chondroitin Sulfate for Cancer treatment
47	Authors	Daniel Zlatanov, Jarin Maisha
	Advisors	Kateryna Kushnir Friedman, Lyubov V. Titova, Jeannine M. Coburn
	Department	Physics
	Summer Program	REU: Functional Materials

Abstract

According to the American Cancer Society, more than two million new cancer cases and over 600,000 cancer-related deaths are projected to occur in the United States in 2026. Although chemotherapy remains one of the most widely used cancer treatments, it is often associated with significant adverse effects because chemotherapeutic agents damage healthy cells in addition to cancerous tissue. Targeted drug delivery directly to tumors offers the potential to reduce systemic toxicity, enable higher localized drug concentrations, and improve patient recovery. Chondroitin sulfate (CS), a sulfated glycosaminoglycan, is a promising hydrogel for localized chemotherapy due to its biocompatibility and anionic groups, which allows binding with cationic anthracycline drugs such as doxorubicin through electrostatic interactions. While CS hydrogels have demonstrated the ability to bind and slowly release cationic drugs, the kinetic mechanisms governing drug–polymer interactions lucking fundamental understanding. In this work, we investigate the interaction between CS and the anthracycline drugs doxorubicin and daunorubicin using transient absorption spectroscopy and time-resolved photoluminescence spectroscopy. These structurally similar compounds differ by a single hydroxyl group, present in doxorubicin and replaced by a hydrogen in daunorubicin, which allows to isolate the contribution of hydrogen bonding and local polarity to binding and release kinetics. By probing the excited-state dynamics of drug molecules in the presence of CS, we characterize the mechanisms of interaction. Understanding this will provide fundamental insight into drug binding and release with CS hydrogels, bringing us closer to the development of intra-tumoral drug delivery systems as adjuvant therapies for cancer treatment.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Autonomous Measurement Optimization for Quantum Sensing of Magnetic Fields
48	Authors	James Nellis, Jacob Feinstein, Jacob Myers, Natalie Frey
	Advisors	Raisa Trubko
	Department	Physics
	Summer Program	REU: Functional Materials

Abstract

Quantum sensing of magnetic fields with nitrogen-vacancy (NV) centers in diamond is used in GPS-free navigation, characterization of 2D and thin film materials, analysis of integrated circuits, and imaging of biological and geophysical samples. For most applications, we aim to reach maximum measurement accuracy in the shortest time. In this work, we designed an autonomous optimization loop to update experimental parameters in real-time and reduce total measurement time. By contrast, typical measurement protocols select experimental parameters after initial calibration and keep parameters static throughout measurements, regardless of changes in the environment. Our calibration-free optimization method determines optimal measurement parameters using sequential Bayesian experiment design with a deep-learning ensemble backbone. In simulated experiments, our dynamic protocol reaches the desired measurement accuracy in 1.5 hours as compared to 4.1 hours with static parameters. This result demonstrates a 2.7 times speedup with no prior knowledge of the parameter landscape. Our next step is to integrate our autonomous optimization loop with hardware in a laboratory setting and evaluate measurement performance. This work has potential for improving NV diamond quantum sensing measurements across a broad range of applications.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Terahertz Probes of Carrier Dynamics and Disorder in Cr:ZnSe
49	Authors	Peter Olszak, Dawei Liu, Mattan Mohel
	Advisors	Kateryna Kushnir Friedman, Lyubov V. Titova
	Department	Physics
	Summer Program	REU: Functional Materials

Abstract

Chromium-doped zinc selenide (Cr:ZnSe) is a versatile room temperature mid-infrared gain medium, supporting broadly tunable lasing across 1.9–3.4 µm with output power levels of up to 100 W and pulse energy levels of tens of mJ and direct applications in molecular spectroscopy, medical diagnostics, and directed energy systems. The lasing performance of these crystals is inherently linked to absence of parasitic impurities, undesired light scattering due to internal defects and other mechanisms leading to internal optical losses. However, the microscopic mechanisms remain far from complete understanding, particularly the roles of defects, disorder, and dopant concentration. In this work, we study carrier and lattice dynamics in undoped ZnSe and Cr-doped ZnSe crystals using terahertz spectroscopy, such as THz photon energy matches to the energy scale of crystal lattice vibration and free carriers motion. We found that chromium incorporation modifies carrier lifetimes and transport characteristics, while frequency-dependent photoconductivity provides insight into carrier localization and the influence of disorder on charge motion. Together, these results provide a microscopic view of the interplay between doping, carrier transport, and lattice disorder in polycrystalline ZnSe-based materials.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Impact of CT-Derived Myocardial Scar on Ventricular Activation and Body-Surface Potentials in a Personalized Computational Heart Model
50	Authors	Alejandra Tello
	Advisors	Shijie Zhou, Artin Elhamirad, Zhen Qi
	Department	Biomedical Engineering
	Summer Program	CARDIO4U Supported by the AHA

