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Summer Undergraduate Research Expo

August 8, 2024
McNamara Alumni Center
Memorial Hall
2:30 – 4:30 PM

1.	**Leanne Airhienbuwa** *Triple Negative Breast Cancer in 3D microtissues* **Advisor: David Wood** **Sponsoring Program**: BME Pathways **Home Institution:** Stony Brook University **Abstract:** Triple-negative breast cancer (TNBC) is a very aggressive form of breast cancer with lower survival rates compared to the other types and is treated with various chemotherapy drugs. "Doxorubicin (DXR) is one of the most-used anticancer drugs in the treatment of triple negative breast cancer"(1). Our study seeks to understand the effects of DXR when treating TNBC cells (Hs578t) in a 3D microtissue environment. The microtissues utilized in this study are able to replicate the tumor microenvironment better than a spheroid would(2) because we can create and utilize the extracellular matrix that makes our model more physiologically relevant. By utilizing this 3D environment we aim to predict drug response, view changes in cell cycle regulation, and complete RNA extraction to understand genetic factors at play. To complete our aims we fabricated microtissues and treated them with doxorubicin and DMSO. After 2 and 5 days, media samples were collected to study in an M65 ELISA. Additionally, tissues were stained and imaged for cell viability. Beyond the microtissues, bulk gels were fabricated to start the process of RNA extraction. Overall this study allowed for a physiologically relevant model to understand the effects of doxorubicin on triple-negative breast cancer.
2.	**Jonathan Auckenthaler** *Scaled-Up Experimental Modeling of Rotation Dynamics of Flagella at Constant Torque* **Advisor: Moumita Dasgupta, Xiang Cheng** **Sponsoring Program**: MRSEC **Home Institution:** Augsburg University **Abstract:** Bacteria like E. coli are propelled by a bundle of helical flagella driven by rotary motors which operate under a constant torque in the normal swimming condition. Although flagellated bacterial swimming has been extensively studied, the collective dynamics of interacting flagella in a bundle dictated by complex hydrodynamic, elasto-hydrodynamic and steric interactions is still not fully understood. To better understand this interplay, we are designing an experimental macroscopic scaled-up model of flagellar bundles. Currently, we are testing a brushed DC motor to implement constant torque using a feedback loop through a proportional-integral-derivative controller (PID). Trials have been conducted to measure torque from a wide range of currents at different constant voltages by attaching a uniform cylinder to the motor-shaft and immersing it in a cylindrical tank filled with a highly viscous fluid. This allows us to calculate the torque of our motor using the principles of Couette flow, and this data will be used to better tune our feedback loop. Once implemented, we will use particle image velocimetry to map the flow-field around our two model flagella at varying distances from each other to gain important insights into the hydrodynamics of flagella in a bundle driven by a constant torque.
3.	**Maryam Bacchus** *Understanding the impact of generative AI assistance in writing-based tasks* **Advisor: Harmanpreet Kaur** **Sponsoring Program**: Human-Centered Computing **Home Institution:** Vassar College **Abstract:** Following the public release of ChatGPT in late 2022, generative AI (genAI) tools have been increasingly embedded in a variety of knowledge work tasks (e.g., writing, coding, information retrieval). We focus on the impact of genAI on writing: individuals across disciplines are now using genAI for both creative and non-creative tasks such as writing articles, cover letters, and application forms. However, with the fast pace of technological advancement in this setting, we have yet to fully realize the impact of using genAI for these tasks. Therefore, we consider the following research questions: (1) how does the process and outcome of writing change when people use AI-assisted tools, and (2) to what extent does personality play a role in this behavior? In order to test these questions, we conducted a within-subjects pilot study where participants completed two writing tasks—with and without an AI-assistant—as well as a short exit interview. Our results speak to the changes in the writing process between the two conditions, attention to detail, and whether or not an individual's levels of conscientiousness and agreeableness connect to their performance.

4.	**Catherine Bao** *Enhancing LLM Accuracy in Self-Diagnosis: Strategies for Optimizing Performance With Accessible Toolkits* **Advisor: Qianwen Wang** **Sponsoring Program**: Human-Centered Computing **Home Institution:** University of Utah **Abstract:** With large language models now achieving nearly 85% accuracy on the USMLE, they still fail to provide accurate at-home diagnoses for the general public because of inadequate information and improper terminology. By introducing a toolkit designed to enhance patient interaction with AI, we can promote precise and structured inquiries to increase the reliability of LLM diagnoses. The toolkit optimizes user input through pre-determined prompt engineering, ensuring inquiries are precise and structured. By refining prompts for a professional tone and guiding users to provide additional relevant details, the toolkit enhances the quality of information provided to the AI. Simulated users from standard datasets were employed to test this approach showing this method significantly improved diagnostic accuracy compared to unstructured, casual prompts. Bridging the gap between AI and user interaction the toolkit aims to create a world where accurate self-diagnosis can make healthcare more accessible.
5.	**Kieron Best** *Design of an End-to-End Droplet System for Cryopreservation of Cells* **Advisor: Chris Hogan** **Sponsoring Program**: ATP-Bio **Home Institution:** North Carolina Agricultural and Technical State University **Abstract:** Vitrification-based cryopreservation is a promising method for storing biological samples for later use, especially cells. Vitrification occurs when a liquid is rapidly cooled below its glass transition temperature, minimizing ice formation and creating a glass-like state. This process requires high-speed cooling rates (10^3 K/sec or more) until the system is below its glass transition temperature (136 K for water). By spraying different concentrations of CPAs and determining the fraction of droplets that are vitrified, the cooling rate in the system can be estimated. A droplet-based vitrification system was developed, using monodisperse droplet generation and an annulus for liquid nitrogen co-flow. This system produces droplets about 50 micrometers in diameter. Optical microscope images of the samples reveal whether vitrification or freezing occurred. Results show that approximately 50% of droplets are vitrified with 15% ethanol or 23% propylene glycol (PG), leading to estimated cooling rates of ~10^4 K/min. These findings suggest that the system achieves some of the fastest cooling rates used in cryopreservation. As a result of our research, we aim to develop high-throughput cryopreservation of cells, supporting cell therapy, biotechnological advancements, and research.
6.	**Trevor Blodgett** *Building Detection Software for Ringdown Gravitational Waves* **Advisor: Michael Coughlin** **Sponsoring Program**: Physics REU **Home Institution:** University of Toledo **Abstract:** Since the first detection of gravitational waves back in 2015, technology has been ever-improving for making detections. Recently, detection softwares have used machine learning for locating gravitational waves. Aframe is a detection software developed by a collaboration of scientists that included The University of Minnesota. Aframe was developed for detecting compact binary coalescences (CBCs). CBCs have three stages inspiral, merger, and ringdown. The purpose of this project was to incorporate detection for ringdown waveforms into Aframe such that the third phase of the CBCs could be detected.

7.	**Maddy Brown** *Can I trust artificial intelligence with questions about my health?* **Advisor: Qianwen Wang** **Sponsoring Program**: Human-Centered Computing **Home Institution:** Carleton College **Abstract:** Large language models (LLMs) are becoming increasingly prevalent in society. They show especially promising potential in the medical field, where medical professionals and patients alike are using artificial intelligence (AI) platforms to fulfill or supplement their health-related inquiries. The performance of LLMs has been tested extensively on professional medical questions from the United States Medical Licensing Exam (USMLE) and other similar datasets. However, LLMs have not been tested on unprofessional medical questions that are likely to come from everyday patients turning to AI platforms for advice about their health. Our study aims to address this gap in the current research by investigating how the performance of GPT-3.5, a widely recognized LLM, on medical questions might be compromised if questions are asked unprofessionally or restricted to certain patient groups that are not covered in current datasets. By feeding GPT-3.5 baseline questions from the USMLE in addition to altered versions of the questions that are phrased in the tone of specific demographic communities, we calculate the difference in accuracy between the performance of GPT-3.5 on professional versus unprofessional medical questions.
8.	**Michelle Brubaker** *Ex Vivo Heart Perfusion: Decrease in Function Over Time* **Advisor: Ryan Nadybal** **Sponsoring Program**: ATP-Bio **Home Institution:** Colorado College **Abstract:** Reperfusion methods are now used to transport hearts going for transplant. However, these organs are susceptible to edema formation, which like in vivo, can become severe enough to interfere with function. Cardiac edema occurs when extracellular fluid accumulates in tissues, resulting in swelling and leading to various cardiac diseases. Due to the uncertain causes of edema, measuring how cardiac function decreases over time during ex vivo perfusion and comparing it with the amount of edema formed allows for further understanding on how this phenomenon affects organ function. The study used a total of 42 swine hearts that had been transferred into an ex vivo heart perfusion (4-6 hours), documenting the pre- and post- weights and measuring left ventricular pressure. LabChart was used to calculate developed pressure and average cyclic minimum and maximum pressures. In all three parameters, the function diminished for the first hour and subsequently remained steady for the next two hours, until function started declining again. Future research should include examining metabolic activities of the heart during ex vivo perfusion and how that relates to edema formation and function. The goal of this work is having the tools to evaluate and bio-preserve organs for return of function.
9.	**Oliver Clarke** *Accessing an Inaccessible Polycarbonate through Post-Polymerization Backbone Modifications* **Advisor: Ian Tonks** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Wesleyan University **Abstract:** Although a polymer's architecture dictates its properties few examples of post-polymerization backbone modifications are reported. Recently, Tonks and Zhukhovitskiy demonstrated a [3,3]-sigmatropic oxo-rearrangement to linearize branched polyesters and polyurethanes. Here, we utilize the [3,3]-sigmatropic oxo-rearrangement to access a polycarbonate structure which is inaccessible through ring-opening polymerization of the respective 5-membered cyclic carbonate.

10.	**Osvaldo Curiel** *Enhancing Nanofiber based Triboelectric Nanogenerators via sputtered metal nanofilms* **Advisor: Chris Leighton** **Sponsoring Program**: MRSEC **Home Institution:** University of Texas Rio Grande Valley **Abstract:** Tribolectric Nanogenerators(TENGs) could revolutionize wearable and portable electronics by converting mechanical energy from everyday movement into electrical energy using the triboelectric effect. Nanofiber based triboelectric nanogenerators are especially promising as their increased contact surface area allows for greater charge transfer, in addition to their mechanical flexibility and biocompatability with human applications.To further augment the charge transfer, vacuum magnetron sputtering will be used to produce nanofilms of various metals on the surface of PLA nanofiber mats. The voltage generated by the modified nanogenerators will then be measured and compared to each other to determine the optimal metal nanofilm. Afterwards, the optimal sample will be characterized via X-Ray Diffraction(XRD) and X-Ray Reflectivity(XRR) to determine the crystal properties and verify film thickness. Finally, a thickness dependency study will determine the optimal nanofilm thickness for maximizing generated voltage.
11.	**Mary Davenport** *Measuring Flare Sizes to Aid in the Search for the Coronal Heating Mechanism* **Advisor: Lindsay Glesener** **Sponsoring Program**: Physics REU **Home Institution:** Gustavus Adolphus College **Abstract:** Astrophysicists have been perplexed by the mystery of the solar corona's high temperature, as its heating source remains unclear. One hypothesis suggests that numerous small flares continuously produce enough thermal energy to account for the observed temperature in the corona. To derive these thermal energies, the physical size of the flare must be known, along with the temperature and brightness. The Nuclear Spectroscopic Telescope ARray (NuSTAR) offers greater sensitivity than other solar instruments, enabling the detection of fainter flares. However, NuSTAR was not optimized for looking at the sun, resulting in poor spatial resolution. Conversely, the Atmospheric Imaging Assembly (AIA) provides clear spatial resolution for calculating the true size of flares. Thus, AIA area is compared to NuSTAR area contours using Python to identify a systematic relationship between the two and to help aid in the search for the coronal heating mechanism.
12.	**Oluwakemi Dawodu** *Discovery of Binders to the TROP2 Receptor for Targeted Cancer Drug Delivery*. **Advisor: Ben Hackel** **Sponsoring Program**: MRSEC **Home Institution:** University of California, Riverside **Abstract:** Cancer is a complicated and nuanced disease that claims the lives of millions every year . Targeted drug therapy has the potential to save numerous lives by preferentially deploying potent molecules on tumor cells while avoiding healthy cells. Trophoblast cell surface antigen 2 (Trop2) is a cell surface glycoprotein that has one intracellular domain, one extracellular, and a transmembrane, as well as a cytoplasmic tail used for signaling7. Trop2 is expressed in normal tissues, but is overexpressed in cancers like ovarian, prostate, pancreatic, and breast. The reason Trop2 is overexpressed is not yet known, but it is a necessary driver in the proliferation of cancer cells and controls the cell cycle through the calcium ion signaling pathway. Trop2 overexpression is associated with metastasis and decreased patient survival. As such, Trop2 is a compelling target for immune engagers, radioligand therapy, ligand-drug conjugates, and other drug targeted therapy. My goal is to identify a protein that can bind strongly (≤5 nM affinity) and selectively (≥100:1 stronger binder to Trop2 versus other proteins).Using a combination of three libraries in yeast, sort for the best binding will be conducted using magnetic activated cells sorting and fluorescence activated cell sorting.

