UNIVERSITY OF MINNESOTA

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Summer Undergraduate Research Expo

August 10, 2023
McNamara Alumni Center
Memorial Hall
2:30 – 4:30 PM

Undergraduate Poster Presentations
Listed Alphabetically by Presenting Author

Presenters should be at their posters at the following times:
2:30 – 3:30 even numbered posters
3:30 – 4:30 odd numbered posters

1. **Charlie Acomb**
Characterization of the Ionospheric Scale Height and Altitude-Density Dependence in Auroral Latitudes
Advisor: Cynthia Cattell
Sponsoring Program: Independent Research
Home Institution: University of Minnesota
Abstract: Many aspects of the dynamics between space weather and Earth relate to the densities of plasma and neutral constituents of the atmosphere. Ionosondes are devices that have been used to measure the plasma density by altitude, but are ineffective at measurements beyond the plasma density peak. To obtain values for neutral densities and plasma densities at altitudes beyond this peak, this study proposes a new technique which utilizes data from the FAST (Fast Auroral SnapshoT Explorer) satellite of precipitating and reflecting particle populations in the upper ionosphere. This process involves analyzing the changes in energy flux of these populations to determine the altitude particles of that energy collided. From this, an exponential fit of the density can be performed. We have successfully been able to determine the collision altitude of particles. Work is still being done to compute the density fitting, and to expand the fitting process to account for the changes in chemical composition in the atmosphere. The resulting density profile will lead to more accurate modeling of the atmosphere and its interaction during solar events. This dataset will also be beneficial in atmospheric and climate studies by giving more complete data of the chemical distribution in the atmosphere.

2. **David Aguirre**
Spark Discharge Mixing Enhancement for Scramjet Fuel Injection
Advisor: Sayan Biswas
Sponsoring Program: ME
Home Institution: Harvey Mudd College
Abstract: Supersonic combustion ramjets (scramjets) are a promising propulsion system for long-range travel and military applications. They operate at hypersonic speeds by using an inlet-outlet system to compress airflow and combust fuel at supersonic conditions. Supersonic combustion comes with a variety of challenges and achieving this efficiently is the focus of modern research. Concurrently, plasmas have been of interest in the field of flow control. This study investigates the influence of nanosecond repetitive spark discharges as a plasma discharge method on the breakup of liquid in supersonic crossflow to improve scramjet fuel combustion efficiency. Experimental analysis involved Schlieren and high-speed direct imaging techniques to study the effects of spark discharges at varying frequencies. Multiple trials were conducted in a miniature wind tunnel, operating at approximately Mach 2 airflow, utilizing a dual tungsten electrode to create the sparks. Data from the high-speed direct imagery was processed in MATLAB to calculate jet penetration height and surface wave frequencies for each trial. The results indicated that spark discharges contributed to reduced jet penetration height. By gaining insights into the impact of spark discharges on fuel breakup and combustion, this research aims to pave the way for advancements in scramjet technology and its practical applications.

3. **David Ajayi**
Title: Investigating the mechanism of nanoparticle toxicity by tracking H2O2 production with electrochemical techniques
Advisor: Eleni Spanolios
Sponsoring Program: Center for Sustainable Nanotechnology
Home Institution: University of Minnesota Rochester
Abstract: Nanoparticles are increasingly being applied to innovative technologies as their unique size-dependent properties contribute to more efficient systems. However, the use of nanoparticles has not been without consequences. Studies show that these engineered nanomaterials can lead to toxic effects on environmental biota by producing reactive oxygen species like hydrogen peroxide (H_2O_2). H_2O_2 is a powerful oxidizer that remains relatively stable in abiotic environments. However, H_2O_2 also has the capacity to rapidly kill cells via hydroxyl radical generation. Lithium Cobalt Oxide (LCO), a common nanoparticle used in the fabrication of lithium-ion batteries, was tested concerning its propensity to generate H_2O_2. Employing electrochemical techniques of amperometry and cyclic voltammetry, the voltage and current of the LCO solutions were compared with a background solution of 0.1M potassium nitrate (KNO_3), in order to track the production of H_2O_2 from these materials in solution over 26 hours. The results indicate that LCO leaked H_2O_2 into the solution over time, with the highest H_2O_2 concentration being released in the first 30 minutes. The observed H_2O_2 emanating from LCO nanoparticles could explain the mechanism for its toxicity in the environment. These findings highlight the need for conscientious material design, ensuring the environmental sustainability of emerging nanotechnologies.

4. **Baraa Al-Jasim**
Synthesis and Structure-Activity-Relationship Study of 1,4-Acylthiazepanes as BD2-Selective BET Bromodomain Inhibitors
Advisor: William Pomerantz
Sponsoring Program: McNair
Home Institution: University of Minnesota-Twin Cities
Abstract: Selective inhibition of the bromodomain and extra-terminal domain (BET) family of proteins regulates gene expression and disrupts disease-associated pathways. Current pan-BET inhibitors exhibit dose-limiting toxicity, minimizing their therapeutic potential. Inhibitors that selectively target the D2 bromodomain are shown to attenuate undesirable side effects in clinical settings. Recently, the Pomerantz lab developed inhibitors based on the 1,4-thiazepane scaffold identified from a small molecule screen of 3D-enriched fragments, which subsequently showed to target the D2 bromodomain in BET proteins. 1,4-thiazepanes exhibit high 3D character, allowing for conformational diversity with the D2 bromodomain as it mimics the acetylated lysine on the histone tail and may potentially engage a non-conserved histidine residue. In this study, we synthesized 1,4-thiazepanes with different substituents on the benzene ring, which can interact with histidine. These synthetic steps included cyclization with a,β-unsaturated esters to yield 1,4-thiazepanones, and subsequent reduction and acylation to yield 1,4-thiazepanes, which were characterized by 1H NMR spectroscopy. Competitive Alpha Screen assays were employed to evaluate the selectivity and binding affinity for D2 bromodomains. By varying substituents on the benzene, we can explore the electronic properties of the ring system to further optimize selectivity and introduce new vectors for the 1,4-thiazepanes to target D2 bromodomains.

5. **Dylan Amiri**
Further Examination of the Recently Proposed Lone Pair Hybrid Model to Evaluate its Validity in Revealing Conjugated Pi Systems in Alkyne-Containing Compounds
Advisor: Valentine St. Hilaire
Sponsoring Program: Independent Research
Home Institution: University of Miami
Abstract: The lone pair hybrid model is a new way to visualize conjugated pi systems in alkyne-containing compounds and was originally proposed by Dylan Amiri. This approach is based on the idea that the pi electrons of a pi bond within an alkyne that are not involved in the conjugated pi system (due to these p-orbitals being perpendicular relative to the parallel p-orbitals contributing to conjugation) can occupy a single atom in the alkyne, but the specific atom they occupy is unclear. Therefore, we present a "lone pair hybrid" that accounts for both atoms being equally able to receive the pi electrons as a lone pair. The model utilizes the inclusive vs. non-inclusive steric number calculation method, which is also a new method proposed by Dylan Amiri to determine the most stable aromatic configuration that a compound can adopt. We utilize this steric number comparison method in conjunction with the lone pair hybrid model to (1) confirm that the atoms involved in the alkyne in the original structure are now sp2-hybridized and (2) determine the most stable aromatic configuration of alkyne-containing compounds.

6. **Dylan Amiri**
A New Method for Determining Aromaticity through Comparison of Inclusive vs. Non-Inclusive Steric Number Calculation in Conjunction with an Alternative Approach to Reveal Conjugated Pi Systems in Alkyne-Containing Compounds
Advisor: Valentine St. Hilaire
Sponsoring Program: Independent Research
Home Institution: University of Miami
Abstract: A required aspect for the classification of a compound as aromatic is it must have a conjugated pi system, which is constituted by a region of overlapping p-orbitals or, in other words, a continuous system of sp2-hybridized atoms. This is usually determined by drawing a valid resonance structure (one with no more than 2 formal charges) for the compound of interest, but we propose a new method intuitively suggesting resonance (if the atom of interest is determined to be sp2-hybridized) involving the comparison of inclusive vs. non-inclusive steric number calculation. For alkyne-containing compounds, we devised an alternative method for determining sp2-hybridization of atoms involved in an alkyne to ultimately reveal a conjugated pi system in the compound. This approach involves the idea that the pi electrons of a pi bond within an alkyne that are not involved in the conjugated pi system (due to these p-orbitals being perpendicular relative to the parallel p-orbitals contributing to conjugation) can occupy a single atom in the alkyne, but the specific atom they occupy is unclear. Therefore, we present a "lone pair hybrid" that accounts for both atoms being equally able to receive the pi electrons as a lone pair.

7. **Evan Arch**
Measuring the Size of a Photon
Advisor: Dan Dahlberg
Sponsoring Program: Physics REU
Home Institution: Carleton College
Abstract: Particles of light, known as photons, do not have an agreed upon size. The distribution of the electric field, or its size, in the direction the photon is traveling is characterized by its wavelength. However, the distribution of a photon's electric field in the plane perpendicular to the direction of travel is not well known. Using wire grid polarizers, we experimentally determined the spacial extent of a 10GHz, linearly polarized, photon's electric field in the direction perpendicular to the polarization.

8. **Elias Arroyo**
Olefin metathesis-based chemically recyclable Pyridine containing Polyoxazolidinones
Advisor: Jessica Lamb
Sponsoring Program: UMN Chemistry CSP
Home Institution: University Of North Carolina at Chapel Hill
Abstract: Polyoxazolidinones (POxas) are an emerging polyurethane subclass containing a five-membered cyclic urethane (oxazolidinone) in the polymer backbone. These polymers have been reported to have high thermal stability (T_d) and they can potentially be used in high thermal applications. POxas are traditionally prepared by the step growth polymerization of diisocyanates and diepoxides. Because diisocyanates are highly toxic and hazardous chemicals derived from phosgene, efforts have been made to develop POxas using non-isocyanate-based syntheses. Our group is currently working on a ring opening metathesis-based chain growth polymerization (ROMP) method of oxazolidinone fused cyclooctenes to make POxas. Although these novel monomers rapidly polymerize, control over their molar mass remains a challenge. Conversely, pyridine containing polymers exhibit widespread applications due to the presence of a Lewis basic nitrogen atom. Pyridine containing monomers that can undergo ROMP are rare due to pyridine coordinating to the metathesis active Ru-catalyst, hindering their ROMP. We hypothesize that by incorporating a weakly coordinating pyridine functionality into oxazolidinone fused cyclooctenes, it could serve as a directing template for the controlled polymerization of these novel monomers. Herein, we synthesized a novel pyridine containing oxazolidinone fused cyclooctene, and attempted its ROMP.

9. **John Auerbach**
Extending the Search for Disappearing Muon Tracks to the HCAL Barrel of the CMS Detector
Advisor: Jeremy Mans
Sponsoring Program: Physics REU
Home Institution: The Pennsylvania State University
Abstract: Cosmological surveys suggest that dark matter constitutes 85% of all mass in the universe, yet there have been few searches for LDM in the MeV to GeV range. Our current study explores muon track disappearance within the CMS experiment during Run 2 of the LHC by proposing a dark Bremsstrahlung radiative process with dark photon masses between 0.1-1GeV. However, event selection of this study is limited to the HCAL endcap due to previously insufficient resolution in the HCAL barrel. Run 3 upgrades to the detector involved replacement of HB photomultiplier tubes for silicon photomultipliers, prompting a broadening of event acceptance across eta. This project aims to prepare for the release of Run 3 data via analysis of Run 2 barrel data, generation of Run 3 MC simulations, and refinement of a BDT algorithm to process additional features. Analysis implicated deteriorated DT cells with lower efficiency regions that should be cut from event selection in Run 3, and testing of the new BDT revealed no significant improvement in performance or feature importance. These results allow better filtration of events and tuning of BDT parameters. Future application to Run 3 data will be used to determine statistical significance of the proposed interaction.

10. **Athreyi Badithela**
Targeted Sorting of Objects in Clutter - Segmentation
Advisor: Karthik Desingh
Sponsoring Program: Independent Research
Home Institution: University of Minnesota
Abstract: This project involves creating a segmentation model that is capable of segmenting any novel unseen objects using interactive segmentation. One example of unique objects in scene is during recycling, where one can encounter transparent, deformable, and opaque objects. Our model uses Meta's SAM to create initial segments of objects. The objects are then moved by a robot while maintaining clutter. We use XMem, a long-term video object segmentation model to track the segments as the objects move. SAM is not capable of perfectly segmenting novel objects. By tracking the over segmented objects, we gain additional information about the objects. Based on this, a couple of heuristic functions were implemented to collapse the over segmented objects. The obtained segments are then used for grasping the objects. From our experiments, we note that there are plenty of metrics to evaluate two masks that need to be collapsed. We specifically use the distance between the centroids of the segments as well as the direction of motion of the centroids. Our results note that this method works very well on opaque multi-colored objects. Future work would involve improving the heuristic to be capable of working on transparent and deformable objects as well.

11. **Jaiden Barthel**
AFFIRMING REALITY: Using Virtual Reality Self-Avatars to Mitigate Gender Dysphoria
Advisor: Evan Suma-Rosenberg
Sponsoring Program: Human-Centered Computing
Home Institution: University of Minnesota
Abstract: This research explores the challenges faced by individuals identifying under the trans umbrella, particularly the distress caused by Gender Dysphoria. It focuses on the potential benefits of self-virtual reality (VR) avatars as a positive space for gender identity exploration and support for transgender individuals. The study aims to investigate the effectiveness of self-VR avatars in mitigating gender dysphoria symptoms and providing better support for affected individuals. By narrowing our focus on self-VR avatars, we seek to understand their impacts on gender dysphoria distress. The study will involve analyzing users' responses within three separate avatar scenarios to evaluate their distress levels. Our findings may shed light on the potential of self-VR avatars as a powerful tool for supporting individuals dealing with gender dysphoria. Ultimately, this research strives to contribute to the development of effective interventions and strategies to enhance the well-being of those navigating their gender identity within the trans community.