Abstract

Myocardial scar can disrupt ventricular propagation and contribute to the substrate for ventricular tachycardia (VT). However, how image-derived scar geometry alters ventricular activation and body-surface electrical signals remains incompletely characterized. This undergraduate study evaluated the effects of incorporating CT-derived scars into a personalized ventricular electrophysiology model. Left ventricular (LV) geometry and abnormal myocardial substrate, identified from intramyocardial fat and reduced wall thickness, were reconstructed from CT images using ADAS 3D. The geometry was converted into a tetrahedral mesh with assigned myocardial fiber orientations. Electrical activation was simulated under identical pacing conditions in scar and no-scar models. In the scar model, dense scar was modeled as nearly nonconductive at 0.001 S/m, while border-zone conductivity was set to 20% of healthy myocardial conductivity as a simplified assumption. In the no-scar model, regions were assigned healthy-tissue conductivity. All other myocardial electrophysiological properties were held constant. The LV was registered to the torso geometry, and simulated transmembrane potentials were used to compute body-surface potentials (BSPs). The 78,906-cell mesh contained 3,595 dense-scar cells and 717 border-zone cells. Incorporating the scar model altered and prolonged LV activation, particularly near the scar and border zone. Maximum activation time increased from 121.55 ms in the no-scar model to 171.60 ms in the scar model, a 50.05-ms prolongation. BSPs were calculated at 352 torso nodes and mean-centered separately at each node before comparison. Across all nodes and time samples, the global normalized RMSE was 6.59% using global peak-to-peak range of the mean-centered no-scar BSP dataset as the denominator. This demonstrates that incorporating patient-specific scar geometry with conductivity can alter simulated LV activation and produce measurable torso-level electrical differences. Because border-zone conductivity was assumed rather than physiologically validated, future studies should evaluate parameter sensitivity and incorporate patient-specific electrophysiological properties.
This work was supported by the AHA CARDIO4U@WPI (Grant No. 26IAUST1549873).

Poster Number		
	Poster Title	Designing a leak-proof flow system for 3D printed blood vessel models
51	Authors	Simone Chapman, Reyla Williams
	Advisors	Yonhgui Ding
	Department	Biomedical Engineering
	Summer Program	CARDIO4U Supported by the AHA

Abstract

Cardiovascular disease remains the leading cause of death worldwide, with atherosclerosis serving as the underlying issue for many of these life-threatening conditions. Atherosclerosis typically develops in regions of disturbed flow, such as arterial branches and curvatures of blood vessels. The inside of these vessels are lined with endothelial cells (EC), which under healthy physiological flow conditions align with the direction of blood flow, and upregulate certain genes and markers that prevent plaque and fatty build up. However, in regions of disturbed flow, ECs lose this aligned morphology and adopt a dysfunctional phenotype which promotes plaque and fatty deposits to build up which narrow and block the arteries. This progression of atherosclerosis can lead to numerous cardiovascular complications like coronary heart disease, peripheral artery disease, heart attack, and stroke. Collectively, cardiovascular diseases affect nearly 50% of the American population. One promising method of combating these misaligned endothelial cells is through engineered surface topography induced cell alignment, which have been shown to guide ECs and improve endothelial function. However, it is unclear if these benefits remain under complex anatomical and physiological conditions. Additionally, in vitro models offer a promising solution to study and better understand cells under disturbed flow conditions. However, current vascular models are typically oversimplified, lacking physiologically relevant 3 dimensional geometries and fail to reproduce the disturbed flow conditions present in branched and curved vessels. Therefore, the overarching goal of this project is to develop a 3D physiologically relevant in vitro model of a small diameter vessel to study how ECs under healthy flow conditions compare to disturbed flow conditions, and to study if the addition of engineered surface topography will protect ECs from disturbed flow induced dysfunction.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Automated Optimization Equipped with GPUs For Fontan Surgery
52	Authors	Madisen McLeod, Yihong Olivia Song
	Advisors	Zhenglun Alan Wei
	Department	Biomedical Engineering
	Summer Program	CARDIO4U Supported by the AHA