13.	**Brennen de Jong** *Evaluation of Ligand-Mediated Dust Dissolution Rates of Iron in Seawater* **Advisor: Rene Boiteau** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Carthage College **Abstract:** Iron (Fe) is an essential micronutrient in the ocean but is insoluble in seawater and is present at low concentrations, limiting surface production in 40% of the ocean. Therefore, understanding Fe cycling in the ocean is important. Saharan dust is the primary source of Fe to the North Atlantic Ocean. Fe sources are typically traceable using δ^{56}Fe signatures, however, the δ^{56}Fe signature in the North Atlantic is heavier than dust or any known sources can account for. Fe-binding ligands could potentially stabilize heavier Fe in the water column. To determine whether ligand-mediated dust dissolution results in fractionation towards heavier δ^{56}Fe, dissolution experiments were performed with dust collected at Tudor Hill Marine Atmospheric Observatory in Bermuda and analyzed by LC-ICP-MS. In an acid leach designed to mobilize Fe that could be bound by strong ligands, 2.84 times more Fe was released per gram of dust by samples collected during a peak Saharan dust event than in samples from an off-peak period. The same trend was seen for manganese and aluminum. Research will be continued in collaboration with Dr. Tim Conway at the University of South Florida to determine the isotopic fractionation of the Fe over the course of these experiments.
14.	**Dyana De Leon-Elizondo** *Incorporation of bio-oils in traditional elastomeric systems* **Advisor: Lynn Walker** **Sponsoring Program**: MRSEC **Home Institution:** University of Texas Rio Grande Valley **Abstract:** In this study, we develop stretchable oil-swollen elastomers with triblock copolymers. Network structures were achieved with ABA copolymer, polystyrene-block-poly (ethylene-co-propylene)-block-polystyrene, PS-PEP-PS (SEPS). With a PS-PEP-PS triblock copolymer, glassy PS blocks can be linked through midblock PEP chains which leads to network structures. When midblock selective oil is introduced, PEP chains that bridge PS blocks are swollen and this can tune viscoelasticity of this network. Therefore, a triblock copolymer, such as SEPS, and a midblock-selective solvent are to be used. This is to say, the purpose of this research study is to provide tunable elasticity to the SEPS elastomer through the use of a midblock-selective solvent targeting the midblock PEP chains. By incorporating linear rheology, we are better able to characterize and quantitatively assess the effect that increased concentrations of oil as well as varied molecular weights of SEPS copolymers have on G' and G". In addition, an AB diblock copolymer, polystyrene-block-poly (ethylene-co-propylene), PS-PEP (SEP), is to be used as a source of comparative analysis as diblock copolymers are not able to form bridges due to the lack of an extra PS block. Further analysis of the concentrations of network structures and their behavior are derived from such characterization.
15.	**Liz Duerr** *Antimicrobial protein modified microfiltration membranes for pathogen removal in drinking water treatment.* **Advisor: Boya Xiong** **Sponsoring Program**: MRSEC **Home Institution:** Baylor University **Abstract:** Moringa oleifera (MO) possesses cationic proteins within its seeds that have known antimicrobial properties. By coating a polydopamine (PDA)-modified commercial polyvinylidene fluoride (PVDF) microfiltration (MF) membrane with MO proteins, we created a membrane that can potentially disinfect pathogens in water. To do so, MO seeds were ground and extracted for water soluble cationic protein. The PVDF MF membrane was first modified with PDA, followed by the aforementioned protein serum (PVDF_PDA_protein), both via a dip coating method. A non PDA-modified membrane was made using vacuum filtration. To assess the success of protein coating, the surface chemistry of the modified membrane was analyzed using Attenuated Total Reflectance FTIR Spectroscopy; this analysis confirmed successful coating of both PDF and protein onto the membrane. The performance of the membranes was assessed for water permeability using dead-end filtration, which was shown to increase slightly with modification. We plan to access the antibacterial activity using contact kill and filtration experiments with *E. coli, B. subtilis* and MS2 bacteriophage. Additionally, resistance to biofouling will be assessed using *P. aeruginosa,* where we project inhibition or delay in biofilm formation. This work potentially could offer a novel, effective, simple, and sustainable water treatment technology for water-borne pathogen removal.

16. **Brianna Endy**
Phase Behavior of a Complex Coacervating System with the Addition of an Anionic Surfactant
Advisor: Lynn Walker
Sponsoring Program: Center for Sustainable Polymers
Home Institution: York College of Pennsylvania
Abstract: Complex coacervation is a liquid-liquid phase separation where oppositely charged species separate into a species dense coacervate phase and a dilute supernatant phase under varying environmental conditions. Coacervates have been used in a variety of consumer formulations, including pharmaceuticals and personal care products, to concentrate active ingredients. Cationic polymers have also been used to remove pollutants like PFOS from water. This work characterizes the phase behavior of a model coacervating system with the addition of an anionic surfactant. This work uses cationic polydiallyldimethylammonium chloride (PDADMAC) and anionic polystyrene sulfonate (PSS) at various KBr concentrations to determine the effects of sodium dodecyl sulfonate (SDS) or anionic dye (Congo red) on the polymer coacervating system. The phase separation was determined using turbidity measurements on a UV-VIS spectrometer and applying the lever rule to samples allowed to settle over time. The compositions of the phases will be used to determine if the anionic species aggregate in the coacervate phase. The results from this work will lead to further research on removal of pollutants, like PFOS, from water.

17. **Ashley Everette**
Cell Culture Techniques for Validation of Spray Based Cryopreservation
Advisor: Chris Hogan
Sponsoring Program: ATP-Bio
Home Institution: North Carolina Agricultural and Technical State University
Abstract: Vitrification-based cryopreservation involves cooling cells, tissues, and biological materials below the glass transition temperature of water (135 K) to prevent ice formation. We are developing a spray-based method for this purpose, focusing on Human Dermal Fibroblast (HDF) cells. This approach includes generating tiny droplets (<100 micrometers) containing cells and cryoprotective agents, and using liquid nitrogen to rapidly cool them, inducing vitrification—a glass-like state where metabolic activity slows, enabling long-term preservation.
Successful implementation requires precise cell culturing to prepare cells for encapsulation and testing in the spray-based vitrification process. HDF cells, stored in liquid nitrogen upon arrival, are cultured in media at 37 °C, incubated, and harvested after 48 hours. Harvesting involves trypsin treatment and several wash steps to ensure cell viability. Once prepared we find that viable HDF cells can be mixed with cryoprotective agents, sprayed and incorporated into droplets, which can be successfully vitrified provided the cryoprotective agents concentration is sufficiently high, and the liquid nitrogen coflow is utilized. Optical microscope images of droplets produced via the spraying of cell culture media reveal the presence of cells within otherwise transparent droplets.

18. **Sam Foley**
Exploring the oxidation properties of poly(vinyl ether)-block-poly(thiirane) block copolymers
Advisor: Jessica Lamb
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: Department of Chemistry, University of Minnesota - Twin Cities
Abstract: Poly(thioether) is a type of polymer that contain sulfur atoms in the backbone of the polymer and are commonly used in coatings, adhesives, and sealants due to excellent thermal stability & weatherability. These polymers are also known to undergo oxidation into poly(sulfoxides) or poly(sulfones) based on the type of oxidant introduced. This ability to react with oxidants is of interest as this can change the chemical and thermal properties of the polymers. Recently, the Lamb Lab has generated novel poly(vinyl ether)-block-poly(thiirane) block copolymers and this work explores the oxidation of the poly(thioether) portion of these block copolymers. In order to determine oxidation conditions of the block copolymer, poly(thioether) homopolymers using different thiirane monomers were generated and subsequently oxidized with different oxidative conditions. The characterization and the thermal properties of these homopolymers were explored.

19.	**Sean Gaffaney** *Implementation of Constant Torque Control in a Macro-Scale Flagellar Model* **Advisor: Xiang Cheng**, **Moumita Dasgupta** **Sponsoring Program**: MRSEC **Home Institution:** Augsburg University **Abstract:** Many microorganisms use tiny molecular motors with propeller-like filaments called flagella to move through their fluid environments. Our lab's broad goal is to develop a macro-scale model of multiple flagellar motors to examine the fluid dynamics of the flagella bundling and the transitions to and from the non-bundling phase. These micromotors operate in high-viscosity conditions using constant torque, so my task was to develop a setup capable of controlling a motor's torque when spinning its rotor in a viscous fluid. We used aluminum cylinders as our test rotors because we can calculate their torque directly, and they simplify the system so there are fewer unknowns to factor in. We used a motor microcontroller and its built-in PID current control to adjust the motor's torque and keep it stable against fluctuations.
20.	**Sofia Garcia** *Exploring the Impact of GAS6 and Cobalt Chloride-Induced Hypoxia on Dormancy in Triple-Negative Breast Cancer Cells* **Advisor: Emilio Tarcitano** **Sponsoring Program**: BME Pathways **Home Institution:** Columbia University **Abstract:** Breast cancer cell dormancy is a state where cells enter a period of inactivity, evading detection and clinical treatment, often described as the G0 phase. In this phase, cells exit the active cycle and enter quiescence, not dividing but capable of re-entering the cycle. Understanding breast cancer cell dormancy is crucial to the development of more effective treatments and prevention strategies for metastasis and cancer recurrence. My project focuses on dormancy in triple-negative breast cancer (TNBC), an aggressive subtype of breast cancer characterized by the absence of estrogen and progesterone receptors and the lack of HER2 protein overexpression. It is well-established that TNBC cells exhibit a propensity for dormancy within the bone marrow, necessitating a thorough understanding of the key factors and mechanisms within this microenvironment that contribute to this phenomenon. This research investigates the role of GAS6 and hypoxia in the dormancy of TNBC cells, both critical aspects of cancer progression and metastasis. By inducing hypoxic conditions using cobalt chloride (CoCl2), we aim to elucidate the molecular mechanisms through which GAS6 and hypoxia interact to maintain cancer cell dormancy. Understanding these interactions could lead to novel therapeutic strategies targeting dormant cells, improving treatment outcomes for TNBC patients.
21.	**Andrea García Ramos** *Synthesis and characterization of nanoparticles based on doxorubicin-PLGA conjugates for further developing cancer treatments* **Advisor: Natalie Boehnke** **Sponsoring Program**: MRSEC **Home Institution:** University of Puerto Rico, Cayey Campus **Abstract:** Nanomedicine offers a promising alternative to traditional chemotherapy by reducing off-target toxicity and enabling targeted drug delivery. In a recent high-throughput nanoparticle study, nano-bio interactions that predict successful nanoparticle (NP) delivery were probed, and it was discovered that certain biologic features can be predictive of delivery outcomes. SLC46A3 was identified as a negative regulator of lipid-based NP uptake, a finding not applicable to polymeric nanoparticles like those composed of poly(lactic-co-glycolic acid) (PLGA). As PLGA NPs are an attractive choice due to their biodegradability, biocompatibility, and controlled drug release capabilities, we are interested in gaining a deeper understanding of the relationship between SLC46A3 levels in cells and NP delivery, particularly in the context for drug-loaded NPs. This study focused on developing PLGA NPs loaded with doxorubicin (DOX), a chemotherapeutic known for its efficacy but also for severe side effects like cardiotoxicity. Via an amide linkage, DOX was conjugated to PLGA because we hypothesize a covalent conjugation will minimize drug loss and enhance stability compared to non-covalent methods. The conjugate was characterized by H-NMR and HPLC. Nanoparticles were formed using nanoprecipitation, with size and polydispersity index characterized by dynamic light scattering and zeta potential measured using electrophoretic light scattering.

22. **Talia Glinberg**
Evaluating the Predictive Accuracy of Tolerance Factors on Chalcogenide Perovskite Metastability
Advisor: Chris Bartel
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota, Twin Cities
Abstract: Chalcogenide perovskites are a type of ionic semiconductors with the chemical formula ABX_3, where X is a chalcogen anion, commonly Sulfur (S), Selenium (Se), or Tellurium (Te). These compounds have shown potential for use in photovoltaics due to attributes such as tolerance to defects and improved optical absorption. Understanding the metastability of these structures is a crucial step in discovering and developing these new materials. This study focuses on assessing the predictive power of the Goldschmidt, Bartel, and Hages tolerance factors to determine the stability of ABS_3 perovskites. These tolerance factors are based on properties such as the size of the ionic radii and atomic electronegativity differences. Using Density Functional Theory results, the ground state structures were identified and energy differences between these ground states and their perovskite forms were quantified. The success and limitations of the tolerance factors were analyzed. Crystal Orbital Hamilton Population (COHP) analysis was performed to study the bonding and antibonding contributions which can be used as a measure of covalency in the context of tolerance factors and metastability. By examining why tolerance factors fail, this study will contribute to a more efficient discovery and synthesis process of new materials.

23. **Erika Gunderson**
Investigations into the ligand effects and regioselectivity of nickel-mediated decarbonylation reactions
Advisor: Jessica Hoover
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Minnesota State University Moorhead
Abstract: The recent rapid increase in the production of polymeric waste requires new strategies to mitigate the environmental impact of these materials. Two methods to manage polymeric waste include polymer upcycling, a process of breaking down polymers into higher-value compounds, and chain modification, a process of adding functionality to the polymer chain. Carbonyls are a prevalent functional group in many polymers making metal-mediated decarbonylation an attractive route for polymer upcycling. However, these reactions operate under high temperatures and pressures, and there is limited control over regioselectivity. In order to address these limitations, model systems can be studied to gain a deeper understanding of the decarbonylation mechanism and its driving forces. The Hoover group uses phthalic anhydrides and phthalimides as model systems to investigate nickel-mediated decarbonylation. The synthesis of NiII-metallacycles that have been reported as key intermediates will be used to understand trends in regioselectivity in nickel-mediated decarbonylation. Additionally, ligand effects will be explored through the comparison of the structure and reactivity of nickelacycles supported by 2,2'-bipyridine and N,N-dimethyl aminopyridine. This poster will highlight our recent efforts to better understand regioselectivity and reactivity in nickel-mediated decarbonylation.