12. **Jazmyn Beasley**
Efficiency of Wind Power Hydrostatic Transmission Test Stand
Advisor: Kim Stelson
Sponsoring Program: ME
Home Institution: Columbia University
Abstract: Fluid power systems offer the advantage of transmitting equivalent power in a significantly smaller space compared to mechanical or electrical drives, especially when dealing with high force or torque requirements. In the context of wind turbines, the project is investigating the efficiency of a wind power hydrostatic test stand that utilizes hardware-in-the-loop (HIL) technology to simulate the performance of hydrostatic transmission wind turbines under real field conditions. The primary objective of this project is to assess the efficiency of the hydrostatic transmission and explore methods to enhance the control of fluid flow and temperature. Specifically, the focus is on comprehending the influence of fluid viscosity and temperature on a hydrostatic transmission wind power application, with the ultimate goal of optimizing the overall efficiency of the transmission.

13. **Cesar Benitez**
Mechanical Properties of Structured Single Fibers and Non-Woven Mats
Advisor: Frank Bates
Sponsoring Program: MRSEC
Home Institution: University of Texas RIo Grande Valley
Abstract: Nonwoven mats, predominantly composed of short/long fibers and porous fibers, have gained considerable contemporary interest due to their wide range of applications in engineering. From filtration media to medical devices, nonwoven mats exhibit valuable properties, making them versatile and sought-after in various fields. The fibers we use are made by the melt-blowing method and are composed of Polybutylene terephthalate (PBT) and Polystyrene (PS). We want to understand the mechanical properties of nonwovens with various fiber structures and compositions by performing tensile tests on mats with different PBT/PS blend and porous fibers. Distinct preparations such as heat treatment, bonding steps, and solvent treatment can provide more insight into their stability and deformation mechanisms. Working towards a deeper understanding of the mechanical properties, the objective is to investigate and analyze the combined mechanical behavior of both the single fiber and the fiber mat. This approach enables the exploration of mechanical properties, acknowledging the significance of both individual fibers and the overall mat structure, considering parameters such as fiber curvature and entanglements. The team expects to directly compare distinct polymer blends and evaluate how the different structures and treatments can affect the mechanical properties.

14. **Benjamin Brekke**
Synthesis of borylaryl triflate aryne precursors containing electronically biased substituents
Advisor: Courtney Roberts
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Concordia College at Moorhead
Abstract: Arynes are well known and well documented precursors for the synthesis of various natural products and conjugated materials. Borylaryl triflate precursors have been gaining attention as of late for the synthesis of metal-aryne complexes through an oxidation addition/transmetalation mechanism. Previous work has been done on monosubstituted unsymmetrical borylaryl triflate precursors to study their resulting regioselectivity. The steric encumbrance of the substituent has been found to be influential on the regioselectivity of metal-catalyzed aryne annulations; however, little research has been done regarding the electronics of the substituent and its ability to affect regioselectivity. Various borylaryl triflate aryne precursors were synthesized containing electron donating and withdrawing groups. The synthesized compounds were characterized by various methods including 1H NMR, 19F-NMR and GC-MS. A brief kinetics study was carried out to determine the effectiveness of some of the synthesized precursors.

15. **Megdalia Bromhal**
Pointing Isn't that Simple: Improving Diver & Robot Interactions in a 3D Underwater Environment
Advisor: Junaed Sattar
Sponsoring Program: Human-Centered Computing
Home Institution: UNC Wilmington
Abstract: You would think pointing to communicate would be simple. If you pointed to a photograph hanging on the wall to your right, your coworker in the room would understand that you're pointing to the photograph. A robot, however, might think you're pointing to the wall behind you, not the photograph. This is because the robot inherently perceives the world in 2D, whereas you and I perceive it in 3D. Thus, my work this summer has revolved around improving human-robot interactions, specifically in underwater environments where the human is a diver, and the robot is an AUV, an automatic underwater vehicle. In these environments, a diver may need to point to coral or a floating piece of trash for the robot to note. So, what I work on is taking the images from the robot and running a pose detector on the diver in the images to get the XY coordinates for the diver's elbows and wrists. I then use a colleague's code to find the Z coordinate. From the now-3D coordinates of the diver's elbows and wrists, we will give the robot a 3D area of interest to search for the object the diver points to.

16. **Seth Buesing**
Detecting phase transitions in a 2D Scalar XY model using a Villain formulation
Advisor: Aleksey Cherman
Sponsoring Program: Physics REU
Home Institution: Macalester College
Abstract: A path integral simulator was developed for the 2D Scalar XY-Model, using a Metropolis Monte Carlo method on the lattice, with the goal of mapping the phase boundary for more general systems, and the eventual examination of a novel order parameter. The 2D Scalar XY-Model displays an infinite-order phase transition for a known parameter set, and thus serves as an excellent starting point for developing this Monte Carlo simulation. We used a Villain formulation of the XY-Model, which uses a discrete field to enforce the periodicity of the scalar field. A Python program was developed that completes a full lattice sweep for an N by N lattice in $\approx 2.5 \cdot 10^{-5} \cdot N^2$ seconds. This program also calculates autocorrelation times and other statistics to assess accuracy and progress and gives the expectation value and error for a desired observable. Our working results agree with the known analytic solutions in sections of the parameter space, yet approaching the expected phase boundary did not display the expected critical slowing down due to false minima in Villain fields, suggesting that we update our algorithm to avoid false correlations between the scalar and Villain fields.

17. **Brook Burbridge**
Simulating Cosmic Ray Electron Production Within the Intracluster Medium Using Magnetohydrodynamics
Advisor: Tom Jones
Sponsoring Program: Physics REU
Home Institution: Valparaiso University
Abstract: On the outskirts of galaxy clusters lies a hydrogen plasma, i.e., loose protons and electrons. In an event such as a merger of two galaxy clusters, a shock is sent through the intracluster medium (ICM), resulting in the acceleration of these protons and electrons to relativistic speed and energies, thus named cosmic rays (CRs). In the presence of the magnetic fields within the ICM, these CRs emit synchrotron radiation in the radio spectrum, producing large clouds of gas radiating in the radio spectrum called radio relics. Recent publications have further deduced the mechanism of acceleration that the shocks cause upon contact with the plasma. WOMBAT1 is a plasma simulation program that simulates cosmic events, such as the creation of a radio relic, by numerically solving the magnetohydrodynamic equations, but has yet to be updated to resemble the newly theorized physics involved. The purpose of this project is to provide WOMBAT1 with these updates and ensure the resulting simulations accurately resemble the mechanisms involved in producing radio relics.

18. **Kiersten Carew**
Optimization of the hydrolyzation of poly(ethylene terephthalate) with cutinase enzyme
Advisor: Boya Xiong
Sponsoring Program: Center for Sustainable Polymers
Home Institution: The Ohio State University
Abstract: Enzymatic hydrolysis of poly(ethylene terephthalate) (PET) show limited conversion to monomers. The reasons behind this are poorly understood, except that higher crystallinities of PET have been correlated with lower conversion. We hypothesize that only a fraction of total enzyme adsorbed to the PET surface show catalytic activity, and this fraction is lower in semi-crystalline PET compared to amorphous PET. Using conventional and inverse Michaelis-Menten kinetic models, we provide a quantitative comparison on actively adsorbed enzymes between amorphous and semi-crystalline PET particles of similar dimensions. Furthermore, we investigated the effect of liquid to solid ratio (μL liquid/mg PET) on the conversion of PET. We found that for both amorphous and semi-crystalline PET at fixed enzyme to PET loading (6.5 mg enzyme/g PET), higher conversion is achieved at higher liquid to solid ratios after 5 days of hydrolysis at 50C. Also, the dominant monoaromatic product at higher liquid to solid ratio is mono-hydroxyethyl terephthalate (MHET) as opposed to terephthalic acid (TPA), which is the dominant product at lower liquid to solid ratio. These findings are intended to provide mechanistic insight into the limitations behind enzymatic hydrolysis of PET as well as direct its process optimization.

19. **Samuel Carlson**
Metamaterials in Motion: Opto-Mechanical Manipulation of Photonic Metasurfaces
Advisor: Ognjen Ilic
Sponsoring Program: Physics REU
Home Institution: Bethel University
Abstract: Light is a powerful tool to manipulate matter, but existing methods require focused intensity that limits the possible shape and size of the object. Here, self-stabilizing optical manipulation is simulated using a particular 'metasurface': a pattern of subwavelength structures resonate with the electric field. Unlike optical tweezing, metasurfaces eliminate constraints on the shape, size, and distance between the surface and the light source. These findings may lead to applications ranging from contactless wafer-scale fabrication to laser-propelled light sails.

20. **Andy Chung**
From Compost to Carbon Dots
Advisor: Uwe Kortshagen
Sponsoring Program: ME
Home Institution: Lehigh University
Abstract: Carbon nanodots (CNDs) have gained significant attention recently due to their potential for green synthesis using biomass waste. Additional beneficial characteristics of CNDs include a broad absorption spectrum, colloidal stability, and inherent biocompatibility due to their non-toxic properties and hydrophilicity. Our project used garlic and onion peels, a waste product, to produce CNDs through plasma treatment. The plasma reactor we built generates an argon plasma under atmospheric conditions. The CND samples created were subjected to 0.8 slm of gas flow and 50 W, then were dispersed in methanol and processed using a sonicator and centrifuge. We produced four samples, each having a different plasma treatment time. The supernatants extracted from the processed samples were characterized using Fourier-transform infrared (FTIR) spectroscopy, UV-visible (UV-Vis) spectrophotometry, and an integrating sphere. These measurements confirmed the production of CNDs through features consistent with CNDs reported in literature. The plasma was also characterized using optical emission spectroscopy (OES) to determine potential reactive species that contributed to the formation of the CNDs. This exploratory research shows great potential for solvent-less, green synthesis of CNDs. Future work involves eliminating concentration yield bias and additional characterization, such as transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS).

21. **Alanna Combs**
Phenotypic Comparison of Adult and Stem Cell Derived Cardiac Fibroblast
Advisor: Brenda Ogle
Sponsoring Program: BME Pathways
Home Institution: Houston Community College
Abstract: It is crucial to determine the level of cultured cardiac tissue functionality for ensuring greatest physiological performance. Previous research has been conducted on the most effective ways to culture essential cells of the heart, such as cardiomyocytes and epicardial cells. This research has extended previous cardiac culturing discoveries to identifying baseline cells that promote high maturity of the most prevalent heart cell, cardiac fibroblasts. A phenotypic comparison study was conducted on adult ventricular and human induced pluripotent stem cell (hiPSC) derived cardiac fibroblasts. Three conditions were used in this study, hiPSC epicardial derived cardiac fibroblasts (M4 EPD-FB), M4 adult left ventricular cardiac fibroblasts (M4 aLVCF) and F5 adult left ventricular cardiac fibroblasts (F5 aLVCF). Each condition was analyzed for cardiac fibroblast phenotype expression via flow cytometry. Confluency was also determined through image analysis of cell cultures. Findings have concluded that the stem cell derived cardiac fibroblasts (EPD-FB) mimic adult fibroblast marker expression, but are smaller in size. While F5aLVCF and M4aLVCF are within the size range of adult fibroblasts, they do not as similarly mimic their protein markers. These findings are essential for creating the most effective engineered cardiac heart tissue.

22. **Téa Cook**
Double Gyroid Formation of Polystyrene-Polylactide Block Copolymer Thin Films on Rigid and Flexible Substrates
Advisor: Christopher Ellison
Sponsoring Program: MRSEC
Home Institution: Georgia Institute of Technology
Abstract: Diblock copolymers self-assemble into various microphases, including the double gyroid, a set of periodic interwoven chiral networks. Double gyroids exhibit enticing optical properties, like circular dichroism. For strong circular dichroism, the orientation and surface termination of the gyroid unit cell must be controlled. Literature shows that changing the surface energy of substrates alters gyroid orientation in thin films. As a result, most studies employ a few standard substrates, which limits applications. This project explores how substrate choice influences double gyroid formation and orientation of polystyrene-polylactide block copolymer (PS-b-PLA) thin films. To facilitate the characterization of transmissive optical properties and to expand application areas, glass, PET, and PES membrane substrates were compared to standard silicon substrates. Surface energy and roughness of substrates were quantified through contact angle measurements and atomic force microscopy (AFM). PS-b-PLA thin films were spun cast and annealed on the chosen substrates, varying annealing time, temperature, and atmosphere to explore double gyroid formation. Double gyroids of various orientations were confirmed on most substrates via scanning electron microscopy and AFM after annealing PS-b-PLA films between 165°C-180°C. Overall, this work expands the range of substrates suitable for double gyroid formation and implies that substrate choice may even provide orientation control.

23. **Yazmin Cortes**
Processing-Mechanical Property Correlations in Pharmaceutical Molecular Crystals
Advisor: Nathan Mara
Sponsoring Program: MRSEC
Home Institution: The University of Texas Rio Grande Valley
Abstract: Mechanical properties of molecular crystals play a vital role in pharmaceutical tablet production. Tablet manufacturing processes are currently empirical and rely on an iterative process to optimize production, proving costly. Efforts are being made to utilize single crystal ingredient mechanical properties to predict the millability and tabletability of pharmaceutical tablets using nanoindentation. To quantify the mechanical properties of these crystals, a high-throughput method of nanoindentation is being applied. The use of nanoindentation is a cost-effective solution to modern tablet production efforts as it can test the properties of a single crystal to a finished tablet. This project has two primary goals – to quantify the modulus and hardness of Carbamazepine Dihydrate (C15H16N2O3) single crystals using Berkovich intenders and to study the stress-strain relationship of Succinic Acid (C4H6O4) using spherical indenters. Additional surface analysis was conducted using a scanning electron microscope (SEM) to study the topography of these single crystals. These studies are vital in developing a fundamental understanding of the deformation behavior of molecular crystals which can be implemented in predicting and improving pharmaceutical processes.