Abstract

In the US, there are over three Fontan Surgeries every day. Fontan surgery is performed to palliate congenital heart defects characterized by single-ventricle physiology. The procedure creates a total cavopulmonary connection (TCPC), which directs systemic venous blood from the body directly to the pulmonary arteries for oxygenation, bypassing the subpulmonary ventricle. Because each patient has a different heart anatomy, patient-specific modeling may need to be evaluated during pre-surgical planning. In the routine workflow, evaluating one surgical option can take about 60 hours in total, including approximately 10 hours of manual input from an engineer, while computational fluid dynamics (CFD) simulations account for most of the computational time. This makes it difficult to efficiently evaluate many possible surgical designs. To speed up the planning process and to make them more useful in clinical practices, an existing automated optimization workflow was used in addition to evaluating the effect of computer processing units (CPU) and graphic processing units (GPU). This project builds on an automated optimization workflow previously developed in AIMCardio lab using a simple TCPC configuration. The workflow has now been extended to more complex, patient-specific geometries, while GPU computing was introduced to accelerate the CFD simulation step. Future work will compare the optimized geometries with clinically selected surgical options and further evaluate the computational performance of CPUs and GPUs. The research was supported by the American Heart Association with Grant # 26IAUST1549873 as a part of the CArdiovascular Research, Development, and Interdisciplinary Opportunities for Undergraduates at WPI (CARDIO4U@WPI). The authors also wish to thank the dedicated members of the Artificial Intelligence and Modeling Laboratory for Cardiovascular Diseases (AIMCardio Lab).

Poster Number		
	Poster Title	Quantifying CD44 Expression to Understand Remodeling in Atheroprone Environments
53	Authors	Arya Shahane, Zoe Vittum, Camden Holm
	Advisors	Solomon Mensah
	Department	Biomedical Engineering
	Summer Program	CARDIO4U Supported by the AHA

Abstract

Atherosclerosis impacts half of all adults above the age of 45. This is a condition causing plaque formation due to abnormal blood flow, leading to life-threatening conditions such as heart attacks and strokes. The glycocalyx is a carbohydrate-rich layer surrounding endothelial cells, or cells that line the blood vessels, playing a role in regulating the vessel barrier and transducing extracellular forces to create intracellular responses. A key catalyst of atherosclerosis development is the CD44 and hyaluronic acid (HA) binding axis, which is a component of the endothelial glycocalyx. Pre-atherosclerotic changes in blood flow patterns and vessel stiffness can change the protein expression of CD44, leading to disease progression. Studying this protein is crucial to better understand how changes to CD44 affect HA binding and hence contribute to the progression of atherosclerosis. With this research, I aim to develop an effective Western blot protocol that can display CD44 expression of human lung microvascular endothelial cells (HLMVECs). A Western blot immunoassay was developed and tested, aiming to extract CD44 from the HLMVECs to quantify expression via fluorescence. This protocol involves lysing the cells and determining overall protein concentration, and then separating the proteins in a polyacrylamide gel to differentiate proteins of various sizes. These protein bands were transferred to a nitrocellulose membrane and stained with a CD44 antibody and a control protein (GAPDH) antibody to visualize under fluorescent conditions on the Azure Imager. This experiment was successful in yielding a membrane with visible CD44 and GAPDH protein bands, demonstrating their presence in healthy HLMVECs. The protocol was further optimized to increase visibility of CD44 bands within the membrane by adjusting CD44 antibody concentrations. The immunoassay will be crucial in future studies for quantifying CD44 expression changes due to HLMVECs being exposed to turbulent flow and stiffened matrices mimicking pre-atherosclerotic conditions.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Characterization of Porous Anisotropic Fibrin Scaffolds with Tunable Mechanics and Degradation
54	Authors	Luke A. Morrow, Bridgette M. Bowyer, Ian M. Anderson, Bryanna L. Samolyk
	Advisors	George D. Pins, Kristen L. Billiar
	Department	Biomedical Engineering
	Summer Program	CARDIO4U Supported by the AHA