24. **Ella Hardwick**
Water Soluble Polymers in Environmental and Industrial Conditions: Novel Radical-Induced Crosslinking Behavior
Advisor: Boya Xiong
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Albion College
Abstract: The ultimate environmental fate of water soluble polymers (WSP) is widely unknown despite high industrial and environmental use. When WSPs encounter radicals, their molecular weight (MW) and structure are subject to change due to radical induced chain-scission and crosslinking. This phenomenon is largely understudied. The objectives of this research is to identify scenarios where water soluble polymers may encounter high amounts of radicals, and simulate these understudied conditions. Preferential crosslinking could lead to increase in MW and it could cause water soluble polymers to become so large they precipitate out of solution. Preliminary results suggested that this is due to concentration of polymer and polymer to radical ratio. A literature review was performed which identified six practical scenarios where water soluble polymers may encounter sufficiently high radicals. A commonly used polymer, polyacrylamide is used as a friction reducer in hydraulic fracturing. The conditions of hydraulic fracturing include adding persulfate to solution to induce the radical degradation of polyacrylamide. When simulating these conditions there was an unexpected increase in the MW of polyacrylamide to the point of precipitating out of solution. It has been found that solid forms at the highest polyacrylamide concentration and the lowest polyacrylamide/radial ratio.

25.	**Haley Harms** *Booster Neutrino Beam Monitoring with the Short Baseline Neutrino Detector Cosmic Ray Tagger* **Advisor: Andrew Furmanski** **Sponsoring Program**: Physics REU **Home Institution:** University of Northern Iowa **Abstract:** The Short-Baseline Neutrino Program at Fermilab seeks to better understand the interactions of fundamental subatomic particles including neutrinos. The Booster Neutrino Beam creates neutrinos which are detected 110 meters downstream by the Short-Baseline Near Detector and its surrounding cosmic ray tagger. It is important when analyzing the detected data to be able to distinguish between beam neutrinos and cosmic rays or other background sources. In this study we have developed a procedure that characterizes the neutrino beam, the goal of which is to quickly identify problems during live detector operation. Insight into which channels are correctly mapped and the distribution of beam and cosmic events helps resolve channel mapping discrepancies and beam misalignments.To understand the beam shape, histograms with time, position, and background neutrino subtractions were created and analyzed through gaussian fits. In a 2D gaussian fit of the beam spot size, we found a chi squared per degree of freedom of 1.66 indicating confidence in a gaussian beam shape.
26.	**Rose Harvey** *Using molecular crowders to optimize cell-free protein synthesis in TXTL* **Advisor: Vincent Noireaux** **Sponsoring Program**: Physics REU **Home Institution:** Michigan Technological University **Abstract:** Protein synthesis in living cells is obtained from the expression of a gene present in a molecule of DNA through the transcription of DNA into RNA, and then the translation of the molecule of RNA into the protein. Protein synthesis can also be reproduced in vitro inside a medium - a cell-free system - that contains a DNA molecule as well as all the genetic machinery required for the reactions of transcription and translation. Among the many factors that contribute to protein synthesis, the presence of biologically inactive large molecules, referred to as molecular crowders, has been shown to have a significant impact. In this work, I explored the effect of various molecular crowders on the yield of the synthesis of a fluorescent protein in the TXTL cell-free system developed in my host lab. Those molecular crowders are biocompatible polymers taken from four families, each with different physic-chemical properties: polyethylene glycol, Dextran, Ficoll and polyvinyl alcohol. With the help of a dispensing robot, I could conduct an optimum-driven high-throughput screening of the effect of their molecular masses and concentrations on the yield of protein synthesis that I measured from the fluorescence intensity of multiple TXTL reactions after 8-10 hours of incubation.
27.	**Sithmi Hewage** *Investigation of Lyotropic Mesophases formed by Catanionic Surfactants* **Advisor: Mahesh Mahanthappa** **Sponsoring Program**: MRSEC **Home Institution:** Iowa State University **Abstract:** Ionic surfactant molecules form lyotropic liquid crystals (LLCs) due to water-driven self-assembly. This project aims to develop network phase LLCs with embedded chemical functionality using catanionic surfactant mixtures to develop ion-selective membranes. Catanionic surfactants are mixtures of oppositely charged amphiphiles. The catanionic system of a diammonium Gemini cation paired with a carboxylate anion was formed and investigated to determine how surfactant architecture influences morphology. A diammonium Gemini surfactant (Br-10,6) was successfully synthesized via a Menshutkin reaction between *N, N, N', N'*-tetramethyl-hexane diamines, and 1-bromoundecane. This was followed by an ion exchange to make the hydroxide form of the diammonium Gemini surfactant (HO-10,6). A salt-free catanionic surfactant was formed by the acid-base reaction between HO-10,6 and lauric acid. The purity and composition of the synthesized surfactants were characterized through ^{1}H-NMR and elemental analysis. Small-angle X-ray Scattering (SAXS) patterns and Polarized Light Microscopy (PLM) experiments show a hexagonally packed cylinder phase for the LLCs formed by the Br-10,6 surfactant. Birefringence was observed for LLCs formed by the catanionic system by PLM experiments, indicating the presence of non-cubic, ordered phases. Future work includes more SAXS and PLM experiments to identify favorable conditions to form network phase LLCs.

28.	**Zeina Hijazi** *Designing an Interview Protocol to Compare Stakeholder Perceptions of Cryopreservation Ethics* **Advisor: Seth Thompson** **Sponsoring Program**: ATP-Bio **Home Institution:** University of Texas at San Antonio **Abstract:** Translating solid organ preservation research will demand adaptation on the part of stakeholders in the field, including related industries, clinicians, and the public. This project builds an interview protocol to examine stakeholders' perceptions of the impact of progressing organ preservation technology, as well as their understanding of the role they play in its translation. During semi-structured interviews, transplant surgeons and biotechnology industry professionals will respond to exploratory questions related to three key themes: anticipated changes to their work, their level of engagement with patients and the public, and ethical considerations. Initial insights from scoping conversations and iterative pilot interviews suggest contrasting priorities between surgeons and industry partners, as well as a wide array of perceptions of the value of solid organ preservation technology and expectations for how it will endure regulation and commercialization. In the future, the developed interview protocol will be used in a qualitative study to probe these emerging patterns further and help begin to map the application of the research.
29.	**Kaori Hirano** *Investigating the Relationship between Cybersickness and Motion Complexity in Virtual Reality* **Advisor: Evan Suma Rosenberg** **Sponsoring Program**: Human-Centered Computing **Home Institution:** Carleton College **Abstract:** This project studied the relationship between cybersickness and motion complexity in virtual reality environments. With between 20-95% of people experiencing cybersickness, it poses a significant barrier to the large-scale adoption of virtual reality and an equity issue to current uses. Motion complexity refers to how much a person's overall movement can be explained by movement in different directions, such as up, down, left, or right. It was hypothesized that different levels of movement complexity would lead to different levels of cybersickness. The data analyzed were from a previous study that induced cybersickness in participants. A motion complexity measure, principal component analysis, and regression analysis were performed to determine the connection between cybersickness and motion complexity.
30.	**Shauntavia Hooper** *Embodiment and its Relation to Cybersickness Within Virtual Reality* **Advisor: Evan Suma Rosenberg** **Sponsoring Program**: Human-Centered Computing **Home Institution:** Carleton College **Abstract:** In the lab I was working in this summer, our overall focus was cybersickness within virtual reality. We wanted to analyze if a participant had the ability to see their virtual body by looking at a mirror if it would decrease their cybersickness. Due to this, I got to analyze the concept of embodiment and its connection to cybersickness. For further context, embodiment is how connected a person is to their virtual body while being inside said virtual body and controlling it within a virtual environment. I was able to create the virtual avatars that are used within the study, creating their movement, and adding virtual mirrors at checkpoints. Virtual reality is an ever-growing field that can greatly positively impact many different fields. For example, in the medical field, it can be used for training and therapy, and with the introduction of consumer virtual reality headsets, many people have begun entering virtual reality gaming. With the issue of cybersickness, many people who may benefit from virtual reality or could use it for leisure are essentially barred from doing so finding what may decrease cybersickness can aid in resolving this issue and make virtual reality more accessible to everyone.

31. **Synnove Hunnes**
Neutrino Beam Monitoring Using the Short Baseline Neutrino Detector Cosmic Ray Tagger
Advisor: Andy Furmanski
Sponsoring Program: Physics REU
Home Institution: Gustavus Adolphus College
Abstract: The phenomenon of neutrino oscillations has intrigued physicists for many decades. The Deep Underground Neutrino Experiment (DUNE) uses a near and far detector to study these oscillations. The Short Baseline Near Detector (SBND) is designed to study weakly-interacting neutrinos but also detects background particles, such as cosmic rays. A Cosmic Ray Tagger (CRT) surrounds SBND and will be used to determine which hits are from cosmic rays. Additionally, the front face of the CRT can be used to monitor the neutrino beam itself. In this work, the beam was identified in the CRT with a timing cut and statistically separated from the cosmic ray background. The detector was visualized with multidimensional histograms. The refined data was fit to a 2D Gaussian to determine the width, beam center, and accuracy of the fit. The resulting fit yielded a chi-square per degree of freedom value of 1.6, indicating that the beam is approximately Gaussian. The imaging tools were used to identify a region of very low activity suggesting a problem with the detector or data collection. This work can be directly incorporated into SBN control room tools for live-time beam alignment.

32. **Kaylah Janis**
Random Telegraph Noise in Ferromagnetic Garnets
Advisor: Dan Dahlberg
Sponsoring Program: Physics REU
Home Institution: Carleton College
Abstract: Ferromagnetic garnets display unique properties due to their crystalline structure, resulting in the magnetization of thin films being perpendicular to the film plane. When subjected to an external ac magnetic field applied perpendicular to the garnet film plane, the magnetic domain widths undergo sinusoidal oscillations. With a sufficiently large ac field, the domains exhibit random telegraph noise (RTN), characterized by two-state switching with a Lorentzian power spectral density (PSD). This study investigates RTN in ferromagnetic garnet samples driven by sinusoidal magnetic fields, focusing on variations with magnetic field strength and frequency. The samples, ~10 μm thick and composed of (Bi, Y, Gd, Tm)$_3$(Fe, Ga)$_5$O$_{12}$ and (Bi, Tm, Gd, Ga)$_3$(Fe, Ga)$_5$O$_{12}$ on a $Gd_3Ga_5O_{12}$ substrate, were placed in a 5 mm diameter solenoid. An ac current generated a sinusoidal magnetic field from 10 Hz to 400 Hz, with peak field strengths up to 100 G. The domains were imaged using the Faraday Effect and captured with a high-speed camera at 1200 fps. PSD analysis of the RTN domain fluctuations over regions on the order of tens to thousands of microns will provide information on how the magnitude and the "knee" frequency
depend upon the field strength and frequency of the magnetic field.

33. **Audrey Jergensen**
Design of divergent synthesis of axially chiral cannabinoids analogs showing increased selectivity for CB2R
Advisor: Alexander Grenning
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Southwestern Oklahoma State University
Abstract: Synthesis development of phytocannabinoids and structural mimics has become increasingly popular due to their many potential pharmaceutical effects on the body, including treatment of neurodegenerative diseases, inflammation, metabolic disorders, nausea, and pain. As a treatment for pain, especially amidst the opioid epidemic, cannabinoid mimics that are selective for the CB2R receptor, without psychoactive side effects, have become a major point of interest. However, there are currently no approved medications that fit this description. This is often due to poor selectivity or poor permeability of the blood brain barrier. This work aims to expand on previously published research about the CB2R selective affinity and functionality of cannabinoid analogs that show axial chirality in place of point chirality disclosed in THC, for example. Herein, a new synthetic approach is described to design similarly axially chiral molecules. Divergent synthesis will allow for the incorporation of diverse functional groups to improve blood brain barrier permeability and show higher aerobic stability. The main synthetic strategy for axially chiral cannabinoids synthesis involves Pd mediated cross-coupling to form the chiral axis between two functionalized aryl partners. A following iterative Ir and Pd cross coupling strategy is under development to build a diverse library of axially chiral cannabinoids.

34. **Wakana Kani**
Optimizing the Bioactive Modification of Alginate Films for MSC Proliferation
Advisor: Theresa Reineke
Sponsoring Program: MRSEC
Home Institution: Colorado School of Mines
Abstract: Mesenchymal stem cell (MSC) treatments are promising for cellular therapy and tissue regeneration for their abilities to self-renew and differentiate. Treatments require billions of MSCs, but current production methods using proteolytic enzyme detachment have issues with cell detachment and premature differentiation. MSC health and quantity can be improved by instead implementing dissolvable bioactive modified-alginate films. Various moieties were coupled to the alginate carboxylate anion for biofunctionalization using 4-(4,6-Dimethoxy-1,3,5-triazin-2-yl)-4-methylmorpholinium chloride (DMTMM). This coupling chemistry was optimized using N,N-diethylethylenediamine (DEDA) as the model amine, elucidating the effects of different reaction conditions including pH, buffers, and the limiting reagent. Alginate films modified with DEDA, arginine methyl ester (AME), or ECM-mimicking peptides were tested for MSC attachment, concluding peptides as a bioactive moiety. Other addition chemistries are being investigated to study how the chemical linkage—bonding between the alginate and bioactive moiety—affects cellular behavior. These multi-step schemes make use of DMTMM or tetrabutylammonium bromide (TBAB) to attach a functional group, useful in an orthogonal chemistry. Each is optimized by screening temperature, pH, and reactant equivalences. The tuned addition chemistry pathways elucidated from this work can be widely applied to different moieties, serving as a foundation for future biofunctional modifications.