24. **Alesya Dewland**
Developing in-situ Superconductor-Insulator-Normal Metal Tunnel Junctions
Advisor: Vlad Pribiag
Sponsoring Program: Physics REU
Home Institution: Wellesley College
Abstract: In this project, I developed in situ superconductor-insulator-normal metal (SIN) tunnel junctions. Such junctions are used in low-temperature transport measurements to probe the local electronic density of states and thus can be used to look for Majorana bound states. Nanoscale Manhattan-style SIN junctions were fabricated using electron beam lithography followed by metal deposition via a multi-step electron-beam evaporation process. The superconductor used was aluminum, and the normal metal was gold. A thin insulating film of aluminum oxide was grown between them in situ using controlled passive oxidation. Measurements on the devices were then performed in a dilution refrigerator at temperatures of around 20 mK. Successful tunnel junctions were identified by measuring their current-voltage characteristics and observing characteristic features in plots of differential conductance versus voltage, including a hard superconducting gap with BCS peaks on either side. Based on these results, it can be concluded that the method used to fabricate these SIN junctions was successful.

25. **Ryan Diaz**
Imitation Learning for Spatio-Geometry Driven Assembly Task with Dual-Arm Manipulator
Advisor: Karthik Desingh
Sponsoring Program: Independent Research
Home Institution: University of Minnesota - Twin Cities
Abstract: Part assembly tasks, such as the peg-in-hole task, are a challenging problem in the field of robotic manipulation. This project focuses specifically on the dual-arm peg-in-hole task of aligning and assembling two objects with geometrical intrusions and extrusions. As this manipulation task requires a high degree of precision, the accurate detection and orientation of the hole and peg is important. We employ a general framework in visuomotor policy learning that utilizes visual pretraining models as vision encoders. This study investigates the robustness of this framework against grasp variations within a dual-arm setup, both in simulation and the real world. Qualitative analysis of experiments done in simulation show that a visual encoder trained from scratch consistently outperforms frozen pretrained models. We then apply this model architecture to experiments involving running the task in the real world, finding that while the model is readily able to adapt to translation variations in grasp, it evidently still needs more signals for rotation variations, which may be provided by wrist-view cameras.

26. **Aidan Dosch**
Engineering a Macroscale Model of E. Coli Swimming
Advisor: Moumita Dasgupta
Sponsoring Program: MRSEC
Home Institution: St. Olaf
Abstract: We engineered an experimental model of bacterial flagella with four scaled up rigid flagella, rotated by stepper motors, surrounding a non-motorized flagella immersed in a tank of silicone oil. Escherichia coli (E .coli) are single-celled bacteria two micrometers in length with zero to ten flagella, helix-shaped appendages, about ten micrometers long. E. coli swim by using rotary motors embedded in their cell envelope that spin their flagella at a constant torque with a RPM faster than the turbine in a modern jet engine. These flagella are key to understanding how microorganisms move, however, their small size means the flagella are difficult to study. Therefore, by keeping Reynolds number constant between our model and the actual E. coli we create an accurate macroscale model to understand different microscale biophysical interactions. We fabricated flagella while keeping the design parameters like the ratio of their radius to length and pitch to length constant. My poster's focus is on the model's design and feasibility testing. On implementation, this model captures specific physical interactions between different structural and functional aspects of the bacteria's swimming, which would be impossible to isolate and study in real E. coli.

27. **Zahra Fattahi**
Improved Isolation of Prenylated Proteins for Prenylomic Analysis Using Cell Fractionation
Advisor: Mark D. Distefano
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Sharif University, Tehran, Iran
Abstract: Protein prenylation involves the attachment of one or two isoprenoid molecules onto cysteine residues positioned near the C-terminus. These proteins are found in all eukaryotic cells. Prenylation is essential for many signal transduction processes. Prenylated proteins have been implicated in the development of many diseases. Of the roughly 200 prenylated proteins found in cells, 60 proteins are constantly identified with proteomics. Here we report our efforts to increase that number through the use of a water-based cell fractionation method. Cells treated with the C15AlkOPP probe were suspended in water, then the prenylated proteins localized to the membrane were separated from cytosolic prenylated proteins and other proteins in the cells by centrifugation. Washing was repeated for 3-5 times in order to isolate the prenylated proteins and increase the concentration of the prenylated proteins in the fractionated lysate. After a click reaction with TAMRA-azide, the quality of the separation was analyzed through a gel fluorescence analysis, in order to visualize the prenylated proteins. That analysis showed the presence of the fluorescent bands that had not been previously observed, suggesting that this method may allow for the identification of new prenylated proteins.

28. **Rachel Fine**
Copolymerization of a CO_2-Derived δ-Valerolactone with Caprolactone and Glycolide
Advisor: Ian Tonks
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Northland College
Abstract: CO_2 is an attractive polymer feedstock due to its abundance as well as well as its potential applicability towards the sequestration of atmospheric fossil fuels released via fossil fuel combustion, however its high thermodynamic stability makes direct polymerization of CO_2 difficult. Rapagnani et al. (2022) achieved CO_2 incorporation in a polymer through the use of an intermediate molecule, 3-ethyl-6-vinlytetrahydro-2H-pyran-2-one (EtVP). Here we present the copolymerization of EtVP with lactones to yield copolymers with lower dispersity and higher molecular weight and percent EtVP uptake than that previously reported in the literature. New data on the reaction kinetics, reactivity ratios, and chemical recyclability of the novel copolymers will also be presented.

29. **Kendra Flanigan**
Revolutionizing Recycling: Assessing the Efficacy of Block Copolymer Compatibilizers for Plastics Recycling
Advisor: Frank Bates
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Smith College
Abstract: The escalating demand for plastic products has raised concerns about waste accumulation, catalyzing recycling efforts. However, the recyclability of the common plastics polyethylene (PE) and isotactic polypropylene (iPP) is limited by their immiscibility, which yields brittle blends. Moreover, current methods of mechanical recycling are imperfect, expensive, and yield products with impurities and thus limited commercial viability. Hydrogenated polybutadiene block copolymers were recently demonstrated to compatibilize PE/iPP blends with loadings under 1 wt%. These were comprised of polyethylene "E" blocks flanking a poly(ethylene-ran-ethyl ethylene) "X" block made iPP-miscible with an ethyl ethylene content of 90%. This research delves into the versatility of $E_{65}X_{88}E_{65}$ as a compatibilizer (where the subscripts refer to block molecular weight in kg/mol) through various mixing protocols, homopolymer grades, and cooling procedures. Blend toughness depended strongly on mixing protocol, highlighting EXE's non-negligible affinity for PE over iPP. Additionally, using cooling conditions outpacing PE's crystallization rate substantially augmented EXE performance, especially in PE-rich blends. Applying these findings to post-consumer recycled plastic resulted in blends with toughness rivaling the virgin resins and showcased EXE compatibilizers as a promising tool to confront the global plastic waste crisis.

30. **Emi Gacaj**
Determining the role of human triple-negative breast cancer cells on primary rat hepatocyte glucose production, utilizing collagen-based microtissues.
Advisor: David Wood
Sponsoring Program: BME Pathways
Home Institution: Columbia University
Abstract: Understanding the mechanisms of cancer metastasis is a vital tool in developing targeted therapeutics and treatments to approach this disease. Glucose production is a crucial metabolic process, and in understanding its modulation by the presence of cancerous cells, we are able to gain a more accurate understanding of the tumor microenvironment, paving the way for innovative strategies. Here, we replicate the characteristics of glucose production in the liver microenvironment, determining if there is a difference between hepatic microtissues that contain the 231 breast cancer cell line and those without. We fabricated 3D human liver models, through high-throughput droplet microfluidics, then allowing the select variables to proliferate, measuring glucose levels and conducting viability staining. Our study successfully revealed a disparity in glucose production between hepatic cells impacted by cancer metastasis and their non-metastatic counterparts. These findings underscore the impact of metastasis on cellular metabolic processes and emphasize the need for a comprehensive understanding of cancer cell interactions within the liver microenvironment.

31. **Elizabeth Gamez**
Development of Nanomaterials for Ultrasound-Mediated Destruction of Metastatic Ovarian Tumors
Advisor: Samira Azarin
Sponsoring Program: MRSEC
Home Institution: The University of Texas Rio Grande Valley
Abstract: Ovarian cancer is one of the most common cancers affecting women, many of these patients develop resistance to standard treatments. Graphene-based biomaterials have been used to deliver a sonosensitizer Chlorin E6 (Ce6) to ovarian cancer cells, enabling non-invasive killing via ultrasound treatment. The objective of this project was to develop a more biocompatible delivery platform for Ce6. A single emulsion solvent evaporation method was used to load Ce6 into poly lactic-co-glycolic acid (PLGA) nanoparticles. The process was optimized by varying the ratios of dichloromethane and dimethyl sulfoxide. Dynamic light scattering showed that the size and charge remained between 250 to 300 nm and -30 to -40 mV, respectively, for all batches. High-performance liquid chromatography showed Ce6 loading efficiencies ranging from 78.032 to 99.607 %. The biocompatibility of the Ce6-loaded PLGA was verified by evaluating viability of OVCAR-8 ovarian cancer cells upon exposure to the particles. Collectively, these results show the ability to develop a process for efficient loading of Ce6 into PLGA nanoparticles for a biocompatible Ce6 delivery platform. Future studies will focus on characterizing tumor killing by Ce6-loaded PLGA upon ultrasound treatment.

32. **Maia Garcia**
Deformation of the cell nucleus after high-speed stretching.
Advisor: Patrick Alford
Sponsoring Program: BME Pathways
Home Institution: North Hennepin Community College
Abstract: Traumatic brain injury (TBI) affects thousands of people; as of 2021, 190 people die each day of TBI. TBI and blast induced trauma can both lead to lifelong health problems. Blast-induced traumatic brain injury (bTBI) specifically can change cellular phenotypes and contractability of the cell. Knowing how bTBI and TBI affects the cells is incredibly important because these are not visible wounds. Using a custom technique called cellular microbial stretching; we are able to measure the effects of traumatic mechanical injury in a singular vascular smooth muscle cell. We stretch vascular smooth muscle cells at different rates, then we measure the deformation of the nucleus via fluorescent imaging. The preliminary results show that the nucleus deforms during stretching, and the deformation depends on the rate of stretching. Prior works suggest that nuclear deformation affects cellular gene expression, so these results provide us insight into how TBI can affect the function of individual vascular smooth muscle cells.

33. **Wanbo Geng**
Exploring the Impact of Artist-Designed Glyphs in Data Visualization: A Comparative Analysis
Advisor: Evan Suma Rosenberg
Sponsoring Program: Human-Centered Computing
Home Institution: University of Minnesota, Twin Cities
Abstract: We designed a user study on the Artifact-Based Rendering (ABR) technique, comparing visualizations designed using physical, artist designed, real-world elements vs. other "state-of-the-art" visualization techniques. Artifact-Based Rendering (ABR) uses physical materials to create immersive, data-driven visualizations. By harnessing the diversity found in nature and artistic mediums, ABR broadens the scope of digital visual language. We hypothesize that artist-designed visualizations using ABR will at least "do no harm" compared with other state-of-the-art techniques, and in prior studies that have been run with ABR, the ABR technique already showed great potential for providing contextual information and the emotional associations that artist-designed shapes can have in a 3D multivariate visualization. Traditionally in visualization research, visualization techniques are evaluated with user studies that record "time" and "errors" on participants performing specific tasks with a particular visualization technique. Our goal is essentially to evaluate the effectiveness of the ABR technique with respect to "traditional" time and errors metrics in terms of shape identification in data visualization.

34. **Talia Glinberg**
FTIR Analysis of Preferential Solvation and Z907 Dye in Various Solvent Environments
Advisor: Aaron Massari
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: When a material dissolves in a liquid, the solvent interacts with the molecules in that material to surround them and form a "solvation shell". The interactions of this shell with the dissolved species can change its properties and reactivity. When solvation occurs in a mixture with more than one solvent, preferential solvation is often observed. In this experiment, infrared spectra were collected to better understand the molecular interactions between a binary solvent mixture and a solute. Z907 dye was dissolved in 11 solutions with different molar ratios of acetonitrile to ethanol. FTIR spectra were collected of each of the solvent mixtures both with and without dissolved Z907. The resulting spectra were then analyzed by subtracting a solvent-only spectrum. Numerous fitting methods were applied in an attempt to best interpret the changes in the spectra. The results indicate that the solvent environments may differ in the various solutions with different molar ratios of component solvents.

35. **Dongwoo Han**
The effect of polymer blend ratio of block length on polybutadiene-b-poly(ethylene oxide) micelle fragmentation kinetics in ionic liquids
Advisor: Tim Lodge
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: The equilibration of micelles formed by diblock copolymers has been highlighted due to their applications in various fields; yet, their fragmentation processes are poorly understood. Previous work on the fragmentation kinetics of 1,2-polybutadiene-*b*-poly(ethylene oxide) (BO), demonstrated that the fragmentation time varies with the total degree of polymerization (N_{total}) as $t_{frag} \sim N_{total}^{9/5}$, which is consistent with the theoretical prediction of Dormidontova, even though that was couched in terms of N_{corona}. In a later study, each block length was modified separately to resolve the contributions of N_{corona} and N_{core} to the fragmentation kinetics, and it is established that $t_{frag} \sim N_{core}^{1.2} \times N_{corona}^{0.6}$. In this study, a series of blend samples of the diblocks with fixed N_{PB} (9 kDa) with different N_{PEO} (9, 14 kDa) and fixed N_{PEO} (14kDa) with different N_{PB} (9, 20 kDa) was prepared in different ratios with 0.25 wt% in 1-ethyl-3-methylimidazolium bis-(trifluoromethylsulfonyl) imide via direct dissolution method to form micelles. The change in sizes of micelles was observed using dynamic scattering light at a high temperature (170 ℃). It is expected that the results will establish a further understanding of the block length effect on fragmentation kinetics.