Abstract

Myocardial infarctions (MI) result in tissue hypoxia, which can cause permanent damage to functional myocardium, leading to the formation of non-contractile scar tissue and a reduction in cardiac function. As such, there is a need to create implantable scaffolds that promote myocardial tissue regeneration. Our laboratory developed a porous anisotropic fibrin scaffold that provides structural, extracellular matrix and topographic cues to guide cardiac regeneration. These scaffolds are fabricated using directional freeze-drying, and prior work has shown that varying the fibrin concentration and freezing temperature enables the tuning of the scaffold microtopography and cellular alignment. However, the resulting scaffold structural and mechanical properties were lower than those of native muscle tissue, creating a need for further processing of our scaffolds to achieve mechanical properties that more closely mimic native tissue stiffness. The goal of this study was to evaluate whether genipin or ultraviolet (UV) crosslinking could tune the mechanical properties, dimensional stability, and proteolytic degradation of porous anisotropic fibrin scaffolds. Scaffolds were fabricated using 10 or 20 mg/mL fibrin, crosslinked with genipin or UV light, and characterized using plasmin degradation assays, hydration-induced shrinkage measurements, and nanoindentation analyses. Genipin-crosslinked scaffolds showed substantially greater resistance to degradation, with the 1.7 mg/mL genipin-crosslinked group retaining 92.33 ± 3.87% of its initial area after 72 hours compared with 44.58 ± 33.04% for the uncrosslinked control. Genipin crosslinking also reduced scaffold shrinkage from 45.14 ± 4.24% to 17.66 ± 12.80% and increased the effective Young's modulus from 1.08 ± 1.13 kPa to 3.26 ± 0.63 kPa. In contrast, UV-crosslinked scaffolds did not show significant changes in degradation, shrinkage, or stiffness compared to uncrosslinked controls. These findings suggest that genipin crosslinking is an effective strategy for improving fibrin scaffold stability and stiffness, while preserving topographic features relevant to future myocardial tissue regeneration applications.

Poster Number	Poster Title	Foot Kinematics and Dynamic Arch Behavior During Barefoot and Shod Running
55	Authors	Melissa Vieira Rodrigues Domingues, Julia Nicolescu
	Advisors	Karen L. Troy
	Department	Biomedical Engineering
	Summer Program	CLIMB

Abstract

It wasn't until the 1970s that modern running footwear was introduced and natural running biomechanics was altered, a consequence of minimal footwear encouraging a forefoot strike pattern, whereas cushioned footwear is associated with a rearfoot strike. Foot biomechanics are strongly influenced by footwear and foot strike pattern, both of which play key roles in running-related injury risk. However, no prior studies have assessed detailed foot biomechanics in barefoot compared to shod running. Given the lack of detailed analysis and the potential benefit in running-related injury prevention that this understanding entails, this project investigated how foot kinematics and dynamic arch behavior differ between barefoot and shod running. We hypothesized that barefoot running would be associated with a lower Dynamic Arch Height Index and a mild forefoot strike pattern, characterized by increased plantarflexion at the ankle and toes. To test this hypothesis, a group of twelve recreational runners (13.5 ± 4.4 miles/week) completed barefoot and shod running trials while motion capture marker trajectories were collected (Vicon Vantage, 100 Hz). These data were then processed in Visual3D software (HasMotion) and used to calculate tibiotalar and metatarsophalangeal joint angles and the Dynamic Arch Height Index. We used Statistical Parametric Mapping and two-tailed paired t-test to compare key outcome variables between barefoot and shod conditions. Compared with the shod condition, barefoot running resulted in lower Dynamic Arch Height Index, decreased tibiotalar dorsiflexion, and increased metatarsophalangeal joint plantarflexion ($p<0.05$). These findings supported the hypothesis and may reflect the impact of footwear characteristics, such as stiffness and arch support, on foot kinematics and arch motion. This enhanced understanding of foot biomechanics improves our comprehension of metatarsal loading under different footwear conditions, potentially contributing to the development of injury prevention strategies. This research was supported by the National Institutes of Health (R15HD104169).

Poster Number		
	Poster Title	Investigating Curcumin Loaded Bacterial Cellulose Membrane for Slow-Release Antimicrobial Wound Dressing
56	Authors	Samantha Wheatley, Alireza Nikbakht
	Advisors	Jeannine M. Coburn
	Department	Biomedical Engineering
	Summer Program	Summer Volunteer Independent Research Project

Abstract

Bacterial cellulose (BC) is a biocompatible, porous, and water-retentive biopolymer commonly used as a wound dressing material but lacks antimicrobial function. Curcumin, a compound with antimicrobial and anti-inflammatory properties, can address this constraint. Poor aqueous solubility of curcumin limits direct therapeutic use, so curcumin can be loaded onto BC to provide stable and sustained delivery to the wound site. Drop-wise application has previously been used to load curcumin onto BC, but this method is not fully defined in literature. To address this gap, a modified loading protocol was used to determine the effect of curcumin loading dose on cumulative release from BC. BC pellicles were loaded in triplicate with 25, 50, and 100 μg/mL curcumin via drop-wise application in 20 μL increments to reach volumes of 40 and 60 μL. Samples were incubated in PBS (37°C) and release was measured over 72 hours via uv/vis spectroscopy evaluating the absorbance at 420 nm. Release was consistently biphasic with a rapid burst over the first 4 hours followed by a plateau by 24 hours. The pattern was preserved: when loading volume increased total release, and these higher concentrations also correlated with a greater percentage released (~80–82.5% at 50–100 μg/mL vs. ~20% at 25 μg/mL), suggesting a minimum loading threshold. These findings establish a standardized loading protocol that lay the groundwork for future work with curcumin-loaded BC as an antimicrobial wound dressing.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number		
	Poster Title	Synthesis of Tetradentate Isoquinoline Based Zinc Photocages
57	Authors	Ryan Alexander, Cayden Bombardier, Jacquelyn Abrams, Connor Doran
	Advisors	Shawn Burdette
	Department	Chemistry
	Summer Program	Summer Research Assistant