35. **Masin Kearney**
Exploration of Penicillin-Binding Protein Redundancy in Gram-Positive Bacteria
Advisor: Erin Carlson
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Emory University
Abstract: The cell wall protects bacteria from environmental stressors such as antibiotics and pH variation. The peptidoglycan (PG) layer of the cell wall is crucial for cell growth and division, determining cellular morphology while preventing osmotic lysis. Gram-positive bacteria, such as *Streptococcus pneumoniae* and *Bacillus subtilis*, have a single inner lipid membrane surrounded by a thick peptidoglycan layer. PG biosynthesis is catalyzed by penicillin-binding proteins (PBPs)–the targets of β-lactam antibiotics. Most bacterial species have between 4 to 16 PBP isoforms, but structural redundancies make their study challenging. To overcome this, we synthesized a series of Penicillin V derivatives to use with a mutant strain of *S. pneumoniae* to study the essential PBP2x. However, we also identified PBP2x selectivity in wild-type *S. pneumoniae*, prompting us to apply these derivatives to other gram-positive bacteria. After determining IC_{50} and minimum inhibitory concentration values in *B. subtilis* for each derivative, we visualized morphology changes with microscopy. We are also studying the effect of pH on PBP activity in *B. subtilis* by investigating the biological modification of PBP1a to PBP1b to determine its relation to alkaline stability. Importantly, the probe designed in our studies will enable discrete investigation of this PBP in future studies.

36. **Adelle Kirshner**
Chemically Recyclable Bio-Based Elastomers for 3D Printing Applications
Advisor: Marc Hillmyer
Sponsoring Program: Center for Sustainable Polymers
Home Institution: California Polytechnic State University, San Luis Obispo
Abstract: The rise of additive manufacturing, also known as 3D printing, has enabled fast and simple production of complex components across aerospace, biomedical, and automotive industries. However, the limited ability to reprocess or recycle the produced thermosets hinders the sustainability aspects of 3D printing and motivates our investigation into chemically recyclable alternatives to currently employed resins. We explored depolymerizable poly(β-methyl-δ-valerolactone) (PβMVL)-based resins for these purposes. Acrylate-capped-PβMVL was combined with varying contents of a small molecule bio-based acrylate to modulate viscosity and crosslinking density, before subsequent crosslinking under ultraviolet light using a commercially available photo-initiator. The resulting crosslinked materials exhibit a tensile strength of up to 3.3 MPa and an elongation of up to 240%. We are currently investigating the chemical recyclability of the crosslinked materials back to βMVL monomer. Future work will focus on optimizing this system for 3D printing via vat photopolymerization.

37.	**Chris Koch** *Investigating the Quantum Hall Effect in Twisted Graphene* **Advisor: Ke Wang** **Sponsoring Program**: Physics REU **Home Institution:** University of Montana **Abstract:** The quantum Hall effect in twisted graphene is a key focus in 2D material physics, offering unique insights into the band structure of twisted graphene systems. This study presents low-temperature magneto-transport data from a dual-gated, twisted trilayer graphene device in a Hall bar configuration. By independently tuning charge carrier density and displacement field, we demonstrate quantum Hall effects specific to individual graphene layers as well as those arising from twist-induced moiré periodicities. Our findings reveal the coexistence and dynamics of layer-specific and moiré-induced quantum Hall states.
38.	**Majeste Kyei-Amponsah** *Engineering Immune Engager Stability* **Advisor: Ben Hackel** **Sponsoring Program**: MRSEC **Home Institution:** Iowa State University **Abstract:** Tri-specific killer engagers (TriKEs) are immunotherapeutics designed to treat cancer. TriKEs contain three parts: a nanobody that stimulates the CD16 receptor on NK (natural killer) cells, an IL-15 cytokine that promotes an increased NK cell response, and an scFv (single chain Fragment variable) that binds to a tumor-associated antigen, thus inducing NK cell activation and tumor cell killing. ScFvs are challenging to utilize in therapeutics due to their instability. In comparison, miniproteins are binding scaffolds about ≤100 amino acids. They are appealing for use in therapeutics due to their modularity within multifunctional constructs, low manufacturing cost, and high resistance to denaturation and proteolysis. This project will test the hypothesis that TriKEs containing hyperstable miniproteins will demonstrate increased stability and production yield compared to TriKEs containing scFvs. I will produce two TriKEs with a miniprotein or scFv tumor engager. I will quantify recombinant yield via gel electrophoresis and validate TriKE size using matrix-assisted laser desorption/ionization mass spectrometry. I will measure each TriKE's midpoint of thermal denaturation using circular dichroism. Given our hypothesis, we expect the miniprotein TriKE to demonstrate superior expression yield and thermal stability. Both TriKEs will target the B7-H3 cancer marker, advancing treatments for B7-H3 positive cancers.
39.	**Karl Lawrie** *Histological Findings Further Medical Device Efficacy in Resistant Hypertension* **Advisor: Matthew Johnson** **Sponsoring Program**: BME Pathways **Home Institution:** Saint John's University **Abstract:** While renal denervation has been established as an instrument to disrupt an impaired reno-renal reflex, the specific anatomic conformation of renal nerves is poorly understood. This could limit the efficacy and specificity of renal denervation techniques. To elucidate the nerve projections around the renal artery, computed tomography (CT) and histology were performed. While the CT data could be used to create a 3D representation of the renal artery, histology data was needed to add discrete details about the nerve anatomy into the representation. With this information, medical devices can be created that fill the gap left by insufficient pharmaceuticals.

40.	**Jessica Li** *Computational Modeling of Optical Properties of Disordered Polymer Microstructures for Passive Daytime Radiative Cooling* **Advisor: Vivian Ferry** **Sponsoring Program**: MRSEC **Home Institution:** University of Michigan **Abstract:** Passive daytime radiative cooling (PDRC) results in net zero energy consumption and zero environmental pollution by leveraging the heat differential between Earth and outer space. PDRC materials must absorb little solar radiation and emit long wavelength infrared radiation through the atmospheric transmission window. Polymers have chemical bonds that emit in the atmospheric transmission window and can be produced at scale for low cost. However, polymers do not inherently reject solar radiation. One solution is to give polymers microstructures with domain sizes similar to or larger than the wavelengths of solar radiation to tailor the optical responses. Using computational modeling, we studied the solar reflection spectra of disordered cocontinuous microstructures derived from polymer blends, which self-assemble through spinodal decomposition. A Cahn-Hilliard model describing the spinodal decomposition process was used to generate microstructures of varying domain sizes. The finite-difference time-domain (FDTD) method, which spatially solves Maxwell's equations, was used to simulate how the domain size influenced reflection spectra. As a result of this work, we have created a simulation pipeline for understanding how domain size influences light management in cocontinuous porous polymers with the goal of providing guidance for PDRC material development.
41.	**Joselin Lopez, Devin Garrity, Ashley Zenzola** *Designing for Building Obsolescence: Testing the Degradation of Different Forms of Concrete with a CO2 Rainfall Simulation* **Advisor: May Hwang** **Sponsoring Program**: NSSA Pathways **Home Institution:** St. Olaf College, Normandale College, Century College **Abstract:** Concrete, a building material, is known for its wastefulness and significant contribution to CO2 emissions. The concrete industry is responsible for creating 5-8% of all man-made emissions of CO2, heighting the greenhouse gas effects. This study investigates the impact of building materials by testing the degradation of concrete samples using a CO2 rainfall simulation. We created 3x3 samples with varying ratios of building materials such as Portland cement, Biochar, Quikrete, and calcium oxide, selected for their durability and strength. The samples were subjected to a Rainmaker, a machine that simulates rainfall using CO2-infused water. The machine ran for 60 minutes in a 5-minute interval with laser scans conducted between each interval to monitor changes. The results indicate a slight degradation, as well as possible mineralization on the samples. Further research is needed to determine the degradation by creating a larger-scale model in a natural environment.
42.	**Cynthia Maldonado** *Improving Object Detection On Autonomous Underwater Vehicles For Trash Detection* **Advisor: Junaed Sattar** **Sponsoring Program**: Human-Centered Computing **Home Institution:** University Of North Carolina Charlotte **Abstract:** Trash poses a great challenge in today's aquatic life and ecosystem. This project helps to safely remove trash without harming the environment by enhancing object detection in Autonomous Underwater Vehicles (AUVs). AUVs are self-powered robots used underwater for exploration and data collection. To improve AUVs we first have to create a dataset of underwater trash images from different aquatic environments. With the help of divers, we can utilize underwater robots equipped with cameras and sensors to capture trash that is commonly found in water. The images are labeled to identify each type of trash in a program called CVAT (Computer Vision Annotation Tool), an online image annotation tool. Hundreds of images are individually labeled using a bounding box to identify each trash item. Using YOLO (You Only Look Once), a state-of-the-art object detection system, we can develop accurate object detection models. By training these models on a large dataset, it can significantly improve the object detection capabilities of AUVs. This research seeks to become a long-term aid to help aquatic life and remove all types of aquatic debris in oceans, seas, and lakes.

43.	**Ethan Maraldo** *Thoughts on Freeze - looking at the public's view of novel biotechnologies* **Advisor: Seth Thompson** **Sponsoring Program**: ATP-Bio **Home Institution:** Georgia Institute of Technology **Abstract:** Before any novel technology can actually be used, it needs to undergo various stages of approval, typically ending with the general public - the people affected by and using these technologies - and cryobiology will be no different. Because of this, it is important to understand how the public feels about cryobiology, and more importantly, if they are even aware of its existence as the ATP-Bio center moves forward with its work. The first step towards understanding how the public feels is understanding exactly what they know, through a form of informal scientific scoping. To conduct this, researchers first talked to members of various labs working on cryobiology projects, and then went to local farmers markets, and held informal discussions with community members about cryobiology. Big takeaways from these markets were the lack of awareness and factual knowledge of cryobiology in the public - even among those who have been involved with organ transplantation in the past. This is important to know, as if this lack of awareness continues as the technology begins to approach clinical stages, people may be less likely to adopt it, as people tend to avoid what they don't know.
44.	**Conner McClelland** *Comparing controlled release kinetics of in vitro subcutaneous models of an adjuvant from a novel melanoma vaccine* **Advisor: Chun Wang** **Sponsoring Program**: BME Pathways **Home Institution:** University of Kansas **Abstract:** Metastatic melanoma, associated with late-stage cancer, is limited in the number of viable treatment methods. Given the immunogenic nature of melanoma tumors, immunotherapy proves a promising treatment method. This project works to develop a safe and feasible vaccine as an early-stage treatment method for BRAF-mutant (mBRAF) metastatic melanoma. A novel polycaprolactone multiblock copolymer containing orthoester linkages (CAP-OA1) offers a promising option as a drug delivery vessel due to its liquid state and excellent biocompatibility. Loaded with mBRAF peptide and resiquimod, an immunostimulatory adjuvant, the liquid polymer depot allows controlled drug release via subcutaneous injection. One important aspect of drug delivery is the use of in vitro release studies to mimic the release kinetics of components in vivo. This study provides valuable insight into the transport mechanisms and release kinetic profiles of resiquimod-loaded CAP-OA1 through in vitro release studies. Release studies were performed using two different methods of subcutaneous delivery and resiquimod concentrations were quantified using UV-vis spectrophotometry. Results will not only give insight into how the vaccine functions in vivo, but also compare different models of subcutaneous delivery.
45.	**Ashlyn McClendon** *Fusing Traditional Ecological Knowledge with Actively Studied Scientific Data in 3D Visualizations* **Advisor: Daniel Keefe** **Sponsoring Program**: Human-Centered Computing **Home Institution:** American University **Abstract:** To solve today's most pressing challenges (e.g., climate change, sustainability) scientists and technologists will need to work hand-in-hand with the communities most impacted by these challenges. Our Indigenous research partners from Micronesia, many of whom have been forced to leave their islands and come to Minnesota, include master Micronesian navigators with historic and contemporary knowledge of fisheries, climate, and interconnected ecology, as well as scientists studying Pacific fisheries. In theory, these two ways of knowing the world (modern science, traditional ecological knowledge) should be perfect complements; yet linking quantitative computer-based scientific data with qualitative traditional knowledge passed on via ceremony, oral traditions, and experiential learning remains a major challenge. Our research aims to combine Indigenous Micronesian knowledge of the seas with Pacific maritime scientific data in a single 3D visualization that is both scientifically accurate and supports immersive first-person data experiences. Early results include implementations of two strategies for establishing common links, over space and/or time, to visualize relevant complementary data together. Results also suggest that mixing narrative and exploratory visualization and animated transitions may help users preserve contextual awareness in these complex visualizations.