36. **Katherine Hartley**
Acknowledging the Gap Between Real and Virtual Nature
Advisor: Victoria Interrante
Sponsoring Program: Human-Centered Computing
Home Institution: University of Florida
Abstract: It might seem like nature is everywhere, but for several populations, like elderly in care homes and the incarcerated, it's a special occasion to experience full immersion and be surrounded by biomass. Current virtual reality systems are capable of completely replacing the visual and auditory stimuli available to a VR user, albeit at a level of fidelity that does not (yet) match that of an actual real-world experience. Progress in virtually replicating haptic, olfactory, and other complex stimuli is ongoing. This experiment investigates the impact of these missing factors on the restorative benefits that a user derives from immersion in a VR-based virtual nature environment. After completing the Trier Social Stress Test, participants were immersed in computer-generated virtual environments both outside in real nature and indoors. We compared multiple restorative outcomes between four conditions, as well as preference ratings among all participants.

37. **Sydney Haubenstricker**
Physicochemical Characterization of a Viscous Polymer Blend as an Injectable Drug Delivery System
Advisor: Chun Wang
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota- Twin Cities
Abstract: Poly(ortho ester) (POE) is an effective sustained release drug delivery system with commercial success in several injectable drug products; however, it is very challenging to work with due to its high viscosity. This project aims to systematically investigate the effect of blending poly(ethylene glycol) (PEG) with POE on clinically relevant material performance, focusing on rheology, hydrolytic degradation, and release kinetics of a model drug. Several tests were conducted to examine the characteristics of the POE/PEG blend (both 50% and 20% PEG) and compare it to POE alone. We found that the blend was significantly less viscous than POE alone, making it much easier to inject through small-gauge syringe needles. The blend had a slightly faster water infiltration rate, and the polymer degradation products became marginally more alkaline over time. In conclusion, the POE/PEG blend shows superior material properties than POE alone as an injectable drug delivery system.

38. **Wade Hernandez**
The Standard Model of Particle Physics [Temp.]
Advisor: Zhen Liu
Sponsoring Program: Physics REU
Home Institution: Appalachian State University
Abstract: My presentation will be on the standard model of particle physics, what it is, what it tells us, as well as a calculation I did with it.

39. **Karyme Hernandez Torrens**
Relative rates of hydrolytic cleavage of di(alkoxy) di(alkyl) silanes.
Advisor: Thomas R. Hoye
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Universidad de Puerto Rico, Mayagüez
Abstract: Pollution from plastics has been a persistent and exponentially growing issue over the past few decades. Single-use plastics, while useful, are generally very slow at degrading, creating a continuous environmental issue. Silicon polymers, or polysiloxanes, are far more durable than plastics and find a variety of uses in everyday life. Additionally, siloxane polymers are thermally and chemically stable, have a flexible molecular chain, and are hydrophobic. However, these capabilities make polysiloxane materials unable to degrade easily in the environment. This is due to the strength of the Si-O bond and its hydrophobicity. The purpose of our research is to develop a monomer compound composed of a di(alkoxy) di(alkyl) silane that will undergo hydrolytic cleavage of the silicone oxygen bond much faster than the same bond of a silicone polymer. This model compound could then be incorporated into a long chain polysiloxane like polydimethylsiloxane and better degrade the material.

40. **Duncan Hill**
Micellization of PEE-PEO Block Copolymers in Organic Solvents for use as Perovskite Nanoreactors
Advisor: Tim Lodge
Sponsoring Program: MRSEC
Home Institution: Bucknell University
Abstract: Block copolymers are made up of chemically distinct polymeric segments connected through a covalent bond. The chemical dissimilarity between segments leads to a variety of self-assembled nanostructures both in bulk and solution. Block copolymer micelles have been studied extensively due to their uses in the fields of drug delivery and energy storage. The objective of the present study is to control the formation of poly(ethyl ethylene)-b-poly(ethyl oxide) (PEE-PEO) block copolymer micelles in organic solvents such as decane and squalane. The intent is to use PEE-PEO micelles as nanoreactors to grow perovskite nanocrystals, a material used to improve optical-electrical properties in solar cells and energy storage devices. As the micelle shape, size and distribution can greatly affect the stability and effectiveness of the perovskite nanocrystals, the micelle size and its distribution have been optimized by varying polymer concentration, temperature, solvent quality, and the method of preparation. Multi-angle dynamic light scattering measurements were carried out to determine the hydrodynamic radius of the micelles and the micelle size distribution. Micelles were also characterized using small-angle X-ray scattering to evaluate the shape of the micelles. Overall, the micelle size and distribution were found to be controlled best by tuning the temperature and solvent quality.

41. **Meredith Hoff**
Selective detection of pesticide enantiomers with chiral nanoparticles using surface-enhanced Raman spectroscopy
Advisor: Christy Haynes
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Wofford College
Abstract: More than 30% of the pesticides in use today are chiral, with enantiomers of the chiral compounds often having different levels of toxicity toward target and non-target organisms (Gu et al.). Therefore, it would be advantageous to be able to distinguish between enantiomers of chiral pesticides to evaluate environmental risks. We propose the use of surface-enhanced Raman spectroscopy (SERS) to be able to detect the different enantiomers using chiral nanoparticles, with the nanoparticles selectively detecting one enantiomer. The synthesis of the chiral nanoparticles is based on two previously published papers (Chen, et al.) (Xu, et al.). The development of the nanoprism seeds and chiral nanoparticles was monitored through UV/Vis spectroscopy, dynamic light scattering (DLS), circular dichroism (CD), and scanning electron microscopy (SEM). The resulting CD data matched literature spectra, demonstrating successful synthesis of the nanoparticles. Additionally, the seeds and nanoparticles were able to be tailored to specific edge lengths, which was confirmed through DLS. The enantiomers of the analyte were separated through high-performance liquid chromatography (HPLC) using a chiral column. The separated enantiomers were then confirmed through CD. Preliminary SERS measurements of the nanoparticles with a chiral pesticide have been taken.

42. **Colin Houts**
Poloxamer Gels in Biocompatible Ionic Liquids to Treat Middle Ear Infections
Advisor: Michelle Calabrese
Sponsoring Program: MRSEC
Home Institution: University of Iowa
Abstract: The current standard of care for otitis media (OM, middle ear infection) has many limitations including contribution to bacterial antibiotic resistance and unwanted side-effects. Recent research has highlighted the potential of aqueous, drug-loaded poloxamer gels (composed of hydrophilic and hydrophobic blocks) for treating OM. These formulations can be directly administered onto the eardrum for targeted, non-invasive drug delivery. However, small-molecule chemical permeation enhancers (CPEs) must be added to the poloxamer gels to enable drug transport across the eardrum, making formulation difficult. Choline-based ionic liquids (IL) are a potential solution to this problem as they are stable, biocompatible, and can serve as both a solvent and CPE. In this work, the interactions of biocompatible poloxamers and choline-based IL are investigated to fine-tune the rheological and structural properties of the drug delivery system. Poloxamer in choline-hexenoic IL and water was shown to transition to a gel state upon heating with a corresponding gel structure of body-centered-cubic (a = 83.5 A). The anion-to-cation ratio of IL and poloxamer concentration were varied to analyze its effect on sol-to-gel transition and associated final gel structure. The results obtained from this study can be exploited to develop more effective drug delivery routes to treat OM.

43. **Clarissa Huisman**
Optimizing the Synthesis of High Molecular Weight Thermoresponsive Triblock Copolymers for Processing Scalability
Advisor: Michelle Calabrese
Sponsoring Program: MRSEC
Home Institution: Simpson College
Abstract: Stimuli-responsive block copolymers are used in a variety of applications including printable electronics, thermoresponsive spray coatings, and drug delivery systems. These polymers are especially favorable in applications due to their tunable properties, versatility, and potential scalability. Polymer architecture has a crucial role in responsiveness, and reversible addition-fragmentation chain transfer (RAFT) polymerization can be used to achieve well-controlled polymers. In this project, RAFT is used to synthesize low dispersity poly(N-isopropylacrylamide-b-dimethylacrylamide) (P(NIPAM-b-DMA)) triblock copolymers. Polymerization was carried out using two RAFT chain transfer agents, 2-(1-carboxy-1-methylethylsulfanylthiocarbonylsulfanyl)-2-methylpropionic acid (CMP) and 2-(dodecylthiocarbonothioylthio)-2-methylpropanoic acid (bis-DDMAT). CMP contains end carboxyl groups, while bis-DDMAT contains end dodecyl carbon chains creating different resulting triblock structures, which should lead to different behaviors in solution. While previous experiments utilizing these triblocks were limited to lower molecular weight polymers, larger molecular weight polymers tend to have higher tensile strength and better longevity in applications. Therefore, we are interested in raising the molecular weight of these polymers to study how this affects structure and processability. Following successful synthesis, cloud-point testing was performed to study optical properties of the polymers as a function of temperature. This work connecting polymer architecture to solution processability will be beneficial to increase the scalability of these stimuli-responsive polymers.

44. **Sabrina Ingram**
Modeling chemical and mechanical signaling to simulate uterine fibroid growth resulting from changes in substrate stiffness
Advisor: Kyoko Yoshida
Sponsoring Program: BME Pathways
Home Institution: University of Alabama
Abstract: Uterine fibroids are non-cancerous tumors that can result in pain, heavy menstrual bleeding, and reproductive dysfunction in 25% of women. These tumors are composed of smooth muscle cells (SMC) and particularly stiff extracellular matrix (ECM). Understanding how mechanical and biochemical cues interact with each other to direct SMC growth, ECM properties, and fibroid development is crucial to effectively treating the tumor. Previous studies have shown that the interaction between the stiffness of the environment surrounding fibroid cells has an impact on tumor growth. The goal of this project was to expand on a previous biochemical network model by adding the capacity to simulate the effects of changes in environment stiffness. Utilizing the software Netflux, these models were made using a logic-based approach. This expanded model was able to both replicate the results of the older model and show the effects of substrate stiffness on certain protein levels and overall tumor size. It accurately captured the results of several studies that focus on the relationship between ECM stiffness, deposition, and Rho levels. While this signaling model was able to replicate the general results of experiments, a potential shortcoming is the qualitative nature of the simulation.

45. **Ismail Irfanullah**
Understanding aging through the detection of senescence-associated secretory phenotype in mouse embryonic fibroblasts
Advisor: Edgar Arriaga
Sponsoring Program: MSROP
Home Institution: University of Minnesota
Abstract: The world is aging, and aging-related diseases are becoming more prevalent. Many of these diseases are associated with cellular senescence, a process in aging cells that causes them to enter cell-cycle arrest. Additionally, senescent cells release a collection of proteins known as the senescence-associated secretory phenotype (SASP). Several studies have been conducted to measure SASP in cells, but previous methods lack the sensitivity and specificity required for measuring senescence on a single-cell level. This study proposes to use mass cytometry with gold nanoparticles in a sandwich enzyme-linked immunosorbent assay (ELISA) to measure SASP in senescent cells, which is hypothesized in this project to increase the reliability of SASP detection and allow for the identification of senescent cells on a single-cell level. Toward this goal, Etoposide (a cancer drug) was used to induce senescence in mouse embryonic fibroblast (MEF) cells. A senescence-associated ?-galactoside assay was conducted to confirm the induction of senescence. Future work includes the evaluation of SASP in the MEF cells treated with etoposide using a commercial ELISA assay. Completion of these tests will then allow us to test the new mass cytometry system on the MEF cells model and subsequently in samples associated with many diseases.

46. **Ishika Jain**
Investigating the Association Between CSF sTREM2 Levels and plasma lipoproteins in Alzheimer's Disease Pathogenesis
Advisor: Danni Li
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota
Abstract: TREM2, a lipid sensing receptor on microglial cells, is implicated in Alzheimer's disease (AD) development. Our research explores the relationship between CSF sTREM2 levels (a biomarker of microglial activation) and blood plasma lipids across the AD disease continuum. Non-demented individuals from the Alzheimer's Disease Neuroimaging Initiative (ADNI) were divided into three cohorts based Ab accumulator status: control (n = 211) (Aβ42-/ PET-), early accumulators (n = 48) (Aβ42+/ PET-), and late accumulators (n =196) (Aβ42+/PET+). 278 plasma lipids/metabolites were analyzed using the Nightingale NMR platform. Through linear regression models we examined associations between the plasma lipids and CSF sTREM2, adjusting for age, sex, # of APOE4 allele, and BMI. In early accumulators, three XS_VLDL lipids:total lipid ratios were associated with CSF sTREM2 levels: cholesterol (C), cholesterol ester (CE), and triglyceride (TG). The cholesterol and cholesteryl ester ratios were negatively correlated, while the triglyceride ratio was positively correlated. In late accumulators, two XXL_VLDL lipids:total lipid ratios were associated with CSF sTREM2 levels ($p < 0.01$): cholesterol ester and cholesterol. Both ratios showed positive correlation with sTREM2. The associations between CSF sTREM2 and certain plasma lipids suggest microglia TREM2 receptors sense brain lipids changes in early AD, which also influences plasma lipids.