Abstract

Zinc photocages are organic chelators that enable temporal and spatial control of the release of Zn^{2+} when irradiated with light. Currently developed zinc photocages require UV light to release chelated zinc, limiting the viability of use in biological assays. Development of a photocage that is red shifted into the visible light spectrum would allow for use in biological assays with significantly reduced risk of damaging cells. Previous work on quinoline based photocages has been shown to red shift the λmax of the cage, because of the cage's ability to facilitate the antenna effect. A tetradentate ligand utilizing isoquinoline was designed to improve the photophysical properties of the Zinc photocage.

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Investigating the genetic relationship between ensa-1 and SNARE genes in ciliogenesis
58	Authors	William Mashoko, Abigail Descoteaux
	Advisors	Inna Nechipurenko
	Department	Biomedical Engineering
	Summer Program	CLIMB

Abstract

Primary cilia are highly specialized sensory organelles that play essential roles in cellular signaling and environmental sensing. Defects in ciliary structure or function disrupt these processes and lead to a diverse group of inherited disorders known as ciliopathies. Although the genetic basis of many ciliopathies has been identified, the molecular mechanisms that regulate ciliary maintenance and morphology remain incompletely understood. Previous work in the Nechipurenko lab has found a role for ENSA-1 in regulating ciliary morphology and maintenance. Specifically, my research examines whether ENSA-1 genetically interacts with SNARE-mediated membrane trafficking pathway that is critical for the proper organization and maintenance of sensory cilia using the nematode Caenorhabditis elegans as an in vivo model system. Through genetic crosses, fluorescence microscopy, and phenotypic analysis, I contributed to the characterization of genetic relationships between ensa-1 and genes encoding fusion machinery for intracellular vesicles. My findings suggest that ensa-1 functions in the same genetic pathway with the SNARE component snb-1 and SNARE-associated unc-18, to regulate ciliogenesis. Collectively, these results provide an important insight into the molecular mechanisms that regulate cilia morphology.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Foot Structure in Pregnancy: A Static and Dynamic Biomechanics Pilot Study
59	Authors	Abby Belding, Emma Slavin
	Advisors	Karen L. Troy
	Department	Biomedical Engineering
	Summer Program	Summer Research Assistant

Abstract

During pregnancy, the body undergoes major hormonal and physiological changes, including increased ligament laxity, weight gain, and anterior shifts in the center of mass. These changes often alter foot alignment, gait patterns, and weight distribution, resulting in discomfort, pain, and heightened fall risk. Although established pregnancy-induced biomechanical changes exist, the structural and functional changes in the feet remain unclear. We hypothesized that gestational age would be associated with arch flattening, an anterior shift in center of pressure, and decreased vertical loading. Our pilot study investigated static and dynamic foot biomechanics across the gestational period in eight pregnant participants. Motion capture marker trajectories (Vicon Vantage, 100 Hz) and ground reaction force data (AMTI, 1000 Hz) were collected during barefoot walking. Plantar muscle strength and static arch height index (AHI) were collected using custom-built dynamometers. We performed a Pearson's correlation analysis to assess relationships between key variables. The hypothesis was partially supported, and despite our lack of statistical power, we observed several potentially important relationships. We found that as gestational age progressed, standing AHI increased ($r=0.61$, $p=0.06$), likely due to foot swelling during pregnancy, while static center of pressure shifted posteriorly ($r=-0.51$, $p=0.13$), possibly to balance the anterior weight gain. During walking, vertical instantaneous loading rate increased ($r=0.54$, $p=0.12$), suggesting more rapid vertical loading with anterior weight gain, and midtarsal joint extension increased ($r=0.55$, $p=0.13$), indicating arch flattening. Although the sample size limited statistical power, these trends form a baseline of information for larger longitudinal studies. Future work will track participants during the postpartum period to evaluate lasting biomechanical changes, and results from this study may be used to inform targeted interventions, like custom orthotics or therapeutic exercises, to preserve mobility and alleviate pain.