46.	**Junior Mejia** *Exploring Augmented Reality Aids for Cognitive and Spatial Assistance* **Advisor: Zhu-Tian Chen** **Sponsoring Program**: Human-Centered Computing **Home Institution:** University of Central Florida **Abstract:** This project investigates the potential application of augmented reality (AR) technology to support individuals with cognitive and spatial impairments, such as dementia. Leveraging AR's immersive capabilities and inspired by existing strategies to manage these challenges, the project aims to enhance daily living and task management. The application allows users to interact with spatial anchors and categorize them as "reminders," "items," or "locations" to achieve distinct functionalities. The project showcases how AR could potentially be tailored to create meaningful, real-world applications that address the specific needs of those with cognitive impairments.
47.	**Anthony Miller** *Magnetic Response of Superconducting Ion Gated Materials* **Advisor: Martin Greven** **Sponsoring Program**: MRSEC **Home Institution:** University of Maryland Baltimore County **Abstract:** Titanium Diselenide ($TiSe_2$), and Molybdenum Disulfide (MoS_2), are part of the class of two-dimensional chalcogenide materials with interesting properties such as superconductivity. In particular, ion gating can be leveraged to tune electronic order in these materials. When an ionic liquid is applied to a material, the charges migrate to the surface and introduce extra charges (or holes) in the material, thus, changing its properties. Here, we use this technique to investigate the magnetic response. When a changing magnetic field is applied, Eddie currents are created in the superconductor which generate a magnetic response that opposes the change, also known as the Meissner Effect. When an oscillating field is applied, the sample will respond in harmonics, With the use of a multi-coil setup, we will measure the magnetic response up to third order. This magnetic response probe will allow us to perform gating experiments to investigate the effect of ion gating on $TiSe_2$ and MoS_2, which are expected to become superconducting for sufficiently high gate voltages. Measuring the third harmonic responses of these materials will broaden our understanding of the emergence of the superconducting state above the superconducting transition temperature.
48.	**Edward Morell** *Investigating Isospin through Group Theory in Particle Physics* **Advisor: Zhen Liu** **Sponsoring Program**: Physics REU **Home Institution:** Florida International University **Abstract:** This research explores the application of group theory to the concept of isospin in particle physics. By delving into the SU(2) group and its representations, the study highlights how isospin symmetry classifies particles and describes their interactions. Through a combination of theoretical exploration and practical examples, this work demonstrates the significance of isospin in understanding the behavior of subatomic particles. The findings contribute to a deeper comprehension of the mathematical structures underlying particle physics and their physical implications.
49.	**Angela Mosconi** *"Get FROMPed": Polyoxazolidinone Synthesis via Frontal ROMP* **Advisor: Jessica Lamb** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Ripon College **Abstract:** Polyoxazolidinones (POxa) are a class of polyurethanes known for their high thermal resistance and traditionally have toxic isocyanate precursors. Previous syntheses of isocyanate-free POxa were performed through step-growth polymerization, but recent work in the Lamb group demonstrates that isocyanate-free POxa can be synthesized via ring-opening metathesis polymerization (ROMP), a chain-growth technique that utilizes the release of ring strain to drive polymerization and allows for the creation of high molecular weight POxa. In this work, we expand this approach to frontal ROMP (FROMP), which requires only an initial heat stimulus to initiate the reaction by utilizing the release of ring-strain energy to carry the polymerization forward along a thermal front in highly concentrated monomer solutions. These benefits make FROMP viable for energy efficient fabrication of bulk materials. FROMP was performed on mixtures of synthesized oxazolidinone monomer and cyclooctadiene (COD) at a small scale using second-generation Grubb's catalyst. This work focuses on the synthesis and characterization of FROMPed polymers with varying COD to Oxa ratio.

50.	**Ryan Mott** *Data Analysis of Amphiphilic Morphologies* **Advisor: Ilja Siepmann** **Sponsoring Program**: MRSEC **Home Institution:** University of Maryland, Baltimore County **Abstract:** Amphiphiles; oligomers that are instantiated by a hydrophilic "head" group followed by an asymmetric and hydrophobic "tail" group, have been shown to have varying morphologies with respect to their "long-tail" to "short-tail" atom count ratio, which we have declared to be the magic tail ratio (MTL) of the amphiphilic oligomer. Depending on the amphiphile's MTL; an amphiphile's morphology can present itself in the form of lamellae (LAM), perforated lamellae (PL), hexagonal cylinders (CYL), and double gyroids (DG), with DG resulting in being the most stable category of amphiphile morphology. Our goal is to be able to achieve an understanding of these morphology patterns and their stabilities with computational modeling and analysis using OVITO, and use of non-linear optimization algorithms from C++ Libraries such as NLopt and Eigen to efficiently find patterns within mass amounts of data. We currently expect but remain uncertain that an a between an amphiphile's MTL is responsible for their varying morphologies
51.	**Heather Muenter** *Designing a New Fluorescent ROS Probe* **Advisor: Christy Haynes** **Sponsoring Program**: UMN Chemistry- Heisig Gleysteen **Home Institution:** University of Minnesota - Twin Cities **Abstract:** Reactive oxygen species (ROS) are short-lived and highly reactive species that contain oxygen. ROS can be naturally found in living organisms but in excess can be linked to several medical conditions such as cancers and neurodegenerative diseases. Additionally, environmental pollutants such as lithium-ion battery waste, can generate high concentrations of ROS that can be harmful for the environment and human health. Finding better ways to detect and image ROS is crucial in both understanding how ROS from pollutants affect the environment as well as impact human health. In this project, we are designing a new class of ROS sensors that aim to detect and image ROS, with potential applications in living cells. This sensor uses amorphous polymeric carbon dots (CDs) with an incorporated cyanine-3-amine (Cy3) dye. CDs can be internalized by various living cells and Cy dyes have distinct colors for optical and spatial detection of ROS. In this work, Cy3-CDs are compared to CDs and Cy3 separately and neutral red is considered as an alternate fluorophore with an overall goal of designing carbon dots to perform sensitive ROS sensing with spatial resolution.
52.	**Anika Nagpal** *Molecular Dynamics Simulations and Network Analysis Towards Evolution of de novo Enzymes* **Advisor: Sapna Sarupria** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Bowdoin College **Abstract:** Protein engineering is useful for therapeutics design, provides environmental benefits, and has industrial applications. Existing experimental strategies incorporate structural and functional properties, but have limited reaction rates. Computational tools aid in streamlining the design process, but even in the best cases, *de novo* enzymes have lower catalytic efficiency than their naturally-occurring counterparts. Here, we couple existing methods for theozyme definition and structure prediction with molecular dynamics simulations and a novel genetic optimization algorithm to design enzymes computationally. Simulations enable efficient sampling throughout the conformational landscape of the predicted protein. We employ a genetic optimization algorithm with closeness centrality – hypothesized to correlate with catalytic activity – as the fitness function. Crossover and random point mutations, and a bracket-style parent selection strategy balance exploration and exploitation. Periodic docking of the highest fitness enzymes tracks improvements in binding affinity. This project looks at TEM-1 β-lactamase, important for antibiotic resistance in *E. coli*, and relevant to antibody-directed enzyme/prodrug therapy. Preliminary results demonstrate successful evolution towards structures with increasing importance of catalytic residues. Overall, this methodology aims to produce enzymes with improved catalytic efficiency at a fraction of the cost of computationally-intensive or experimental approaches, addressing a challenge in design of *de novo* enzymes.

53. **Faith Neely**
Machine Learning Algorithms to Identify Droplet Size and Phase in a Droplet Based Vitrification System
Advisor: Chris Hogan
Sponsoring Program: ATP-Bio
Home Institution: North Carolina Agricultural and Technical State University
Abstract: Droplet based vitrification is a promising technology to cryopreserve cells. In droplet based vitrification, microdroplets containing cells and cryoprotective agents (CPAs) are generated and mixed with a co-flow of liquid nitrogen. Sufficiently fast mixing and high enough CPA leads to vitrification with minimal ice formation, which is ideal for cell cryopreservation. However, as CPAs are toxic to cells, it is important to identify the minimum CPA concentration needed for vitrification, and in turn, it is necessary to develop automated methods to determine the fraction of droplet vitrified, and their size distributions. We have developed and trained machine learning based algorithms to both identify droplet sizes and phase (glass or containing ice) in optical microscope images.

54. **Eleanor OConnor**
Expanding the scope of TCT mediated cationic-anionic sequential polymerization for block copolymers
Advisor: Jessica Lamb
Sponsoring Program: MRSEC
Home Institution: Harvey Mudd College
Abstract: Block copolymers (BCPs) are polymers formed from multiple monomers in discrete blocks. These materials may have unique properties and functions. Generally, when synthesizing BCPs, the same polymerization method (radical, anionic, cationic) must be used to add each monomer—limiting the class of monomers one can use. The Lamb research group uses thiocarbonyl thio (TCT) compounds to mediate both cationic and anionic polymerizations triggered by light and heat, respectively. This enables the synthesis of BCP's composed of vinyl ether and thiirane blocks. However, the scope of the BCPs possible is currently limited to one vinyl ether monomer—ethyl vinyl ether. This is because it is the only known poly(vinyl ether) soluble in the anionic polymerization solvent. This summer, we attempted to expand the scope of BCPs possible by investigating alternative solvents and solvent mixtures for the anionic polymerization. Vinyl ether polymers were synthesized and their solubility in a range of solvents was characterized. Next, anionic polymerization was performed in these solvent mixtures and the conversion and dispersity of the resulting polymers was characterized by NMR and SEC. Finally, solvent mixtures that showed promise for the thiirane homopolymerization were used to chain extend vinyl ether polymers to create novel BCPs.

55. **Muntas Osman**
Water Transport and Kidney Stones Using a Drosophila Malpighian Tubule Model
Advisor: Jeffrey Ratliff-Crain
Sponsoring Program: Independent Research
Home Institution: U of M Rochester
Abstract: Kidney stones represent a significant clinical issue for which there is no treatment and afflicting ~10% worldwide. Increasing urinary flow and decreasing ion supersaturation by drinking water is effective in reducing kidney stone occurrence. Here, we followed Ca-oxalate (**CaOx**) crystal formation in *Drosophila* Malpighian tubules (**MT**) to investigate if genetic manipulation of water channels (Drip, Prip) and salt transporter (NDAE1) in stellate cells. F1-knockdowns were made by crossing c724-GAL4 flies with UAS-RNAi lines (Drip, Prip, NDAE1). F1 flies were fed food supplemented with 10 mM NaOx for 4 days. MTs were dissected, fixed to slides, and CaOx crystals quantified using birefringence (polarizing microscope). Previously, MTs were shown secrete fluid faster on a per-cell basis than any other epithelium. Drip and Prip, exhibit significant and specific water permeability when expressed in *Xenopus* oocytes. Drip and Prip-knockdowns decrease fluid secretion and crystal formation. Our findings indicate that AQP-knockdowns result in more CaOx crystals compared to controls. Additionally, NDAE1 knockdown in MT-stellate cells also increases CaOx crystals. This suggests that NDAE1-mediated ion movements contribute to transepithelial water transport normally. Together these data illustrate that AQP water transport and salt-driven water transport keep MT secretions dilute to avoid crystal formation. Potentially development of aquaretics and therapeutics that increase urine flow may be helpful for kidney stone disease especially if merely drinking more water is difficult.

56.	**Dev Patel** *Recreating and Adapting Previous Virtual-Reality-Based Driving Simulators to Allow for Multi-Agent Autonomous Vehicle Studies* **Advisor: Seongjin Choi** **Sponsoring Program**: UROP/URS **Home Institution:** University of Minnesota Twin Cities **Abstract:** A significant portion of modern studies regarding the operations of vehicles rely on driving simulators, especially those involving autonomous vehicles (AVs). In the era of AVs, it is imperative to reach an understanding of how human drivers perceive and interact with AVs. This information can be used to inform future AV algorithms to both perceive environments more efficiently and yield better to human habits. This information could be gained through field experiments, but those are incredibly expensive to set up in the real world and are even harder to replicate or scale. However, recent software has been developed to allow standard desktop machines to act as VR driving simulators. In this work, this software has been adapted to run on newer hardware, a different VR headset, and a different VR API layer. Additionally, some advancements have been made in enabling multi-agent VR driving simulations to allow for future human-to-human-to-AV studies.
57.	**Evan Phillips** *Surface Promotion of Programmable Large-Area Metal-on-Carbon Catalytic Condensers by Aqueous Cesium Carbonate Solution* **Advisor: Paul Dauenhauer** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** University of Florida **Abstract:** Previous research in the field of programmable heterogeneous catalysis reports the creation of 1cm by 1cm catalytic condenser devices that operate by changing the electron density of a catalytically active metal thin film to affect the binding energy of reactive intermediates. However, little is known about the electronic structure of the device surfaces and how these characteristics can be tuned to influence reactivity. To address this, an aqueous solution of cesium carbonate was spin coated onto the device surface, and then decomposed into cesium oxide through varying heat treatments, with the goals of decreasing the device work function, and donating additional electrons for reaction. EDS and XPS were performed to determine the final surface concentration of cesium, as well as chemical state data. Kelvin Probe Force Microscopy was used to measure the work function of the surface. TPD measurements were used to determine a change in binding energy of the reactive intermediates. Lastly, sheet conductance measurements were performed to ensure the device remained electrically conductive after experimentation. These findings will provide insight to the promotion of catalytic and electronic properties of catalytic condensers in the presence of cesium, which in turn will allow for more widespread use of these devices.
58.	**Anthony Portales** *Effect of corona chain entanglement on structure and dynamics of homopolymer/diblock copolymer binary blends* **Advisor: Timothy Lodge** **Sponsoring Program**: MRSEC **Home Institution:** The University of Texas Rio Grande Valley **Abstract:** Block copolymers can self-assemble into nanoscale spheres called micelles. In concentrated solutions, micelles can order into a body-centered cubic (BCC) lattice. Understanding the relationship between structural and dynamic properties of ordered micelle is crucial for designing polymers for industrial applications. This study uses a polystyrene-poly(ethylene-alt-propylene) (PS-PEP) diblock polymer in squalane, a solvent selective for the PEP block, to form micelles with a PS core and a PEP corona. We will investigate the effects of corona chain entanglement on the rheological, or flow, behavior of BCC-packed block copolymer micelles by blending varying amounts of PEP homopolymer with PS-PEP diblock. The primary objective is to determine how altering corona entanglements influence micelle properties and dynamics, more specifically whether chain entanglement is the sole determinant of the dominant rheological timescale. To focus on chain entanglement, we will fix the concentration of PS-PEP and modulate the ratio of PEP homopolymer and squalane. We will use small-angle X-ray scattering to analyze the microstructure, such as micelle core size and domain spacing. Afterwards, rheology will be used to determine the flow behavior at temperatures –40 °C to 160 °C. These methods aim to understand the relationship between structure and dynamics of block copolymer-based micelle solutions.