47. **Anna Janni**
The Effect of Metallic Coatings on Atomic Force Microscope Cantilever Noise
Advisor: Dan Dahlberg
Sponsoring Program: Physics REU
Home Institution: University of Minnesota
Abstract: Atomic force microscopes (AFM) measure the topography of materials with a cantilever that reflects laser light from its end onto photodiodes. Gold and other metals coat cantilevers to improve the laser signal they reflect. Whether and how metallic coating affects the mechanical noise in AFM cantilevers is not well understood. To that end, we obtain the power spectral density of voltage differences across AFM photodiodes with a signal analyzer to measure noise in cantilevers coated with different amounts (0, 150, 300, and 400 nm) of added gold and added titanium. We coat cantilevers with electron-beam evaporation and sputtering. Thus far, our measurements show that 1/f noise increases with added metal.

48. **Melody Johnson**
Biobased degradable poly(carbonate-thioether) networks from isosorbide- and terpene-based monomers
Advisor: Theresa Reineke
Sponsoring Program: Center for Sustainable Polymers
Home Institution: North Dakota State University
Abstract: Many commercial plastic products create major environmental problems due to their sourcing from petroleum and their inability to degrade at the end of use. This project aimed to create degradable plastic alternatives from isosorbide, a commercially available derivative of glucose, and a small library of terpenoids, fragrant compounds isolated from various essential oils. Terpenoids containing hydroxyl groups were incorporated onto isosorbide to form carbonate-containing ene monomers. These monomers were then crosslinked with isosorbide-containing thiols to form network materials using thiol-ene photopolymerization. Tensile characterization of the isosorbide-terpene samples exhibited higher strain at break (128 to 204%) than terpene-only samples (26 to 40%). The isosorbide-terpene samples also experienced an increased glass transition temperature (-2 to 22 °C) than a terpene-only control (-6 °C), likely due to the rigid, bicyclic structure of isosorbide. The degradation of the polymers showed variable mass loss under basic conditions and stability under acidic and neutral conditions.

49. **Rishikesh Joshi**
Predicting Mental Health Wellness in Drug Users Using Machine Learning
Advisor: Ju Sun
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota Twin Cities
Abstract: In this research project, I aimed to develop an effective machine learning model to predict the overall happiness of drug users. I explored correlations between mental health outcomes and various factors, including drug use, risk profiles, personality traits, demographics, and additional psychosocial features.
This study utilized an anonymous survey from a research study, encompassing responses from 5000+ psychedelic and non-psychedelic drug users. Leveraging algorithms such as Neural Networks, Support Vector Machines, and K-Nearest Neighbors, yielded unsatisfactory results. However, employing more advanced techniques like XGBoost and TabNet achieved promising outcomes, with mean absolute error of approximately 0.5, root mean squared error of about 0.6, and root mean squared log error of less than 0.2, despite the target variable's range being from 1 to 4.
Through feature importance analysis, I identified extraversion, nationality, and frequency of meditation as the top three predictors for overall happiness. These findings offer insights for mental health interventions and policy decisions, specifically targeting drug users.
In conclusion, this project presents a novel approach utilizing machine learning to accurately predict drug users' overall happiness. The study's positive results and significant feature importances underscore its potential to impact public health policy and support drug users' well-being.

50. **Mija Kastelic**
Temporal Progression of Senescence in MEF Cells
Advisor: Edgar Arriaga
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Middle East Technical University
Abstract: Increasing rates of age-related diseases are a pressing issue with the world's aging population. To tackle this issue, we need a better understanding of what causes these pathologies. Senescence is a process of cellular aging characterized by cell cycle arrest and has been linked to age-associated illnesses. However, because senescence involves many underlying mechanisms which present differently depending on the cell location, senescence detection requires the multiparametric analysis of single cells.

Here, I present my work toward developing a mass cytometry-based method for monitoring the expression of senescence biomarkers throughout the process. Mass cytometry, or cytometry by time-of-flight (CyTOF), involves the detection of proteins via heavy metal isotopes that are used as antibody tags. For this work, senescence was induced with a genotoxic drug, and senescence protein biomarkers labeled with antibodies were measured at multiple stages throughout the process. Preliminary data analysis showed that treated samples exhibited a high degree of variability in biomarker levels. Further analysis will be conducted to determine the optimal method for sorting senescent and non-senescent cells in a heterogeneous sample. Once complete, this method will enable us to infer how cellular mechanisms change as cells become senescent, allowing for the design of better senescence-targeting therapeutics.

51. **Kyle Koss**
Understanding Autophosphorylation in V. cholerae
Advisor: Ambika Bhagi-Damodaran
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Ripon College
Abstract: Two component systems are common within signal transduction pathways across many species of bacteria. Intercellular molecular signals that regulate these two component systems allow bacteria to sense and respond to environmental stimuli. Histidine kinases are involved in signal transduction pathways within bacteria that detect signaling molecules with a receptor domain that allows for the autophosphorylation of the phosphate accepting domain. Phosphotransfer occurs between the phosphate accepting domain of the histidine kinase and a second protein, called a response regulator, which typically functions as a transcription factor to help the organism adapt to the environmental stimulus it is sensing. The expression and purification of the kinase domain of a Histidine Kinase found in *Vibrio cholerae* allows for the development of an assay to visualize autophosphorylation in various conditions and provide insight on the mechanism of autophosphorylation and how it impacts signal transduction.

52. **Catherine La Riviere**
Topology and Kinematics of Arch Disclinations in 3D Nematic Liquid Crystals
Advisor: Jorge Viñals
Sponsoring Program: Physics REU
Home Institution: Wellesley College
Abstract: Understanding the structure and motion of disclinations in nematic liquid crystals is vital to understanding the evolution of nematic systems. This project investigated the topology and motion of an arch disclination in a 3D nematic liquid crystal. We characterized the topology of a stable arch disclination from an anchored +½ and -½ defect pair to a surface in a three dimensional system. We then found the velocity of the disclination following applied shear both by applying the kinematic law of disclination line motion derived by Schimming & Viñals as well as through direct computation of the disclination core's velocity. Through comparing these two methods of calculating the velocity of the arch disclination, we are working to verify the effectiveness of the law of motion for disclination lines.

53. **Malcolm Lathrop-Allen**
Heat Transfer in Counterflow Nozzle Spray Cooling
Advisor: Vinod Srinivasan
Sponsoring Program: ME
Home Institution: Gettysburg College
Abstract: Moore's Law drives exponential growth in computation, arguing that the ability of engineers to design and implement smaller, denser, more powerful electronics produces an exponential trend in computational power. However, higher transistor counts in microprocessor chips produce greater power output per unit area, necessitating improved heat dissipation technology. One such novel solution is spray cooling, which proposes increased heat transfer efficiency by harnessing the energy required for water to vapour phase change. Best performance has been found using counterflow nozzles, which utilise air flow to atomise liquids into fine, low velocity droplets in a controlled and predicable manner. In order to maximise efficiency and increase the maximum dispersible heat flux, spray cooling can be augmented through microtexturization of chip-surfaces, resulting in greater contact surface area and changes in liquid-wicking properties. Prior experiments have attempted to investigate different microtexturization geometries, and found that optimal heat transfer performance occurs with micropillars of equidistant height and pitch in the 5-20 μm range. Rather than varying chip surface-roughness, this study instead aims to investigate the performance of one specific nozzle geometry by varying liquid and air flow rates to sample various spray regimes for their heat transfer characteristics at a fixed surface-roughness.

54. **Andrea Ligocki**
Dye loading and release from swelling polymers for agricultural applications
Advisor: Christy Haynes
Sponsoring Program: Center for Sustainable Nanotechnology
Home Institution: University of Minnesota - Twin Cities
Abstract: To achieve the United Nations' goal of eradicating hunger by 2030, it is necessary to improve crop production through sustainable and cost-effective solutions. Nanoparticles are increasingly being used to improve agricultural crop production because they can promote nutrient absorption, lower soil and water contamination, and increase the plant's resilience in non-ideal environments. Polymeric nanoparticles like poly-2-(diethylamino)ethyl methacrylate (pDEAEMA) have extensively been used for drug delivery in biomedicine due to their ability to reversibly swell in acidic media - a property this work will optimize to serve as a cargo release mechanism for agricultural applications. The plant leaf interior has acidic compartments; thus, with a foliar delivery approach, pDEAEMA has potential to diversify the landscape of nano-enabled cargo delivery to plants. pDEAEMA size, surface charge, and swelling behavior were extensively characterized using dynamic light scattering and transmission electron microscopy while the dye loading and release was optimized using confocal microscopy, in comparison with a non-swelling polymer control. Preliminary results suggest that there are polymer size-based differences in dye loading as measured by fluorescence intensity and confocal microscopy. Upon completion, this work will facilitate use of pDEAEMA nanoparticles to deliver beneficial cargo, thereby enhancing crop production.

55. **Alondra Madsen**
Sustainable Mobility: The Power of Control in Connected and Automated Vehicles
Advisor: Zongxuan Sun
Sponsoring Program: ME
Home Institution: University of Texas at Austin
Abstract: Connected and automated vehicles (CAVs) have the potential to revolutionize transportation, offering significant energy, mobility, and safety advantages. CAVs utilize Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication technologies to obtain real-world information such as speed, position, and signal phase and timing (SPaT) information. This project focuses on integrating a unified control framework that combines real-world traffic prediction with co-optimized vehicle motion and powertrain operation. A specific focus lies on investigating energy consumption at intersections since they are known to be a point of traffic congestion, where considerable energy is lost due to the deceleration and acceleration in the presence of red signals. SPaT and other CAVs' data was collected at Scott County's CSAH 18/CSAH 21/Southbridge Boulevard intersection in Minnesota and processed using Python aiming to uncover ways to enhance energy efficiency at intersections, propelling us towards a more sustainable and efficient future of transportation.

56. **Alexis Mann**
Synthesis of Structurally Complex Cyclopropanes via Free Carbenes Derived from Alkynes
Advisor: Thomas Hoye
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Ball State University
Abstract: Cyclopropanes are widely present in many natural products and medicinally relevant compounds. As the 10th most common small ring structure within drug discovery since the 1960's, cyclopropanes are recognized as key synthetic intermediates in synthesis of complex ring structures. The nearly 27 kcal/mol strain within cyclopropane rings has been utilized within skeletal rearrangements by synthetic chemists1. Cyclopropanes are commonly synthesized by reacting olefins with either free carbenes or metalated carbenoid species, as exemplified by the Simmons-Smith reaction. Recent work by Qian and Hoye disclosed the generation of free carbenes derived from alkynes in the absence of metals. This work expands upon Qian and Hoye's findings by demonstrating, for the first time, that free carbenes derived from alkynes can engage with tethered alkenes to form structurally complex cyclopropanated products. NMR and GCMS techniques were used for structure determination and characterization. A variety of cyclopropanated products were successfully synthesized by altering the tethered alkene to produce new ring structures. This synthesis allowed for utilization of the principles of green chemistry by avoiding the use of metals to generate the free carbenes and has employed a new technique in order to synthesize complex cyclopropanes.

57. **Ani Melichar**
Tracking the Generation Reactive Oxygen Species Electrochemically
Advisor: Christy Haynes
Sponsoring Program: Center for Sustainable Nanotechnology
Home Institution: University of Arizona
Abstract: Reactive oxygen species (ROS) are short-lived molecules that can be overproduced by cells under stress and have toxic effects on living organisms and the environment. Currently it is difficult to identify which ROS is being generated and where in the cell its originating from. This project aimed to develop methods of ROS synthesis that allow their generation to be monitored electrochemically. Electrochemistry is advantageous because it is quantitative and allows us to directly detect the ROS instead of detecting a byproduct of their interactions. ROS including hydroxyl radical, superoxide, and singlet oxygen were generated through various synthetic methods and detected with cyclic voltammetry. Understanding which ROS is being generated and from where in the cell it is originating allows us to better understand the mechanisms that cause ROS to be toxic. By understanding these toxic mechanisms we can hope to create solutions to eliminate them and reduce the effect of ROS on the environment.

58. **Anthony Mendoza**
Using Shadows Of Tailored Microspheres To Create Optical Metasurfaces
Advisor: Vivian Ferry
Sponsoring Program: MRSEC
Home Institution: The University Of Texas Rio Grande Valley
Abstract: Metasurfaces are engineered nanostructures that manipulate light in specific ways that are useful for a variety of applications. The traditional method of creating metasurfaces is expensive and is only able to create a small area. Shadow sphere lithography (SSL) is a low-cost solution that can be scaled for larger areas. This technique involves arranging spherical particles in a hexagonal pattern on a substrate, utilizing them as shadow masks during oblique angle evaporation of functional materials to form desired metasurface structures. To overcome the constraints of hexagonal arrangements, we replaced the planar substrate for sphere deposition with a topographically patterned substrate. This approach enabled precise filling of wells on the patterned substrate with spheres, while keeping the raised areas free from spheres through "discontinuous dewetting." Tailoring parameters such as sphere ink printing speed and surface tension facilitated this process. After deposition, spheres were transferred to a planar substrate via transfer printing. This process involved placing the sphere-coated patterned substrates on a semi-cured NOA layer, followed by UV treatment. After UV treatment, the patterned substrate was peeled off, leaving the spheres atop the planar NOA. Experimental results demonstrate potential microsphere arrangement control, paving the way for diverse SSL metasurfaces.