Poster Number	Poster Title	GLD-3 and RNP-8 are both required for normal MEX-3 expression in the C. elegans germline
60	Authors	Bella Perry, Alison Bawabe, Danni Li
	Advisors	Karl-Frédéric Vieux
	Department	Biology & Biotechnology
	Summer Program	CLIMB

Abstract

RNA transcripts are tightly regulated in the C. elegans germline. RNA tailing, or the addition of nucleotide sequences to the 3' end of transcripts, is critical to the spatio-temporal regulation of RNA translation. Specifically, poly(A) tails promote both RNA stability and translation, increasing protein expression. GLD-2 is a non-canonical poly(A) polymerase that requires physical interactions with two other RNA binding proteins, as GLD-2 itself does not contain an RNA binding motif. GLD-3 and RNP-8 recruit GLD-2 and facilitate poly(A) tailing of its targets. However, GLD-3 is found ubiquitously across germline compartments, while RNP-8 is heavily expressed only in the proximal arm of the gonad, suggesting different roles in spatiotemporal gene regulation during gametogenesis. To date, only GLD-3 has been implicated in the expression of MEX-3. Our modeling of mex-3 translation, however, predicts that RNP-8 is also involved. The goal of this research is to determine how the mutually exclusive binding dynamics of GLD-3 and RNP-8 with GLD-2 impact regulation of MEX-3, a key protein that supports germline development in C. elegans. To investigate this, we performed RNAi knockdowns of gld-3 and rnp-8 independently and together, in different GFP-tagged C. elegans strains. GLD-3, RNP-8, and MEX-3 expression were determined by confocal microscopy and quantification of the associated fluorescent signals in the corresponding strains. We first tested the efficacy of gld-3 and rnp-8 RNAi on GLD-3 and RNP-8, respectively. While we were only able to mildly deplete GLD-3 expression, RNP-8 could be significantly downregulated. We then determined the effects of GLD-3 and RNP-8 depletion on MEX-3 expression. Our data shows that RNP-8 is required for the distal expression of MEX-3. We also found that proximal MEX-3 expression is GLD-3 and RNP-8- independent, and increases in their absence, suggesting that another poly(A) polymerase may be involved in its regulation.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	A Novel Method for Ground Reaction Force Assignment in Running
61	Authors	Duncan MacDonald, Emma Slavin
	Advisors	Karen L. Troy
	Department	Biomedical Engineering
	Summer Program	Summer Research Assistant

Abstract

Runners are subject to overuse injuries due to cyclic, high magnitude loading, with metatarsal bone stress injuries (BSIs) being one of the most common examples. Multi-segment foot models allow for detailed analysis of kinematics (ex. joint angles) but are not validated for the calculation of foot kinetics (ex. joint moment) because only one ground reaction force (GRF) vector is assigned to the whole foot. Current biomechanical research lacks a simple and effective method to apportion GRFs among segments of the foot. This project aimed to develop a novel method of apportioning the total GRF to multiple foot segments using plantar pressure data. Motion capture data (Vicon Vantage, 100Hz) from shod running was collected along with both ground reaction force (AMTI, 1000Hz) and plantar pressure data (XSensor Intelligent Insoles Pro, 150Hz). Plantar pressure data was organized into segments which reflect the segments of the lab's foot model. A custom MATLAB (MathWorks) script was used to calculate segment-specific GRF for running stance phase. Segment-specific joint moments were calculated in Visual 3D (HasMotion) using the single GRF vector and the software's automatic force assignment method, as well as using the apportioned GRF and center of pressure for each segment. Statistical parametric mapping using paired two-tailed t-tests found differences in joint moments between the two methods for the talocrural (54-95% stance phase, $p < 0.01$), midtarsal (84-96% stance phase, $p < 0.01$), and tarsometatarsal (78-96% stance phase, $p < 0.01$) joints. This new method of GRF assignment gives a more informed analysis of foot segment loading during stance phase, helping researchers better understand how metatarsal BSIs and related injuries occur in runners. This research was supported by the National Institutes of Health under award number R15HD104169 (to KLT).