59.	**Maura Putzer, Avani Papadopoulos** *The Impact of Individual Preferences on the Restorativeness of Virtual Reality Experiences* **Advisor: Victoria Interrante** **Sponsoring Program**: Human-Centered Computing **Home Institution:** Smith College **Abstract:** Being immersed in nature has a beneficial impact on mental health. Virtual Reality (VR) can offer virtual access to naturalistic settings during events like dialysis and chemotherapy that prevent people from experiencing real natural environments. This study investigates the extent to which individual differences and preferences affect the perceived restorativeness of various environments, hypothesizing that high-biomass environments are universally restorative regardless of the individual. Our methodology involves three parts: (1) presenting static images of several natural environments to participants, (2) immersing participants in several VR natural environments, and (3) immersing participants in a single VR environment, either of their choosing or ours, following stressor tasks. Stressor tasks include mock job interviews and mental arithmetic. Following VR or image immersion, we will use surveys, such as the Perceived Restorativeness Scale (PRS), to assess the restorativeness of the environment. We will similarly use memory-related tasks, such as the n-back and backward digit span (BDS) test, in part 3 to determine the participant's response to the VR environment.
60.	**Jose Ramirez** *Predicting Fiber Spinnability through Dripping-onto-Substrate Extensional Rheology* **Advisor: Michelle Calabrese** **Sponsoring Program**: MRSEC **Home Institution:** The University of Texas Rio Grande Valley (UTRGV) **Abstract:** Nature's nanofibers (1 nm-1 μm), exemplified by silkworms, are lightweight, have controllable pore structures, and possess high surface area-to-volume ratios, making them ideal for applications like filtration, sensors, textiles, tissue engineering, and energy storage. However, these applications often demand properties beyond those of natural fibers, spurring interest in polymer-based nanofibers with tunable performance. While electrospinning is a common production method, it requires high voltage, has low production rates, and is limited in compatible formulations. Centrifugal spinning (ForceSpinning™) offers a higher production volume, operational ease, and nanofibers with controlled morphological features and mechanical properties comparable to electrospun fibers. This study aims to investigate the elongational flow behavior of polymer solutions/emulsions using dripping-onto-substrate (DoS) extensional rheology. Initial experiments with aqueous poly(ethylene oxide) (PEO) solutions will lead to a detailed study on PEO/polycaprolactone emulsions in chloroform with a set range of internal and external phases. Analyzing the breakup behavior of these solutions under extension will reveal polymer properties essential for consistent spinnability. This research aims to elucidate the structure-process-property relationships during ForceSpinning™, facilitating the rapid screening of samples for this technique potentially revolutionizing high-throughput nanofiber production for advanced applications.
61.	**Sigrid Real-Aguilar** *Comparison of Shewanella oneidensis Response to Chronic Chromate and Metal Oxide Nanoparticle Stress* **Advisor: Erin Carlson** **Sponsoring Program**: Center for Sustainable Nanotechnology **Home Institution:** Duke University **Abstract:** Many industrial processes result in human and environmental exposure to toxic materials, such as hexavalent chromium Cr(VI). To investigate the potential impacts of this transition metal on environmental organisms, we have performed chronic exposure in the metal-reducing bacterium, *Shewanella oneidensis*. Proteomic studies have demonstrated that prolonged chromium exposure results in differentially expressed proteins that are involved in multiple signaling pathways and iron uptake. However, it has not been elucidated if this organism undergoes genome-level changes due to chronic chromate stress. Our group has previously shown that *S. oneidensis* can develop resistance to the metal oxide nanomaterial nickel manganese cobalt oxide. Here, we aimed to determine whether resistance evolved from Cr(VI) exposure would result in genomic, proteomic, and phenotypic changes similar to those observed in the nickel manganese cobalt oxide-resistant strain. To achieve this, *S. oneidensis* MR-1 cultures were grown aerobically in Lysogeny Broth (LB) media and exposed to increasing potassium chromate $K_2CrO_4^{-2}$ concentrations. Bacterial viability was assessed through optical density measurements after each passage, while microscopy was used to evaluate filamentation. Given the cytotoxic nature of chromate, the genomic alterations that result from the development of chromate resistance in *S. oneidensis* are pivotal to understanding fundamental bacterial adaptation and behavior.

62.	**Ainsley Reeves** *Resonance Raman Studies of Silicon Quantum Dots* **Advisor: Renee Frontiera** **Sponsoring Program**: UMN Chemistry- Heisig Gleysteen **Home Institution:** University of Minnesota-Twin Cities **Abstract:** Quantum dots are nanoscale semiconductor particles that are able to emit light in different colors based on their size. Found in everyday items like computer and TV screens, they are often made out of toxic metals like cadmium. Alternative quantum dots have been synthesized from the nontoxic element silicon, but these quantum dots have different functions. One difference is the ability to attach different surface species in order to tune the quantum dot to a particular color without changing its size. The system analyzed in this report is the linking of anthracene to silicon quantum dots. The molecules analyzed have different molecules linking the quantum dot to anthracene, namely an ethyl group (9EA) and a vinyl group (9VA). The different linking species provide different degrees of coupling, which impacts the efficiency of the molecules interaction with light. The method we use to analyze the degree of coupling is resonance Raman spectroscopy. This technique differs from normal Raman in that the molecules are excited to an electronic state rather than a virtual state, revealing what vibrational modes are most strongly coupled to the excited electronic state, as the more intense the vibrational mode is the more strongly it is coupled.
63.	**Elizabeth Rehwinkel** *Plasmon Driven Electron Transfer* **Advisor: Renee Frontiera** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Smith College **Abstract:** Plasmonic materials are of interest because they can be used to drive chemical reactions with sunlight serving as an environmental alternative for fossil fuels. Plasmons occur when light interacts with metal nanoparticles creating oscillating electric fields on the nanoparticles. When the plasmons decay they can generate energy and electrons that can transfer to molecules on the surface of the nanoparticle. However, many plasmonic reactions are inefficient and poorly understood, so research into their mechanism is important. This research project investigated two plasmonic systems to evaluate if they displayed electron transfer and could be used as model systems for future work. Continuous-wave Raman spectroscopy was used to probe the plasmonic electron transfer capability of gold nanoparticles with adsorbed tetrathiafulvalene (TTF) or Buckminsterfullerene (Buckyballs). Both TTF and Buckyballs have shifts in their Raman peaks that indicate electron transfer is occurring on the metallic nanoparticles. We also used Raman microscopy to map the electron transfer to both molecules to determine if their reaction yield is higher at certain areas on the plasmonic substrates.
64.	**Victor Rogowski** *Synthesis of Dicationic Doubly Linked Bis-Metallocenium Catalysts* **Advisor: Steven Kass** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Elmhurst University **Abstract:** The preparation of two bis-metallocenium compounds, including bis-cobaltocenium and bis-ferrocenium, was attempted. H1-NMR and ESI spectral data suggests the formation of these compounds was successful, though, further improvement of synthesis and purification methods is required. The successful synthesis of these compounds has been previously reported, but their catalytic properties have not been explored. It is anticipated that these compounds will behave as effective Lewis acids and serve as catalysts for a wide variety of transformations. Their catalytic activity should be analyzed in further detail.

65.	**Gracie Rohr** *Examining acid end group functionalization as a process to improve the degradability of polylactide-based blends* **Advisor: Chris Ellison** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** St. Norbert College **Abstract:** Polylactide (PLA) is the world's leading synthetic, bio-renewable, and compostable polymer. Despite its advantages, PLA's degradability is limited by several factors, including the need for higher-than-ambient temperatures, water for hydrolysis, and bacterial presence. To accelerate PLA degradation, various additives have been investigated to facilitate the breakdown process and overcome these composting limitations. Additives are screened for their effects on mechanical, thermal, and optical properties to ensure the polymer performs as expected or with improved properties. Ensuring the process remains industrially relevant, the focus has been on identifying cost-effective and labor-efficient additives. Short-chain polymers, often a byproduct of mass production, have shown promise as an additive when acid end groups are attached through a simple reaction. This approach utilizes readily available materials and has improved PLA degradation. The acid concentration has been adjusted to determine the optimal amount necessary for efficient degradation. This approach holds promise for enhancing PLA's compostability, making it a more viable and sustainable option for widespread industrial use.
66.	**Heriberto Santoyo-Rustrian** *Producing Water Repellent Fibers using Polyester-PDMS Copolymers and Melt-Blowing* **Advisor: Chris Ellison** **Sponsoring Program**: MRSEC **Home Institution:** Univsery of Texas at Rio Grande Valley **Abstract:** We are making hydrophobic fibers with a robust surface coating using a simple and scalable processing method. Using a microcompounder, we can blend Polyester with a small concentration of hydroxyl-terminated PDMS (Polydimethylsiloxane) to form a Polyester-PDMS copolymer. Then, we can produce fibers from the blends by melt-blowing, an industrial method used to produce large quantities of fibers. We hypothesize the low surface energy of PDMS will make the copolymer located at the surface of the blend. We study different mechanisms of surface blooming using films, fibers, and annealing procedures. We evaluate if this process occurs during melt-blowing by testing if the surface of the fibers is more hydrophobic. We can measure hydrophobicity by measuring the contact angle of a water drop on the surface of fiber mats. We evaluate different ratios of the polymers to determine how much PDMS is necessary to make the fibers hydrophobic.
67.	**Peyton Schlueter** *Coumarin 343 Quenching by Zinc Oxide Nanocrystals* **Advisor: Wayne Gladfelter** **Sponsoring Program**: MRSEC **Home Institution:** University of Minnesota **Abstract:** Previous research has explored how surfactants, such as oleic acid, affect nanocrystals' properties and function. This research aims to understand the effects of oleate-capping on the ability of the zinc oxide nanocrystal to quench Coumarin 343 dye. To accomplish this, adsorption isotherms were measured using changes in emission intensity of oleate-capped zinc oxide nanocrystals with Coumarin 343 in dichloromethane as well as bare zinc oxide nanocrystals with Coumarin 343 in methanol. The Langmuir model utilized the emission data and quantified the maximum number of dyes that could be adsorbed to the nanocrystal as well as the equilibrium binding constants.
68.	**Devon Scott** *Studying Star Columns using Cross Correlation with Pan-Starrs* **Advisor: Patrick Kelly** **Sponsoring Program**: Physics REU **Home Institution:** Virginia Commonwealth University **Abstract:** Star Columns are a feature present in astronomical plots of Brightness vs Full Width at Half Maximum (FWHM) values of objects extracted from telescope images. Star Columns can help indicate which objects might be galaxies instead of stars because stars have similar FWHM values regardless of brightness, which is why they appear in columns. In contrast brighter galaxies usually have larger FWHM values. The key objective is to measure resolution of the telescope from the value of where the star column is, with the additional focus for this project being cross correlating objects extracted from the Turbo Telescope teams prototype telescope with known stars from a Pan-Starrs Catalogue to make sure Star columns are accurate for better study.