59. **Nicole Mertens**
The Effect of Photo-crosslinking on the Cellular Uptake of Polymeric Nanodroplets
Advisor: Chun Wang
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota
Abstract: Polymeric micelles are a family of nanoparticles for delivery of poorly soluble drugs to treat numerous diseases including cancer. They form by self-assembly of amphiphilic polymers in aqueous phase. Literature has shown that elasticity of nanoparticles has an influence on cellular uptake, but not much is known about such behavior involving soft polymeric micelles, which limits their use for drug delivery.
The objective of this study is to determine the efficacy of cellular uptake of very soft polymer nanodroplets and compare the effect of UV-crosslinked, stiffer nanodroplets with non-crosslinked, softer ones. We synthesized pPA20, an UV photo-crosslinkable amphiphilic polymer, which forms nanodroplets in water with average diameter of 50 nm at 1 mg/mL and can be loaded with poorly soluble dye. pPA20 consists of polycaprolactone segments via acetal linkers and end-capped with a UV-crosslinkable methacrylate. The constituents of pPA20 are not cytotoxic and biocompatible. There was equal uptake between crosslinked or un-crosslinked nanodroplets in human pancreatic carcinoma cells. Since crosslinking stiffens polymer chains, the elasticity of very soft nanodroplets does not have significant influence on cellular uptake. Solid and liquid-like nanodroplets are equally efficient in delivering poorly soluble molecules into cells, bolstering their potential utility in anticancer drug delivery.

60. **Milena Mesfun**
Magnetic field induced ordering of block copolymers
Advisor: Michelle Calabrese
Sponsoring Program: MRSEC
Home Institution: University of Alabama
Abstract: Poloxamers are amphiphilic ABA type triblock co-polymers that act like a surfactant in water, creating a micelle with a "B" type hydrophobic polypropylene oxide core and "A" type hydrophilic polyethylene oxide coronas. They are widely applicable as hydrogels; notably, they have been utilized in biocatalysis, drug delivery, and drug stability. In this project, we probed an atypical response of disordered poloxamer solution to ordered gel transition in response to magnetic fields. The behavior of a poloxamer solution in presence of an applied magnetic field (B= 0.5T) was investigated using magnetorheology, where the rheological characteristics of the samples were studied while exposed to an in situ magnetic field. Specifically, the time required by the poloxamers to transition from their disordered to gel state under magnetization, referred to as critical time, was tracked as a function of block ratio and molecular weight. The gels were characterized using small-angle x-ray scattering (SAXS), which revealed structural information about the gels obtained post-magnetization for 3 hours beyond the critical time. The critical time decreased exponentially and the modulus remained relatively consistent when increasing the molecular weight of the poloxamer. These results are helpful for future applications by demonstrating the tunability of magnetically-induced poloxamer gels.

61. **Sharmaka Mohamud**
Chitosan-coated mesoporous silica nanoparticles for agricultural application
Advisor: Christy Haynes
Sponsoring Program: PRELS
Home Institution: University of Minnesota
Abstract: With the global population growing at an alarming rate, there is a need for efficient and sustainable agricultural technologies to provide food security; however, approximately 20-40% of agricultural corps are lost to disease every year. Specifically, Fusarium wilt is a major factor limiting global soybean production. Silicon can play an important role in initiating a plant's defense against diseases. Acquired through a plant's roots as silicic acid, it polymerizes to form silica phytoliths that strengthen the plant's cells walls, making it more challenging for pathogens to infect the plant tissues. Separately, chitosan has also been shown to be important in plant disease resistance as it initiates a signaling cascade within plants to strengthen their natural defense mechanism. Thus, this work investigates mesoporous silica nanoparticles (MSNs) and chitosan-coated mesoporous silica nanoparticles (CTS-MSNs) to combat Fusarium wilt in soybeans. MSNs and CTS-MSNs have been synthesized and characterized to investigate their size, surface charge, and pore structure. Greenhouse and field studies to assess the impact of these materials on Fusarium-infected and healthy plants are currently underway. Together, these studies will demonstrate the use of MSNs with or without a chitosan coating as a nanoenabled agricultural technology to increase soybean crop health and yields.

62. **Sebastian Montero**
Self-assembling Patterns in Organic Semiconducting Thin Films
Advisor: Russell Holmes
Sponsoring Program: MRSEC
Home Institution: University of Florida
Abstract: Micrometer-scale periodic patterns have been shown to increase outcoupling efficiency for OLED and photonic devices. However, lithography-free methods such as thin film wrinkling require multiple layers and the application of anisotropic stress. Recently, a thermal annealing-driven method demonstrated the propagation of self-assembling patterns, tunable from a range of 800 – 2400 nm, simultaneously with crystallization. The goal of this project is to optimize this phenomenon by using organic molecules with a low bulk glass transition temperature (T_g) to increase suitability for OLED devices. To do this, organic molecules (4,7-Diphenyl-1,10-phenanthroline (Bphen) and N,N'-diphenyl-N,N'-bis(1-naphthyl)-1,1'-biphenyl-4,4 (NPB)) were deposited on a silicon substrate using physical vapor deposition (PVD). Ellipsometry was then used to characterize deposited film thickness, and films were annealed using a heating stage at 20 - 60°C above their respective T_g. Pattern growth was then observed under an optical microscope and analyzed by using timeseries imaging to measure crystalline growth rates. Results reveal the presence of pattern formation in NPB at 140-155°C, while Bphen exhibits the potential for this phenomenon when annealed from 95 - 110°C. Observing pattern formation in a low T_g molecule increases the likelihood of corrugated structure implementation onto OLED devices with this phenomenon.

63. **Claire Nelson**
Self-Assembly Behaviors of Asymmetric Homopolymer-Core-Shell Hybrid Bottlebrush Block Copolymers
Advisor: Mahesh Mahanthappa
Sponsoring Program: MRSEC
Home Institution: Colorado School of Mines
Abstract: Network phases formed by block copolymer self-assembly have potential applications ranging from nanotemplating to drug delivery. One way to expand the self-assembly lengthscales and their applications beyond the 10-50 nm range accessible using linear block copolymers is by considering architecturally complex bottlebrush copolymers. The Mahanthappa group previously synthesized hybrid bottlebrush polymers comprising segments of homopolymer and core-shell side chains that microphase separate into lamellae and double gyroid (Q^{230}) networks, depending on the side chain composition along the brush backbone. To gain insights into the polymer packing arrangements in these structures, hybrid brushes with compositionally asymmetric core-shell side chains were studied. The macromonomer side chains in these hybrid bottlebrushes were synthesized by sequential ring-opening transesterification polymerizations (ROTEP) of ε-decalactone and D,L-lactide initiated by 5-norbornene-2-*exo*-methanol. The desired bottlebrushes were then produced by a sequential living ring-opening metathesis polymerization (ROMP) "grafting through" approach to enchain blocks of the two macromonomer side chains. All polymers were characterized using ^{1}H NMR and size-exclusion chromatography (SEC), and their microphase separated morphologies were determined with small-angle X-ray scattering (SAXS). Future work will explore how network phase stability depends on the core-shell macromonomer side chain compositions and the backbone grafting density.

64. **Duc Hoa Nguyen**
Generating Precise Grasp Locations and Controlling UR5 Robot Arm for Object Manipulation in Recycling Robotics
Advisor: Karthik Desingh
Sponsoring Program: Human-Centered Computing
Home Institution: UCLA
Abstract: Our project aims to revolutionize recycling through innovative robotics, using the UR5 robot arm. We focus on creating precise capture points for diverse objects and efficiently controlling the arm for accurate grasping.
To achieve this, we employ a D515 camera for scanning, obtaining XYZ coordinates and depth information to create a detailed point cloud map of the environment and targeted objects. From this map, we compute multiple potential capture positions for the robot arm. Our key approach involves identifying the optimal capture point based on object shape, orientation, and stability to ensure successful grasping. This enables the robot arm to handle objects with precision and efficiency. We implement this technology using the UR5 robot arm and a control program that guides it smoothly toward the capture point. Through a combination of real-time feedback and precise motion planning, the robot arm performs a smooth and accurate grasp, securely lifting the object and dropping it in a designated area.
The project's ultimate goal is to enable the robot arm to autonomously pick up recyclable plastic bottles and shells, significantly improving recycling efficiency and promoting sustainability.

65. **Uyen Nguyen**
Monitoring Plasmon-Driven Reaction with Continuous Wave and Pulsed Laser Excitation
Advisor: Renee Frontiera
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Dickinson College
Abstract: Plasmonic materials such as gold and silver have received attention due to their ability to interact strongly with light. They concentrate the light energy into a nanoscale volume of an enhanced electric field called hotspots, known to drive several important industrially relevant chemical reactions. For instance, hydrogen dissociation has been observed at room temperature in the presence of plasmons, and water splitting and various redox reactions have been seen to occur with enhanced selectivity. Despite promising features, plasmon-driven reactions have low efficiency and have not been realized on an industrial scale due to low efficiency. Hence, scientists have studied the impact of substrate types, excitation wavelength, and other parameters on reactions' productivity. However, there is a limited understanding of the performance of plasmon-mediated reactions under different types of light sources used. This project investigates the effect of coherent light sources (continuous wave and pulsed laser) and incoherent light sources (sunlight) on the conversion of 4-nitrobenzenethiol to 4,4′-dimercaptoazobenzene by plasmonic gold nanoparticles. The sample underwent irradiation with a continuous wave laser, pulsed laser, and sunlight then the reaction yield was monitored. The work identifies the efficiency of plasmon-driven reactions under various light sources and helps to bridge the gap toward commercialization.

66. **Brandon Nguyen**
Understanding Catalyst Roles in Aluminum Nanocrystal Synthesis
Advisor: Ian Tonks
Sponsoring Program: UMN Chemistry- Lando
Home Institution: University of Kansas
Abstract: Metal nanoparticles have a variety of applications including photocatalysts and biosensing, owing to their unique plasmonic properties. The size and shape of the nanoparticles dictate the plasmonic properties of the nanoparticles. The synthesis of gold (Au) and silver (Ag) nanoparticles has been heavily studied to control the size and shape of the nanoparticles. Aluminum (Al) has recently been shown to be an alternative to these expensive metals, but the reactivity of the Al precursors makes the synthesis of the nanoparticles difficult to control. Recently, it has been shown that Titanium (Ti) catalysts reacted with Aluminum hydride (AlH_3) are able to control the size and shape of Al nanoparticles. Bis(pentamethylcyclopentadienyl)titanium dichloride ($Cp^*_2TiCl_2$) was chosen to compare the selectivity in the shape control with other cyclopentadienyl Ti catalysts. As the concentration of the $Cp^*_2TiCl_2$ increases, the selectivity for octahedral morphologies increases. The nanoparticles did not show cubic morphologies, unlike with other cyclopentadienyl Ti catalysts. An EPR study was employed to gain an understanding of the Al-Ti intermediate formed. To further understand the mechanism, a unique Aluminum-titanium model complex was synthesized and will be reacted with H_2 or AlH_3 to understand the reversible formation of the intermediate Al-Ti complex.

67. **Zacharia Nyambega**
Investigating Protein-Only Ligands' Inhibitory Potential in Protein-Small Molecule Hybrids for Drug Discovery
Advisor: Ben Hackel
Sponsoring Program: MRSEC
Home Institution: North Carolina State University
Abstract: Molecular targeting is a powerful technique utilized in therapeutics, diagnostics, and fundamental biology research, involving binding ligands such as proteins and small molecules. Despite their individual advantages, both classes exhibit limitations. Protein—small molecule hybrids (PriSMs) have the potential to merge the beneficial aspects of each class. During our investigation into new PriSMs targeting carbonic anhydrases (CAs), we discovered unconjugated proteins capable of binding to the targets in the absence of small molecules. In this study, we focus on the identification and characterization of these protein-only binders, specifically exploring the inhibitory potential of fibronectin, a protein-only ligand, against carbonic anhydrase isoforms II, IX, and XII. Employing fluorescence-activated cell sorting (FACS), we isolated fibronectin clones initially identified as PriSMs that exhibited binding to these isoforms in the absence of small drug molecules. Sanger DNA sequencing allowed us to identify candidate clones for activity determination, followed by extraction and transformation into E. coli to enable large-scale protein production. The produced proteins will be purified using metal-affinity chromatography, and their inhibitory efficacy evaluated through a 4-nitrophenyl acetate carbonic anhydrase activity assay. This study's findings will shed light on the unique behavior of these protein-only binders, enhancing their potential applications in drug discovery.

68. **Katie O'Leary**
Effects of Phthalate on the Upper Limit of Detection of Ion-Selective Electrodes
Advisor: Philippe Buhlmann
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Carleton College
Abstract: Phthalate is an ion present in commercially-available pH buffer solutions that is known to interfere with the working range of ion-selective electrodes (ISEs). Prevention of phthalate interference is a thus key objective in industrial and research settings that utilize ISEs. Quantitative theoretical models for the upper detection limit of ISEs as well as nuclear magnetic resonance (NMR) spectroscopy were employed with conventional ISEs to better understand the nature of phthalate interference.

69. **Ayooluwa Odeyinka**
Communities of Support in YouTube Comments
Advisor: Stevie Chancellor
Sponsoring Program: Human-Centered Computing
Home Institution: Williams College
Abstract: Have you ever been watching a YouTube video but find yourself more interested in the comments than the video itself? Well that's due to a number of factors, one of which is the communities that tend to form under these videos, especially ones that mention mental health. The research I'm doing focuses on analyzing these communities that form in the comment section, as well as the influencers themselves and seeing how opinions of mental health put out by YouTube Influencers results in positive or stigmatizing frames of mental illness. The data is gathered using YouTube's Application Programming Interface (API) and is broken down using python and pandas.The data we gather from the API is then analyzed using natural language processing and other methods.

70. **Marco Ortiz**
Radical germylzincation of alkynes to prepare vinylgermanes
Advisor: Alejandro Perez Luna
Sponsoring Program: Independent Research
Home Institution: Sorbonne Université
Abstract: Germanium-containing compounds like vinylgermanes have been in high demand recently for their applications in organic synthesis and in medicinal chemistry. By combining radical hydrogermylation chemistry and radical zinc-transfer chemistry, the ROCS lab has developed a new entry to tri- and tetra-substituted vinylgermanes through an original alkyne germylzincation reaction. In the case of propargylic alcohols, the approach is fully regio- and stereoselective. The extension to propargylic acetates and tosylates is now considered. Satisfactory conversion of vinylgermanes has been observed via hydrogermylation, while radical germylzincation needs further optimization. Developed strategies toward vinylgermanes and the understanding of radical chain processes will be presented.