Poster Number	Poster Title	Mechanoadaptation of the 2nd Metatarsal: The Influence of Adolescent vs. Adult Physical Activity
62	Authors	Katie Pierce, Julia Nicolescu
	Advisors	Karen L. Troy
	Department	Biomedical Engineering
	Summer Program	Summer Research Assistant

Abstract

Bone quality, a combination of composition and architectural characteristics, dictates overall skeletal strength and fracture resistance. Through bone remodeling, bone adapts to mechanical loading, but the structural outcome of this adaptation may differ depending on the developmental timing of the loading. As primary load-bearing structures in the forefoot, metatarsals experience substantial ground reaction forces during physical activity and are particularly susceptible to bone stress injuries. Understanding how physical activity and its timing across adolescence influence metatarsal micro- and macro-structure is essential for developing strategies to optimize bone strength and prevent injuries. This study examined how physical activity during adolescence (≤15) versus after adolescence (>15) influences second metatarsal bone quality. The past Bone-specific Physical Activity Questionnaire (pBPAQ) was used to quantify load intensity, activity frequency, and years of participation of 14 participants across both age ranges. High Resolution Peripheral Quantitative Computed Tomography (HR-pQCT) scans of the dominant second metatarsal were contoured to evaluate micro-architecture, as well as segmented to generate a 3D mask of the second metatarsal for macro-architectural calculations. Multiple linear regression analyses demonstrated that ≤15 pBPAQ scores correlated significantly and positively with macro-structural parameters (moment of inertia and polar moment of inertia), whereas >15 pBPAQ scores correlated significantly and positively with a micro-structural parameter (trabecular thickness) ($p<0.05$). Higher bending and twisting resistance, and thicker trabecular bone all contribute to enhanced bone strength. These findings indicate that physical activity during adolescence primarily dictates the overall macro-structural geometry of the second metatarsal, while post-adolescent physical activity impacts its internal micro-structure. Altogether, physical activity across both developmental ranges enhances different bone quality parameters of the second metatarsal, contributing to reduced fracture risk. This research was supported by the National Institutes of Health under award number R15HD104169.

Poster Number	Poster Title	Development of an Extracellular Matrix for an Aortic Valve-on-a-Chip
63	Authors	Delaney Mohl, Elisa Bilotta, Madison Silva, Juanyong Li, Rozanne Mungai
	Advisors	Kristen Billiar
	Department	Biomedical Engineering
	Summer Program	Tissue Mechanics and Mechanobiology Lab - Billiar Lab

Abstract

Calcific Aortic Valve Disease (CAVD), affecting an estimated 2.5 million people worldwide, involves complex molecular mechanisms driving valve stiffening and mineral deposition, yet no treatment exists beyond surgical valve replacement. These mechanisms are difficult to dissect in the complex in vivo environment, so a physiologically relevant in vitro model is needed to better understand disease-driving cellular mechanisms and support future therapeutic development. The goal of this study is to optimize a 3D valve-on-a-chip platform using cell-populated fibrin hydrogels and compare the resulting neo-tissue to collagen hydrogels. Fibrin gels (4mg/mL fibrinogen and thrombin) were seeded with Neonatal Human Dermal Fibroblasts (NHDFs) or Porcine Aortic Valvular Interstitial Cells (PAVICs) and cultured over 7 days in DMEM + 10% FBS, with or without matrix-enhancing supplements (GlutaMAX, insulin, ascorbic acid) and with or without TGF-Beta (TGF-β). Real-time media color shifts in pH were quantified via Red/Green greyscale ratios to assess cellular activity. Fibrin gel degradation and collagen gel compaction were tracked microscopically. Matrix remodeling was visualized using histology with Masson's trichrome staining. Media supplementation and TGF-β accelerated colorimetric shifts, signaling heightened metabolic activity. NHDFs compacted and remodeled the matrix to greater extents under these conditions. PAVICs compacted collagen gels throughout the culture period but actively degraded the surrounding fibrin matrix too quickly to form neo-tissue, indicating a need for protease inhibition. Together, these findings establish a fibrin as a promising scaffold for valve-on-a-chip models of cellular remodeling dynamics in CAVD. Future work will extend culture periods to promote fibrin turnover and collagen assembly, optimize Masson's trichrome staining to resolve current limitations in collagen detection, and incorporate the serine protease inhibitor aprotinin during gel casting to limit premature PAVIC-mediated fibrin degradation. Collectively, these steps will ensure long-term structural stability of the matrix before applying dynamic flow and stretch to emulate the valve's hemodynamic environment.