69.	**Alex Sell** *Titanium-ligand complexes as catalysts for 1,2-alkyne diamination using 1,1-disubstituted hydrazine* **Advisor: Ian Tonks** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Augustana College **Abstract:** 1,2-diamines are an important class of molecules, but their synthesis can often require late transition metals such as Pd, which are precious, toxic, and costly. Previously reported titanium(IV) complexes have shown to catalyze a 1,2-diamination of alkenes using 1,1-disubstituted hydrazine, but selectivity is limited by a competing hydrohydrazination reaction. In this work, a series of titanium(IV) complexes using chelating ligands are synthesized and reported. These complexes are believed to promote better selectivity for diamination products. The synthesis of these complexes is detailed, along with their characterization using NMR. Results will also be shown for the catalytic efficiency of the complexes.
70.	**Diego Setien** *Effects of Superconductivity by Annealing Ruthenium Based Oxides* **Advisor: Bharat Jalan** **Sponsoring Program**: MRSEC **Home Institution:** University of Texas At Rio Grande Valley **Abstract:** Effects of superconductivity by Annealing Ruthenium Based Oxides Ruthenium based binary and complex oxides show various interesting properties ranging from simple metallic nature to ferromagnetism and superconductivity. These properties can be changed drastically by tuning the crystal structure and lattice parameter of the materials thru oxygen annealing. The crystal structure and the lattice parameter can be tuned by annealing the material at different conditions. I will be studying the effect of annealing on the structural and electronic properties of high-quality single-crystalline molecular beam epitaxy grown Sr2RuO4 and SrRuO3 thin films by using X-ray diffraction and evaluating the correlation between physical changes to superconductivity.
71.	**Amira Shakur** *Role of CPE Tail Length on Rheological Properties of Poloxamer Hydrogels for Drug Delivery* **Advisor: Michelle Calabrese** **Sponsoring Program**: MRSEC **Home Institution:** The Pennsylvania State University **Abstract:** Middle ear infections are exceedingly common in children under five and lack direct and noninvasive treatment. Aqueous solutions of poloxamers can be used for transtympanic delivery for the treatment of otitis media, or middle ear infections, due to their thermoreversible micellization behavior. This work utilizes Poloxamer 407 (P407), which is an ABA triblock polymer that undergoes a solution-to-gel transition with increasing temperature. When P407 is paired with the antibiotic ciprofloxacin HCl and the chemical permeation enhancer (CPE) methyl laurate (ML), a "pseudo-surfactant" complex forms between the antibiotic and CPE, enhancing the permeation of the tympanic membrane in the ear. This work evaluates how variations in P407 concentration affect the gel structure, mechanical properties, and micellization kinetics of P407 hydrogels. Rheology and differential scanning calorimetry were used to observe the effects of different CPE tail lengths on gelation and mechanical properties of the hydrogels. By tuning the onset gelation of the formulations, drug delivery can be facilitated near body temperature. These findings will contribute to a broader study to design a direct and single-dose method of treating otitis media.

72.	**Alexis Sherman** *Critical Review of Specific Surface Degradation Rates: A Case Study of Polystyrene* **Advisor: Boya Xiong** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Cornell University **Abstract:** To understand and compare the end-of-life impact of plastics, we must systematically investigate the persistence of various plastics in different environmental conditions. Conventional plastics can break down under multi-step and multi-mechanism degradation pathways, releasing micro- and nanoplastics, dissolved carbon, and CO2. This project aims to quantify plastic degradation using specific surface degradation rates (SSDRs), which allows for comparison of polymers regardless of their composition, shape, degradation mechanism, or environmental compartment. Through an extensive literature review, we extracted data on plastic mass loss, particle size distribution, and dissolved organic carbon measurements to calculate SSDRs for different polystyrene (PS) forms. The results indicate that the polymer manufacturing process has a significant impact on its degradation; expanded PS has a degradation rate ~1000 μm/yr, while conventional PS has a degradation rate ~50 μm/yr. Understanding these degradation rates will provide valuable insights into the environmental lifetimes of plastics that can inform the sustainable design of future polymers.
73.	**Whitney Short** *Developing quantum algorithms for modeling open quantum systems at temperature with the Bloch-Redfield equation* **Advisor: Kade Head-Marsden** **Sponsoring Program**: MRSEC **Home Institution:** Washington University in St. Louis **Abstract:** Behavior in many quantum systems relevant to present chemistry and materials science is driven by interaction with an external environment. Quantum algorithms are a useful tool to study the evolution of these open quantum systems, but presently, the majority of these algorithms can only model behavior at low temperature. The Bloch-Redfield equation, conversely, offers the ability to examine thermodynamically produced dynamics in open systems, allowing us to access observables pertaining to temperature. Here, we investigate how the Bloch-Redfield equation can be implemented to model open quantum systems on current quantum computers. Current hardware can only implement unitary gates, so we map the non-unitary Bloch-Redfield operations into unitary ones, providing a mode to model non-unitary behavior at temperature on a quantum computer. As this process can be costly, we optimize the circuits and operator decompositions by taking advantage of often present characteristics like sparsity and symmetry.
74.	**Gabrielle Solymosy** *Electrochemical characterization of ionogels and ionic liquids in varying environmental conditions* **Advisor: Kelsey Stoerzinger** **Sponsoring Program**: MRSEC **Home Institution:** The University of Chicago **Abstract:** Ionogels, consisting of an ionic liquid (IL) encapsulated within a polymer matrix, present a unique combination of ionic conductivity and mechanical robustness, making them promising candidates for electrochemical gating, supercapacitors, and solid electrolytes. While the effects of ion identity and humidity on ILs have been well-documented, the polymer matrix raises critical questions about the polymer's influence on ion diffusion. This work explores the electrochemical behavior of ionogels compared to neat ionic liquids using cyclic voltammetry (CV) to determine their electrochemical windows. The neat ionic liquid 1-ethyl-3- methylimidazolium bis(trifluoromethylsulfonyl) imide ([EMIM] [TFSI]) and EMIM TFSI within a poly(vinylidene fluoride-co-hexafluoropropylene) (P(VDF-HFP)) copolymer matrix is investigated. Screen-printed electrodes are employed to examine stability windows on platinum (Pt), gold (Au), and platinum-gold alloy (Pt-Au) electrodes, where varying the electrode enables understanding of the mechanism of degradation. In situ Fourier Transform Infrared (FTIR) spectroscopy can probe the distribution of ions at the ionogel-electrode interface. These systems are sparged with argon (Ar), oxygen (O_2), or air to investigate the role of dissolved water and oxygen. In this project, a deeper understanding of the processes governing ionogel behavior is determined, influenced by ion identity and environment, and their implications for advanced electrochemical applications.

75.	**Colton Stewart** *Determining Practical Application Parameters for the Use of Laponite Clay to Treat Harmful Algal Blooms in Minnesota's Aquatic Environments* **Advisor: Avery Agles** **Sponsoring Program**: NSSA Pathways **Home Institution:** Normandale College **Abstract:** Harmful algal blooms (HABs) pose significant threats to aquatic ecosystems and public health in Minnesota. This study explores the practical application parameters for using Laponite clay to treat HABs. Laponite, a synthetic layered silicate, demonstrates potential in adsorbing and removing algal cells from water bodies. Laboratory-grown cyanobacteria, provided by Yuan Li at SAFL, were subjected to varying concentrations of Laponite (0.01%, 0.05%, 0.1%) over a two-hour period. Cell removal rates were measured using a hemocytometer and laser-based counting method. These procedures are ongoing, and for the purpose of this presentation, we will focus on one particular variable: the effect of time on the flocculating properties of Laponite solutions, specifically comparing the performance of solutions prepared 1 hour versus 10 days in advance. Our results indicate that Laponite effectively reduces cyanobacteria concentrations through flocculation. The study evaluates the impact of Laponite aging (1 hr vs. 10 days) on its removal efficiency. These findings suggest that Laponite clay is a promising agent for mitigating HABs in Minnesota's aquatic environments, offering a potentially scalable solution to combat the increased presence and impact of harmful algal blooms in Minnesota's aquatic ecosystems.
76.	**Nicholas Stoyanovic** *An Emulsion Method for Producing Sustainable Cellulose Microbeads* **Advisor: Michelle Calabrese** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Georgia Institute of Technology **Abstract:** Non-degradable microplastic pollutants pose a serious threat to the environment due to their small size, which makes them difficult to remove from the biosphere. Their effects on human health remain largely unknown, yet these pollutants have been found in human blood, lung tissue, and testes. Plastic microbeads are found in personal care consumer products (PCCPs) such as toothpastes and face washes due to their shape and mechanical properties, serving as rheological modifiers and exfoliants. Microbeads developed from non-derivatized cellulose and lignin feedstocks present a sustainable alternative to petroleum-based microbeads, as they are biodegradable. To be commercially competitive, these biomass-derived beads would need to be of the appropriate size range (~200-800 microns in diameter) and have similar shapes and mechanical properties as existing microbeads. Such beads can be produced by dissolving biomass in 1-ethyl-3-methylimidazolium acetate (EMImAc), mixing with mineral oil, and then precipitating with ethanol. In this study, we examine how stir speed and impeller size affect the size distribution and aspect ratios of cellulose microbeads, as well as how temperature control can enhance the incorporation of lignin into the processed biomass.
77.	**Zoeretha Suakollie** *Measuring the Dynamics of Vascular Smooth Muscle Cells Contraction Using Traction Force Microscopy `* **Advisor: Victor Barocas** **Sponsoring Program**: BME Pathways **Home Institution:** Morgan State University **Abstract:** The prevalence of cardiovascular disease as a leading cause of death worldwide underscores the critical need to advance our understanding of its underlying mechanisms. At the forefront of this pursuit is the pivotal role played by vascular smooth muscle cells (VSMCs) in regulating blood pressure through their dynamic contraction and relaxation processes. Our current research initiative is focused on unraveling the intricate dynamics of VSMC contractions, particularly by employing a sophisticated methodology known as Traction Force Microscopy. This innovative technique involves the development of a specialized deformable gel matrix embedded with fluorescent beads, providing a platform for the adhesion of VSMCs. By inducing controlled contractions in these VSMCs through the introduction of potassium chloride, we are able to capture high-resolution visual data and precisely quantify the speed and force of their contractions. This comprehensive approach allows us to gain insights into the specific biomechanical mechanisms underlying VSMC function, particularly within the context of cardiovascular disease. Through our meticulous investigation using Traction Force Microscopy, we aim to elucidate the nuanced interplay between VSMC dynamics and cardiovascular disease pathophysiology, ultimately paving the way for the development of targeted interventions and therapeutic strategies.

78.	**Audrey Surdell** *Sustainable Polyesters from CO2 and Butadiene: Synthesis and Polymerization of EVP-Derived Monomers* **Advisor: Ian Tonks** **Sponsoring Program**: Center for Sustainable Polymers **Home Institution:** Seattle University **Abstract:** Given that carbon dioxide (CO_2) is both inexpensive and abundant, its status as a prevalent waste product makes it an appealing option as a sustainable feedstock in polymer synthesis. The direct polymerization of CO_2 with olefins is currently inaccessible due to its high thermodynamic stability. This can be circumvented by utilizing a six-membered lactone intermediate, 3-ethyl-6-vinyltetrahydro-2*H*-pyran-2-one (**EVP**) that forms from the telomerization of CO_2 and butadiene. Currently, high molecular weight polyesters have not been achieved with EVP, which leads to this work: the transformation of **EVP** to form other monomers of interest. By utilizing Michael addition and simple substitution chemistry, 3,3,6-triethyltetrahydero-2*H*-pyran-2-one (**TEtP**), 3,3-diethyl-6-vinyltetrahydro-2*H*-pyran-2-one (**DiEt-EVP**), and 3-(1-nitropropan-2-yl)-6-vinyltetrahydro-2*H*-pyran-2-one (**NEVP**), is described. Initial work focused on the optimization and purification of these novel monomers along with initial polymerization tests. The ring-opening polymerization (ROP) of **DiEt-EVP** using 1-cyclohexyl-3-phenylurea as a catalyst and potassium bis(trimethylsilyl)amide as a base yields polymers with molar masses up to 29.4 kg/mol and a dispersity of 1.2. The polymerization of this monomer shows potential for novel polyesters that are chemically recyclable, providing a useful pathway for the development of sustainable materials. Future work will focus on ROP of **TEtP** and **NEVP** along with further characterization of the CO_2-derived polyesters.
79.	**Victoria Thompson** *Synthesis of Redox Active Polymers via RAFT* **Advisor: Michelle Calabrese** **Sponsoring Program**: MRSEC **Home Institution:** University of Florida **Abstract:** Redox-active polymers exhibit tunable electrochemical binding, a property contingent on polymer design, enabling their utilization in diverse applications such as water purification. Poly(TEMPO methacrylate) (PTMA) is a redox-active polymer characterized by a nitroxide radical pendant group. When PTMA is combined with electrically conductive carbon nanotubes (CNTs) and coated onto substrate, a porous network forms. This network has demonstrated selective and reversible binding to polyfluoroalkyl substances (PFAS) when used in an electrochemical cell. Higher molecular weight PTMA improves device stability and efficiency but makes the polymer more difficult to process. Thus, for scalable application, balance must be achieved between good processability and device stability. Utilizing reversible addition-fragmentation chain transfer (RAFT) polymerization followed by post-polymerization oxidation, a process of synthesizing PTMA with targeted molecular weight and low dispersity can be established to determine the optimal point of maximum stability while retaining suitable processability. The precursor polymer synthesis will be optimized using in-lab equipment to allow for future repeated implementation. Polymer molecular weight and dispersity was characterized using Size Exclusion Chromatography (SEC) and Nuclear Magnetic Resonance (NMR). The future of this project includes evaluating processability through solubility screenings and dripping onto substrate (DoS) to establish the optimal balance between processability and device stability.
80.	**Ana Katrina Tiu** *Carbon Dots for Enhanced Phytoremediation of PFAS in Lemna minor (common duckweed)* **Advisor: Christy Haynes** **Sponsoring Program**: Center for Sustainable Nanotechnology **Home Institution:** College of the Holy Cross **Abstract:** Per- and polyfluoroalkyl substances (PFAS), also known as "forever chemicals," are a critical concern due to their detrimental biological effects, prevalence, and environmental persistence. Existing remediation strategies are severely limited given the variability in PFAS physicochemical properties and limited degradation pathways. Phytoremediation, the use of plants for contaminant removal, presents a promising opportunity, but has only been successful for a small subset of the 15,000+ PFAS molecules. To overcome these limitations, we propose using carbon dots (CDs), an easily synthesized biocompatible nanoparticle, to improve phytoremediation effectiveness by acting as a carrier for PFAS into and throughout plant tissue. To achieve this broad goal, we have focused on (1) investigating the affinity of different CDs in various conditions for 3 PFAS species: PFOA, PFOS, and GenX, and (2) testing CD-uptake enhancement using *Lemna minor*, an abundant aquatic plant. Early results suggest CDs bind more strongly to PFOS than PFOA or GenX and that pH is a driving factor for CD-PFAS binding reversibility. We are currently working towards optimizing *Lemna minor* growing conditions and identifying critical plant pathways to monitor during PFAS/CD exposure.