71. **Marlon Oviedo Alfonso**
Progress Towards the Synthesis and Biological Testing of Small Molecule Bifunctional Ten Eleven Translocation Dioxygenase Inhibitors
Advisor: Natalia Tretyakova
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: Ten Eleven Translocation (TET) dioxygenases 1-3 is an alpha-ketoglutarate and Fe (II) dependent family of enzymes that catalyze the oxidation of 5-methylcytosine into hydroxymethylcytosine, formylcytosine and carboxycytosine. This catalytic oxidation leads to different gene expression and gene silencing. Current inhibitors for TET either mimic alpha ketoglutarate or cytosine with medium inhibitory effect. Described here is the synthesis and biological testing of our bifunctional inhibitors that include an alpha-ketoglutarate and cytosine mimics.

72. **Dashawn Paige**
Energy Model Tuning from Connected Vehicle Data
Advisor: William Northrop
Sponsoring Program: ME
Home Institution: The Pennsylvania State University
Abstract: In this project, a model of a Class 8 diesel vehicle was tuned based on real-world driving data collected from a fleet of trucks used for regional hauling operations. This model was then applied to study the changes in vehicle range when the outdoor temperature fluctuates. Using this dataset, trends in vehicle performance via repeated driving simulations in different real and simulated conditions were observed. A Python script was created to preprocess the data, perform exploratory data analysis, and tune the vehicle model. Through exploratory data analysis, empirical trends in the available data were identified that may later be tested for causal relationships to changes in vehicle performance. The vehicle model can estimate energy usage over a given drive cycle using equations derived from the longitudinal vehicle dynamics and powertrain components. This approach allows us to simulate driving conditions that may not have been encountered in the original dataset. This problem is important because temperature effects on vehicle performance can impact fuel usage and emissions. In the future, a physically-similar Class 8 battery electric vehicle model can be constructed from the baseline diesel truck model to investigate the performance of electric vehicles.

73. **Abby Persell**
Gadolinium Receptors As A Tool For Aqueous Carbon Capture
Advisor: Valerie Pierre
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Carleton College
Abstract: A series of macrocyclic and linear gadolinium complexes were studied to determine their affinity for bicarbonate. The ability of each complex to bind bicarbonate was determined using NMR relaxometry. The selectivity of each complex towards bicarbonate compared to other marine anions was also measured. Gd-DO3A was found to selectively bind bicarbonate.

74. **Gemma Pham**
Ionic Site Leaching and Biofouling Effects of Ion-Selective Membranes Exposed to Biological Samples
Advisor: Philippe Buhlmann
Sponsoring Program: UMN-Chemistry
Home Institution: UMN Chemistry
Abstract: Exposure of conventional polymeric-based ion-selective electrode (ISE) membranes to biological samples such as blood serum and urine, results in undesired signal drift and loss of selectivity, otherwise known as biofouling. One possible reason for biofouling is that the sample solution interferents interact with the membrane, causing the loss of ionophore and ionic sites. The hypothesis is that the albumin in the serum binds ionophore and ionic sites at the membrane/sample interface and thereby transports them out of ion-selective membranes into the bulk of the sample solution, which then causes the EMF drift in potentiometric measurements. To test this hypothesis, ISEs with proton ion-selective membranes were used, and two sets of measurements were conducted: one with albumin present and another without albumin while considering the effects of the sample flow in a flow-through cell. Our findings indicate that the potential drift observed in ISM may not be solely due to albumin. Although the hypothesis of albumin involvement was not supported by the data, this study provided valuable insights into the complex interactions between biomolecules and ion-selective membranes. To explore the complexities of biofouling in ISM, ongoing measurements with blood serum samples are underway to further elucidate the observed effects.

75. **Gavin Potts**
Enzymatic Activity of FTase and STE24 on Peptide Sequences
Advisor: Mark Distefano
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Morningside University
Abstract: Protein prenylation is a post-translational protein modification essential for cell functioning and is a potential therapeutic target for cancer and Alzheimer's disease. In eukaryotic cells, protein prenylation is a regulated three-step process. In this pathway, a 15-carbon farnesyl isoprenoid is attached to a cysteine near the C-terminus of the protein to a four amino acid sequence called a CaaX box (cysteine and variable amino acids). Using previous research as a guide1, this project focused on two steps within the prenylation pathway, the attachment of a farnesyl isoprenoid group catalyzed by FTase along with CaaX box cleavage facilitated by the sterol-24 (Ste24) enzyme. Several peptide sequences based on previous library screens were chosen for further evaluation. These peptides were synthesized with a DsGRAG peptide sequence, an upstream sequence known to aid in solubility and ionization. These peptide sequences were found to be successfully prenylated both by FTase and through chemical prenylation and can go on to be cleaved by Ste24. These peptides will then be sent to collaborators at Purdue University for Ste24 specificity assays.

76. **Zeina Qubbaj**
Improving Thermal Stability of PS and PS-b-PLA Double Gyroids with UV Crosslinking
Advisor: Christopher Ellison
Sponsoring Program: MRSEC
Home Institution: The University of Texas Rio Grande Valley
Abstract: Double gyroid (DG) is a complex 3D structure that is attractive for applications such as biosensing and optics. Useful inorganic DG structures can be templated from the self-assembly of block copolymers; however, this often requires elevated temperatures for thermal annealing or template transformations. The goal of this project was to improve the thermal stability of polystyrene-block-polylactic acid (PS-b-PLA) DG templates by optimizing UV crosslinking conditions (wavelength, intensity, and time) which imparts high temperature stability by immobilizing the polymers. Initially, chemical stability was used as a proxy for thermal stability and tested by soaking potentially crosslinked PS thin films in toluene and then measuring the remaining thickness via spectroscopic ellipsometry. Morphological changes in the films were observed using the optical microscope and SEM. The optimal UV exposure was determined to be 3 hours at a wavelength of 183 nm with an intensity of 5 mW/cm^2. Contact angle testing revealed oxidation of the films, possibly due to the UV source creating ozone which likely reacted with the polymer surface. This condition was then used to crosslink self-assembled PS-b-PLA films and PS templates prior to thermal stability testing.

77. **Siena Quinn**
Morphology and aggregation of cellulose microbeads produced using an emulsification method
Advisor: Michelle Calabrese
Sponsoring Program: Center for Sustainable Polymers
Home Institution: University of San Diego California
Abstract: Microbeads are often used in personal care consumer products (PCCPs) as exfoliants and rheological modifiers. These microplastics can pass through wastewater treatment systems and enter the environment, contributing to aquatic plastic pollution. Biomass microbeads were developed as a sustainable and surfactant-free alternative to these microplastics using emulsion synthesis. This synthesis is a robust and scalable procedure that relies on renewable cellulose as a feedstock. Differences in aggregation and morphology of the beads were observed as a result of various oils present within the emulsion with ranging viscosities. In addition to these structural differences, a range of bead size distributions were achieved due to varying interfacial tension measurements between the oil phase and the ionic liquid phase. The altering of parameters within the emulsion procedure allows for an adaptable product capable of replacing cosmetic microplastics within industry. These biomass microbeads are non-toxic, biodegradable, and can be mass produced using emulsion synthesis.

78. **Daniel Retic**
Visualizing Hydrodynamic interaction of scaled up Flagella Model
Advisor: Moumita Dasgupta
Sponsoring Program: MRSEC
Home Institution: Augsburg University
Abstract: The physical swimming mechanisms used by microorganisms like bacteria are different compared to larger animals like humans. Escherichia Coli (E. Coli) bacteria use hair-like structures called flagella for locomotion. During translational movement, the flagella intertwine to create a bundle, the physical basis of which is not fully understood. To understand flagellar bundling, we created a macro model of four active flagella and one passive flagellum in silicon oil. We are testing if the four active flagella rotating together can give rise to sufficient drag in the surrounding fluid which is capable of propelling the passive one. The Reynolds number (the inertial force divided by the viscous force) is kept constant with actual bacteria (~10^-2). We use Particle image velocimetry (PIV), using tracer particles and laser sheet. I will discuss the experimental design and computational implementation of PIV and then show results obtained in terms of the mean flow field and vorticity for a single model flagellum and how we can extrapolate that learning to our actual five flagella setup.

79. **Ella Rider**
VolumiVive: Adding Interactive Elements to 360 Degree Video
Advisor: Lana Yarosh
Sponsoring Program: Human-Centered Computing
Home Institution: University of Wisconsin—Oshkosh
Abstract: While Virtual Reality experiences are meant to be immersive and interactive, most 360° video technologies in use only provide panoramic views of a scene—making use of two dimensions despite masquerading as three. Volumetric video is a video type that captures a scene in full 3D, enabling a viewer to see 'what's going on' from any angle they like. We use our recording system, composed of six Microsoft Kinect cameras, six laptop computers, and one five-sided calibration marker, to record volumetric videos for VolumiVive. VolumiVive is a program that allows the user to add custom interactive elements to any video from inside the virtual space, to increase personalized and meaningful interactions with the content. Combining volumetric video's immersion with the freedom to design one's own interactions, VolumiVive invites users to fully step into the scene, choose their own paths and feel more in tune with their virtual surroundings than previously possible. Future research into the feasibility of its implementation into fields such as education, as a tool to help teach material, and sports, to support athlete training, is a next step for this project, following the official study.

80. **Bianca Rios Rodriguez**
The stability of Moringa Oleifera protein enabled antiviral face covering for airborne coronavirus controls
Advisor: Boya Xiong
Sponsoring Program: MRSEC
Home Institution: University of Puerto Rico
Abstract: There's an urgent need for solutions to combat viral infections. This issue is crucial for establishing personal protective equipment (PPE), since current antiviral agents exhibit limitations such as reduced efficacy, potential toxicity, and antibiotic resistance. The protein from the Moringa oleifera (MO) tree, which belongs to host defense peptides that has superior antimicrobial and antiviral properties, but with little cytotoxicity, and do not induce resistance. The stability of the coated material is equally vital due to stable coating ensures the longevity of the material's antiviral properties. We developed an antiviral textile coated with MO protein through simple electrostatic binding, inactivating the virus and preventing its transmission. Under various conditions, we'll determine their suitability for use as PPE. Specifically, the efficacy of materials aged at room temperature for 10, 30, and 60 days, their response to repeated exposure (5 cycles) to a mimetic coronavirus, and impact of thermal changes from 25 ˚C to 50 ˚C. Finally, we will conduct laundry cycles (2, 4, 6, 8) coating testing to evaluate the ability of the coating to detach and be recoated. The research aims at the stability of the coated materials allowing the development of successful and extended antibacterial textiles applied as PPE.

81. **Fabian Rodriguez**
RAFT photopolymerization of PNIPAM based block copolymers
Advisor: Michelle Calabrese
Sponsoring Program: MRSEC
Home Institution: University of Texas Rio Grande Valley
Abstract: Poly(*N*-isopropyl acrylamide) (PNIPAM) has been studied for various biomedical applications such as drug delivery, wound dressings, and, specifically, sensing via hydrogels due to a characteristic phase transition around 32°C. An avenue to improve the sensitivity of PNIPAM hydrogel biosensors is by increasing the surface area via gelling PNIPAM nanofibers. This summer, block copolymers (BCPs) containing PNIPAM were synthesized using photo reversible addition-fragmentation chain transfer (RAFT). While RAFT is a commonly used controlled polymerization technique, photoinitiated RAFT can yield polymers with ultra-high molecular weights and can be performed under mild conditions. Therefore, photoinitiated RAFT is promising for synthesizing polymers ideal for nanofibers and hydrogels due to enhanced viscoelastic and mechanical properties. A compact UV setup was implemented using a commercially available nail curing device and varying the light intensity. The methodology was optimized using common lab equipment to enable widespread implementation. Alongside PNIPAM, the highly hydrophilic poly(*N*,*N*-dimethyl acrylamide) (PDMA) is a promising candidate as a stabilizing block since it improves the mechanical properties of hydrogels. Hence, BCPs using PNIPAM, PDMA may produce mechanically strong, thermoresponsive, fibers with distinct morphologies that can be subsequently processed into hydrogels ideal for robust sensing applications.

82. **Turibius Rozario**
Design of a lab scale ocean wave powered desalination system
Advisor: Jim Van de Ven
Sponsoring Program: ME
Home Institution: University of Maryland, Baltimore County
Abstract: We propose an autonomous and self-powered wave energy harvesting system. Such a system would provide a decentralized and environmentally resilient source of clean electricity and freshwater for remote coastal communities. The wave energy is harvested using a large oscillating flap hinged at the sea bed, whose kinetic energy is then transferred into hydraulics; the pressurized seawater is used to generate electricity and freshwater. We model this full scale system using existing hydraulic equipment and ocean wave simulation data. This system has to be scaled down for in lab testing purposes. In this study, we use space and power constraints to a specify a lab scale, set an existing electric motor and oil hydraulic components to simulate ocean waves, and look at the dynamic similarity between the different scales to appropriately validate our model. Equations for fluid flow, and computations on system efficiency and size are used to select specific hardware. The equipment and existing lab space are used to design custom parts for component fixtures, and select appropriate piping instruments. Consequently, we develop an assembly model for the hardware-in-the-loop testing system along with a bill of materials and construction guidelines.