Poster Number		
	Poster Title	Investigation of Organically Terminating Conductive MXene Nanolayers
64	Authors	Thomas Peters, Collin Shuff
	Advisors	Ronald L. Grimm
	Department	Chemistry & Biochemistry
	Summer Program	GrimmGroup

Abstract

MXenes are a group of two-dimensional metal carbide and nitride nanomaterials with various terminating species such as anionic halides and hydroxides. MXenes have practical applications in flexible electronics, electronic shielding, biomedical engineering, and many other fields due to their electronic properties. MXenes form flakes when coated on a surface so the charge must travel between flakes under current, meaning MXenes gain their electronic properties from a combination of inter and intra flake properties. By changing the surface terminations on MXene nanolayers, unique dipoles are formed that create new MXenes for new applications. Molten salt synthesis was investigated as a way to form MXenes with organic terminations. We discuss how specific salt ratios and processing techniques impact thermally sensitive precursors in these processes. We also discuss use of chlorine terminated MXene with the structure $Ti_3C_2Cl_2$ in substitution reaction pathways. The Ti-Cl bond is particularly weak, allowing the chlorine to act as a leaving group to form new materials under the right conditions. Synthesis of these compounds will demonstrate pathways for attaching varieties of terminations on MXenes, opening new opportunities in MXene termination research. Characterization with X-ray photoelectron spectroscopy (XPS) is used to investigate the structure of synthesized MXenes.

Poster Number		
	Poster Title	Characterization of Extracellular Vesicles Using Differing Methods
65	Authors	Ariella Price , Kerstin Andrews, Alexandra Harrison,
	Advisors	Christina M. Bailey-Hytholt
	Department	Chemical Engineering
	Summer Program	Bailey-Hytholt Lab Summer Research

Abstract

The Placenta is one of the most misunderstood organs in the human body. An integral communicator for the placenta is Extracellular Vesicles or EVs as they bring biomarkers around the human body. All cells have EVs apart of them and the cells used to trial the methods were HTR-8s and JEG-3s which are both models of placental Extravillous trophoblasts (EVTs). There are three types of EVs are microvesicles, apoptotic bodies, and exosomes; a good method for finding specifics of these has not been found. Exosomes are the main EVs this research was looking for and will continue to look for as research continues. A way to get data for the EVs in cells is to isolate the exosomes; then use the nanosight to find concentration and particles per cell, or use the zetasizer to find zeta potential, and lastly use the ultracentrifuge to see if spinning at faster speeds would change the amount of EVs collected.

Worcester Polytechnic Institute

2026 WPI Summer Research Showcase Program

Poster Number	Poster Title	Evaluation of Extrusion Parameters on Physicochemical Properties of pH-responsive Liposomes for Drug Delivery to Staphylococcus epidermidis
66	Authors	Winnie Yang, Emily Lei, Scarlett Xu, Alexandra Harrison, Patryck Michalik
	Advisors	Christina M. Bailey-Hytholt, Elizabeth J. Stewart
	Department	Chemical Engineering
	Summer Program	Undergraduate Summer Research

Abstract

Staphylococcus epidermidis is one of the most common causes of infections acquired in a hospital setting, with difficulty in treatment due to biofilm formation. Biofilms have reduced susceptibility to antibiotics compared to planktonic cells and have natural pH gradients (pH 4-6) within their structures. Liposomes are spherical vesicles used in drug delivery and can be engineered to be pH-responsive in the microenvironment of biofilms. Here, liposomes were formulated with MC3, an ionizable lipid with pKa of 6.44, DSPC, and cholesterol by thin-film rehydration followed by extrusion with either a 100 nm polycarbonate membrane filter or sequential 100 nm+50 nm filters. When characterizing 100 nm extruded liposomes, the hydrodynamic diameter was 170.9 nm, polydispersity index (PdI) was 0.226, and zeta potential was –7.04 mV. The hydrodynamic diameter of 100 nm+50 nm extruded liposomes was 149.7 nm, PdI was 0.267, and zeta potential was –2.39 mV. Next, liposomes were diluted in pH-buffered solutions to evaluate the effect of pH on liposome characteristics. As pH decreased, size increased, indicating swelling of liposomes; zeta potential became increasingly neutral and was positive at pH 4. 100 nm extruded liposomes had a notable size increase of 67 nm at pH 6.5, whereas with 100 nm+50 nm extruded liposomes a size increase of 77 nm occurred at pH 5.5. Liposomes extruded with 100 nm filters were typically larger than 100 nm+50 nm extruded liposomes when neutral and from pH 5.5-8, but smaller from pH 3.5-5. Zeta potential is largely affected by lipid composition and pH and therefore was not significantly affected by the filters used. The pH study for both extrusion methods showed protonation of liposomes within the pH range of biofilms, as suggested by the shift to a positive zeta potential and the size increase at pH 6.5 and 5.5 as compared to neutral liposomes.