81.	**Dorothea Tse** *Uncovering Mechanisms of Neurodegenerative Diseases by Measuring Cerebrospinal Fluid Flow in Mice* **Advisor: Jeff Tithof** **Sponsoring Program**: ME **Home Institution:** University of Minnesota, Twin Cities **Abstract:** The discovery of the glymphatic system about a decade ago has revolutionized our understanding of the metabolic waste removal process in the brain. The glymphatic system involves flow of cerebrospinal fluid (CSF, a colorless fluid composed primarily of water) through the brain to remove waste molecules. Rapidly growing research on the glymphatic system continues to reveal how its dysfunction plays an important role in neurodegenerative diseases such as Alzheimer's disease. However, the driving mechanism of the glymphatic system is still poorly understood because of the complexity of performing in vivo quantitative measurements to accurately characterize CSF flow. This study employs surgical methods and two-photon microscopy to collect in vivo videos of fluorescent microspheres flowing in CSF. Data analysis is conducted by performing particle tracking velocimetry to compare mean particle flow speeds between mice of different ages. Prior studies demonstrate that glymphatic transport decreases with age, but our preliminary results suggest there is no significant difference in mean flow speed between young and old mice. Our research provides valuable insights for conducting more experiments on old mice and quantifying the CSF flow at the surface of the brain.
82.	**Faith Tung** *Tuning tris(amido) redox active ligands to expand the reactivity of d^0 yttrium complexes* **Advisor: Courtney Roberts** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** The University of Texas at Dallas **Abstract:** d^0 early transition metals represent an intriguing possibility in catalysis since their lack of d valence electrons can prevent side reactions and introduce potentially orthogonal reactivity to traditional late transition metal catalysts. Although the lack of d electrons also creates a barrier to any reactivity, redox active ligands can enable redox transformations. For instance, these ligands allow cross-coupling with d^0 metal catalysts by providing electrons for oxidative addition and reductive elimination. Previously, the Roberts group has performed alkyl-alkyl cross-coupling at d^0 metal centers, without β-hydride elimination, by using a tridentate tris(amido) redox active ligand. Here, the steric and electronic properties of the redox active ligand are tuned by changing the ligand substituents to alter the reactivity of d^0 yttrium complexes.
83.	**Shridhar Vashishtha** *Robustness in Selective Classification* **Advisor: Ju Sun** **Sponsoring Program**: Pathways **Home Institution:** University of Minnesota-Twin Cities **Abstract:** Selective Classification is a machine learning method that abstains from making predictions when uncertain about making them. Thus, it improves reliability and performance. This method has valuable applications where erroneous predictions can have significant consequences. However, the robustness of Selective Classification models, especially under adversarial conditions, remains an area of research. This work presents ways to improve the robustness of selective classification tasks.
84.	**Zoe Vetter** *Progress Towards Developing a Targeted Covalent Inhibitor of PCAF* **Advisor: Will Pomerantz** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Truman State University **Abstract:** Changes in the accessibility of chromatin allow for alterations in gene expression without modifying the genetic code, a process called epigenetics. P300/CBP Associated Factor (PCAF) is an enzyme involved in chromatin remodeling, known to promote HIV-1 transcription and implicated in glioblastoma progression, making it a promising drug target. The Pomerantz lab is interested in developing a targeted covalent inhibitor of PCAF by adding a lysine-reactive group to a lead scaffold (BZ1). One such molecule used a dichlorotriazine reactive group, but it was found to covalently bind to other bromodomain-containing proteins, causing selectivity issues. To address this, we substituted one of the reactive chlorines with a clickable alkyne. This modification should reduce reactivity and allow for the future development of a fluorescent probe using click chemistry.

85. **Catherine Welch**
Characterization of Chargino Mass Reconstruction Algorithms in Searches for R-parity Violating Supersymmetry
Advisor: Nadja Strobbe
Sponsoring Program: Physics REU
Home Institution: University of Washington
Abstract: Supersymmetry (SUSY) is a model in particle physics that posits a symmetry between fermions and bosons not predicted by the Standard Model (SM). Minimal SUSY theories have a $\mathbb{Z}2$ symmetry known as R-parity that constrains the allowed interactions between SUSY and SM particles. Theories that break this symmetry are known collectively as R-parity violating (RPV) theories. One hypothetical RPV decay of the top quark's supersymmetric partner into SM particles involves a chargino as an intermediate decay product. To distinguish this process from the SM background, it is useful to calculate the mass of this chargino from a selection of jets in the detector — in this case, the Compact Muon Solenoid at CERN. We investigate various methods for reconstructing the chargino mass, and quantify their performances using both a canonical significance formula and an iterative Gaussian fit of the chargino mass peak. We conclude that an ordinality–based heuristic to identify the constituent jets performs best across the mass plane; the specific algorithm varies depending on SUSY particle masses. We also investigate the use of machine learning methods to identify which jets most likely correspond to chargino decay products.

86. **Iona Welsch**
Fabrication of Large-Area Stamps Using Stamp and Step Technique for Roll-to-roll Nanoimprint Lithography
Advisor: Vivian Ferry
Sponsoring Program: MRSEC
Home Institution: St. Olaf College
Abstract: Nanoimprint lithography (NIL) is an efficient method for creating large-area nanopatterns, known for its high throughput, high resolution and low cost. Its commercial applications are growing in fields like photonics, surface engineering, and metamaterials. The NIL process starts with fabricating a master mold using techniques like optical or electron-beam lithography, which is used to produce imprinting stamps that create nanopatterned surfaces. Scaling NIL to a roll-to-roll (R2R) process is challenging because current master pattern fabrication methods are limited to small areas. Typically, large-area stamps for R2R NIL are made by stitching together small-area stamps, leading to rough surfaces at the seams. To address this, we implemented a method called stamp and step, which involves making multiple imprints with minimal gaps using a small-area stamp on a substrate. The edge roughness of these small imprints was optimized by adjusting the imprinting pressure. Additionally, we developed self-standing imprints. These imprints were applied to a substrate that already contains multiple imprints, reducing gaps and ensuring seamless coverage. By applying these techniques, we successfully produced a large-area master mold and a corresponding large-area stamp for R2R imprinting. Experimental results highlight the promise of this method for advancing various large-area NIL-based devices and materials.

87. **Savannah Williams**
Real-Time Cardiac Edema Tracking: A Novel Approach to Post-Extraction Heart Monitoring
Advisor: Ryan Nadybal
Sponsoring Program: ATP-Bio
Home Institution: Unniversity of Minnesota
Abstract: This study presents an innovative scale system for continuous heart weight measurement post-extraction, addressing a critical gap in cardiovascular research. Ex vivo perfused hearts are prone to edema, impairing hemodynamic function. While edema has been quantified by weighing organs before and after perfusion, this method doesn't indicate when or how rapidly it forms. We hypothesize that monitoring edema formation will provide greater insight into organ function and can evaluate therapeutics for isolated hearts or preservation techniques.
Our system incorporates load cells into the perfusion apparatus, allowing continuous weight measurement. A SparkFun Qwiic Scale amplifies load cell readings, transmitting data to a microcontroller for interpretation. A Mux board enables two Qwiic Scales on the same I2C bus. This method observes small weight changes frequently, with fluid accumulation occurring only in the tissue interstitium. Continuous weight monitoring may provide an early indicator of cardiac function deterioration. After characterizing edema formation, therapies will be tested to mitigate and reverse it. This device enables the collection of previously unobtainable data, potentially improving organ preservation techniques and deepening understanding of post-mortem cardiac processes. Future work may integrate additional sensors and expand to other organs.

88.	**Megan Williams, Devinn Chi** *NaloxSAVER: Overdose Detection System for Public Spaces* **Advisor: Svetlana Yarosh** **Sponsoring Program**: Human-Centered Computing **Home Institution:** American University, Macalester University **Abstract:** The opioid crisis remains a critical public health issue in the United States, with the Centers for Disease Control estimating over 105,000 overdose deaths in the past year. While significant efforts have been made in prevention and recovery, there is a pressing need for immediate, life-saving measures for individuals at risk of opioid overdose. Naloxone, a drug that can save lives if administered within a three-minute window, is essential in this effort. Our product, NaloxSAVER, addresses the gap in current resources by combining thermal infrared cameras with RGB cameras to detect opioid overdoses through monitoring breathing patterns. A live stream web interface includes an alert system when an overdose is detected, along with an informational video on how to administer the drug. We designed and implemented this novel system to provide rapid and accurate detection, achieving a 94% accuracy rate. We envision our product being implemented in public spaces where overdoses are frequent, such as metro and subway cars. By offering an immediate response mechanism, NaloxSAVER has the potential to save lives and improve outcomes in the fight against the opioid crisis.
89.	**Haisley Windsor** *Structural Characterization of Stressed Monoclonal Antibodies using Native Ion Mobility Mass Spectrometry* **Advisor: Varun Gadkari** **Sponsoring Program**: UMN Chemistry- Lando **Home Institution:** Truman State University **Abstract:** Monoclonal antibody biotherapeutics are used for treating a wide range of diseases including cancer and inflammatory illnesses. Their rise in popularity is due to their high target affinity, minimal toxicity, and high efficacy. However, it is necessary to understand how unexpected stress conditions affect their behavior prior to widespread usage. To address this, experiments with a focus on the structure of denatured antibody subunits were conducted. Individual subunits of IgG1 were analyzed by reduction of the disulfide bonds which connect the heavy and light chains. This process was meticulously optimized and followed by nESI on a cyclic IMS-MS platform. The resulting ion mobility mass spectra were used to generate characteristic fingerprint plots of each charge state of the heavy chain, light chain, and their complexes. A critical part of this study was the determination of CIU-50 values from these fingerprint plots. To stimulate stress conditions encountered during storage and production, experiments were conducted under heat, acidic/basic pH, and freeze-thaw cycles. Comparative analysis between stressed and control CIU-50 values indicated a decreased stability of IgG1 under stress. In conclusion, these findings show the importance of monitoring the integrity of monoclonal antibodies in medical settings to ensure their efficacy.

Teacher Poster Presentations

Listed Alphabetically by Presenting Author

.	**Sara Baldvins** *Developing a Researcher: Designing Curriculum to Explicitly Teach Skills Necessary for Success in a Research Setting* **Advisor: Boya Xiong** **Sponsoring Program**: MRSEC **Home Institution:** Friends Academy, Long Island, NY **Abstract:** As STEM educators we have a two-fold responsibility of both teaching the content of our field and also of preparing our students to become successful researchers. Too often, the pressure of finishing our curriculum under the time crunch of the semester forces us to choose between content and skills. Most often, we choose content at the cost of skills. The work of this MRSEC RET Project aims to identify the universal skills necessary to build impactful and confident researchers. This project as makes some suggestions of curricula and instructional strategies for explicitly and intentionally teaching research skills.
91.	**Cassandra Lydon** *Innovative Approaches to Chemistry Instruction for High School Classrooms: A Workshop for Summer 2025* **Advisor: Phil Engen** **Sponsoring Program**: MRSEC **Home Institution:** White Bear Lake High School **Abstract:** As STEM educators we strive to meet the standards as they change and to tackle the challenge of staying current and relatable to youth in our classrooms while we illustrate the global impact and importance of scientific research at our students' levels. To address these challenges, the proposed 3-day workshop will focus on innovative approaches to chemistry instruction for high school classrooms and include topics such as sustainability, green chemistry and climate action. Through the MRSEC RET program, Beyond Benign, and other programs, teachers and university researchers have collaborated to develop a collection of activities grounded in modern research yet suitable for the high school classroom. The workshop is designed for high school chemistry teachers who are passionate about transforming their teaching practices and inspiring students in chemistry. Workshop participants will leave with practical strategies and activities for implementing innovative chemistry instruction. They will also leave with access to a curated collection of resources and tools for enhancing chemistry lessons and a network of like-minded educators for ongoing collaboration and support. Our goal is to provide inspiration and confidence to educators to create engaging, meaningful, and student-centered chemistry experiences in their classrooms.
92.	**Jayson Sandeen** *Modeling Microplastic formation from weathering processes and detection using fluorescent microscopy in the high school classroom.* **Advisor: Boya Xiong** **Sponsoring Program**: MRSEC **Home Institution:** University of Minnesota **Abstract:** Seeing is believing. The development of curriculum regarding the production of microplastics from weathering through various means has lacked experimental opportunities in the general high school classroom. This project focuses on introducing students to weathering processes of various plastic types, and the subsequent identification of small particle production through fluorescent labeling and microscopic examination. The ability to see very small fragments of plastic will hopefully engage students to become more environmentally conscious.