83. **Jihan Schepmann**
Development of Bivalent Inhibitors for Bromodomain-Containing Proteins as Potential Treatment Method for Alcoholic Hepatitis
Advisor: William Pomerantz
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Southwestern University
Abstract: Alcoholic hepatitis (AH) is an inflammatory liver disease caused by alcohol abuse. This inflammatory pathway is hypothesized to be under epigenetic regulation which is driven by post-translational modifications that normally promote cell growth. With increased alcohol exposure, this pathway becomes dysregulated and causes cell disease and death. BET proteins (BRD2, 3, 4, and T) are epigenetic "reader" proteins that have two N-terminal bromodomains (D1 and D2) that recognize and bind to acetylated lysine residues in transcription factors, which can lead to the inflammation seen in AH. Small-molecule inhibitor 10t was synthesized to inhibit this interaction and was found to have a unique binding selectivity, binding to all BET D1 domains and BRD4 D2. However, its clinical potential is limited due to toxicity. In this project, I aim to design and synthesize bivalent analogs of 10t to selectively target both the BRD4 D1 and D2 domains, further improving its selectivity profile. Several reaction conditions and linker types have been screened to synthesize these compounds. Once the bivalent analogs are obtained, they will be tested for selectivity, potency, and toxicity. Lastly, these potential clinical candidates are then sent to the Mayo Clinic to determine overall efficacy in liver inflammation and other diseases.

84. **Kevin Schill**
Weakly Coordinating Cations: A Cobaltocenium Hemicarceplex
Advisor: Steven Kass
Sponsoring Program: UMN Chemistry- Lando
Home Institution: St. Norbert College
Abstract: Weakly coordinating cation salts are an understudied class of compounds that can open the path to more reactive anions and in turn drive reactions that otherwise would not occur. In this project, a metallocenium ion ($CoCp_2^+$) was encapsulated within a molecular cage called a hemicarcerand to form the target hemicarceplex for study. By encapsulating the positively charged cobaltocenium ion, the hemicarcerand physically separates the cation from the anion, which is located outside of the complex, resulting in a weaker coordination between the oppositely charged ions. This is hypothesized to enhance the reactivity of the anion, and lead to faster reaction rates as well as facilitating reactions with less activated substrates. Through a five-step synthesis of the hemicarcerand and an additional incorporation of the cobaltocenium ion, the chloride of the complex was synthesized. The weakly coordinating behavior of the salt and its physical properties has yet to be studied. The study of these physical properties will provide insight with regard to any modifications to the complex that may be needed to ensure weak coordination with the counteranion.

85. **Mikayla Schmidt**
In Vivo Implementation of Closed Loop Adaptive Real Time Deep Brain Stimulation Control for Seizure Prevention
Advisor: Theoden Netoff
Sponsoring Program: BME Pathways
Home Institution: University of Saint Thomas
Abstract: Presently, pharmaceutical therapies are the initial standard of care treatment for the reduction of seizures. Unfortunately, one in three people with epilepsy develop resistance or are non-responders to drug therapy. Patients that do not experience therapeutic benefit from drugs may qualify for surgical resection of the epileptic brain region or deep brain stimulation (DBS) for more complex epileptic activity location origination. DBS is a FDA approved therapy where electrical stimulation is delivered to a brain target for suppression of refractory epileptic activity. While effective, DBS typically reduces seizure frequency in most patients and few achieve seizure freedom, leaving room for significant improvement. Current DBS is open-loop, like a pacemaker, but we hypothesize closed-loop therapies that stimulate based on the measured neural activity may be more effective with fewer side effects. Our preliminary work investigating closed-loop stimulation for seizure suppression required the implementation of a previously developed algorithm in a rat in vivo model. I assisted in the surgical preparation, intraoperative recording, and post-operative processing of extracted brain tissue. These proofs-of-concept in vivo experiments to ensure proper electrode placement through dyed tract tracing and closed-loop algorithm electrophysiological setup validation will allow for continued analysis and development of the algorithm.

86. **Trevin Schmidt**
Directing the Energy of Light With Optical Metamaterials
Advisor: Ognjen Ilic
Sponsoring Program: ME
Home Institution: Bethel University
Abstract: Optical devices, such as mirrors and lenses, alter light beams in a way that changes the polarization, amplitude, or phase of incident light. By creating metamaterials that have geometric structures that are similar in size to the wavelength of light, we can achieve the same effect that traditional lenses and mirrors have in a much smaller package. Imprinting these nanostructures on individual particles allow for optical control on a very small scale. This summer I created an optical setup that allows for the testing and imaging of these particles. This will allow future research to further explore how light is interacting with differently designed nanostructures.

87. **Alec Schwendinger**
Determining Effects of Solvent Concentration in Polymer Solutions on Extensional Relaxation Time
Advisor: Michelle Calabrese
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota - Twin Cities
Abstract: Polymer solutions hold great potential for many industries which require viscous fluids. Industries such as coating, printing, or even agricultural chemical spreading rely heavily on understanding these fluids. Understanding the rheological properties of these solutions provides information to aid in more efficient flow and spreading methods for the solutions. A major property in understanding a solution's overall behavior is its extensional relaxation time. Measuring this required using a Dripping onto Substrate (DoS) rheometer along with a high-speed camera to record image sequences to use FIJI image analysis software to extract data to determine this relaxation time. This value quantitatively distinguishes how quickly a polymer will go from a coiled state to an extended state and then return to a coiled state in drop formation in the solution. Understanding how different solvent systems affect this value in a polymer solution can help determine effective solvent systems for various applications. The major change performed to understand solvent effects was the composition of a binary solvent system (DMF/Water).

88. **Christopher Sedmak**
Comparison of nanostructured carbon materials for use in miniaturized solid-contact ion-selective electrodes
Advisor: Andreas Stein
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Hastings College
Abstract: Wearable sensors for continuous measurement of ion concentrations in interstitial fluid would revolutionize patient care, both in hospitals and for everyday use. Real time and continuous monitoring of various biomarkers would allow for faster diagnosis and response for emergency medical triage and general diagnosis. Continuous measurement requires creating an ion-selective sensor that does not need to be recalibrated regularly and has good long-term stability. The Stein and Bühlmann groups have previously made solid-contact ion-selective electrodes with good long-term stability, using porous carbon materials with high surface area and high capacitance, but these devices were quite large. We are currently working on miniaturizing the devices to fabricate microneedle patches. The microneedles will be coated with very small amounts of the carbon material. The question arises whether this amount will be sufficient to achieve the desired capacitance and potential stability. Here we present our research on specific capacitance determination of three nanoscale carbon materials (carbon black nanoparticles, mesoporous carbon spheres, and colloid-imprinted mesoporous carbon) to determine if they can produce the desired level of theoretical long-term stability in miniaturized solid-contact ion-selective microneedle patches.

89. **Revanth Krishna Senthilkumaran**
Training a Mobile Manipulation Agent Towards Furniture Organization
Advisor: Karthik Desingh
Sponsoring Program: Human-Centered Computing
Home Institution: Purdue University - West Lafayette
Abstract: Using a robot to navigate through and manipulate objects in the environment has been proven by companies such as Boston Dynamics. Even with the ability to move and manipulate, learning what actions are necessary towards fulfilling a task autonomously remains a challenging problem for robots. Through this work, we focussed on training an agent, in our case the Boston Dynamics Spot robot, capable of identifying and manipulating a single chair by selecting a grasp location and a destination. For this task, we build on the Per-Act vision-language model which has previously been used for table-top manipulation. Per-Act uses a voxel-representation of 3D space to infer waypoints, which are intermediate states that an end-effector has to sequentially reach in order to complete a task. To construct this voxel space, we develop a system to collect and process data from Spot. The data collected from Spot includes camera information from six different cameras on the robot, its location, and a state indicating if it has completed a task. Per-Act is then trained and an evaluation script is used to assess how well the model learns.

90. **Abdullah Shahkhan**
Development of Preclinical Modeling Deep Brain Stimulation (DBS) Planning Software for Accurate DBS Electrode Placement
Advisor: Matthew Johnson
Sponsoring Program: MSROP
Home Institution: University of Minnesota
Abstract: Deep brain stimulation (DBS) is an effective Parkinson's disease treatment. To target brain structures and place DBS electrodes accurately, preclinical preoperative imaging data requires subject-specific analysis. This study analyzed morphological brain differences in preoperative imaging data of rhesus macaque non-human primates (NHP) using anatomical and stereotactic neurosurgical software's electrode based coordinates. The Macaque Neuromaps Atlas provided coordinates for the dorsolateral subthalamic nucleus, a DBS target for motor movement regulation. By comparing Cicerone-generated STN coordinates for five NHPs with the reference Macaque NeuroMaps Atlas anterior-commissure STN coordinates, this study identifies significant differences of 14mm, 1.1mm, and 0.16mm in ML, VD, and AP coordinates, indicating a need for electrode relocation in DBS surgeries with software (Rohlfing et al., 2012). The development of a user-friendly GUI with a DBS chamber can be integrated in 3D Slicer to meet Cicerone users' visualization needs. The study emphasizes accurate DBS electrode placement in preclinical models and improving DBS trajectory planning using Cicerone. DBS placement based on the Macaque NeuroMaps Atlas presents a detrimental impact on DBS surgical outcomes. Cicerone users will benefit from locating other brain structures through further developments of a 3D Slicer extension.

91. **Akshat Sharma**
Conductivity of Amorphous Semiconductor Materials
Advisor: James Kakalios
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota
Abstract: There is great interest in understanding the electronic properties of thin film amorphous semiconductors, as these materials can be used in a wide range of applications, including solar cells and flat-panel displays. This paper presents an investigation into the temperature dependence of thin film amorphous semiconductors. Samples investigated include n-type doped hydrogenous amorphous silicon and undoped hydrogenated amorphous germanium. By studying the conductivity following a high-temperature anneal as a function of cooling rate, we observed two regimes - a low temperature regime where the conductivity is sensitive to the cooling rate and a high temperature region where the conductivity is independent of thermal history. Interestingly, the sensitivity to cooling rate for the amorphous silicon film is reverse from that found in the amorphous germanium sample. Using the Zabrodskii Reduced Activation Energy technique, we tested various models for the temperature dependence of the conductivity for highly disordered semiconductors. The underlying mechanisms responsible for these intriguing phenomena remains under investigation. The results of this study contribute to the broader understanding of amorphous materials' electrical properties under various experimental conditions.

92. **Kathleen Shea**
Technology-Mediated Disclosures for Sensitive Information
Advisor: Lana Yarosh
Sponsoring Program: Human-Centered Computing
Home Institution: Colorado College
Abstract: This project aims to find ways in which technology is able to mitigate the burden of public stigma that people living with Human Immunodeficiency Virus (HIV) experience. Using participatory and speculative design principles, my advisor, Fernando Maestre, worked with this population to identify the ways in which they want technology to support them. After conducting co-design workshops, participants identified the need for technology to assist them in disclosing their HIV diagnosis. This led to the creation of an application prototype that allows people living with HIV to disclose their diagnosis, express their emotions, provide educational resources, and be explicit with what they need from their disclosure recipient. The study has recently concluded the piloting stage and has shown promising results in fostering supportive interactions during HIV disclosure. In particular, participants in the pilot (n=8) identified generalizability, customizability, access to educational resources, and user-friendly design as positive and important features of the application. Participants also identified ideas for future iterations of the app, which will be reflected in the user-study that will be conducted in the fall. Ultimately, the study aspires to expand the app's utility beyond HIV disclosures to address other sensitive topics that people find challenging to discuss.

93. **Tim Tan**
Identification of Enterococcus faecalis's biofilm synthesized enzyme's binding site and possible drug molecule inhibition to reduce antibiotic resistance
Advisor: Jason Goodpaster
Sponsoring Program: UROP/URS
Home Institution: University of Minnesota, College of Science of Engineering, Chemistry Department
Abstract: Our proposal is to identify a suitable binding site to a protein required for biofilm formation in Enterococcus faecalis and discover a suitable drug molecule to inhibit this action. The heterogeneity of the biofilm matrix provides a selectivity that can help separate nutrients from the environment and prevent penetration of antibiotics.Recent research from the Willett lab here at UMN in the Microbiology & Immunology Department has analyzed a key enzyme related to biofilm synthesis of Enterococcus faecalis.Building upon this finding, this research is designed to identify the reaction site and possible drug molecules as inhibitors for this enzyme. To achieve this, drug library screening will be conducted to test the enzymes with different drug molecules. The ChEMBL database, a collection of over 2.3 million compounds curated by the European Molecular Biology Laboratory, will be used for this purpose. Autodock would be used for this purpose to pair the reaction site found from autoligand and react with these 2.3 million drug molecules and rank the top 10000 drug molecules that have the best result in terms of bonding affinity. This research will produce a significant amount of data from two perspectives.

94. **Maren Thompson**
Synthesis of a Stable Photocatalyst for Cationic-Anionic Switchable Polymerization System
Advisor: Jessica Lamb
Sponsoring Program: MRSEC
Home Institution: Arizona State University
Abstract: Block copolymers have potential applications in areas such as membranes and drug delivery because they can self-assemble into nanostructures, but a current barrier to implementing them is the complex synthesis process, particularly when each block uses a different polymerization mechanism. In this case, synthesis traditionally requires end-group modification of each individual block. One proposed solution is a "one-pot" switchable system with a universal mediator and using external stimuli to control the polymerization sequence: a photocatalyst could perform cationic polymerization when the solution is exposed to light, then anionic polymerization occurs when the solution is heated without needing a separate end-group modification step. This requires a photocatalyst with redox potentials that can perform cationic polymerization and that is neutral so it remains stable in contact with the anionic components of the system. The project involves the synthesis of a neutral photocatalyst (3,6-CF_3-4CzIPN) hypothesized to possess these target redox potentials. Each step in the synthesis will be analyzed using NMR spectroscopy and variables (time, heat) will be altered to optimize the yield. Upon successful synthesis of 3,6-CF_3-4CzIPN, its redox potentials will be measured using cyclic voltammetry and fluorescence spectra and its photocatalytic abilities tested in the cationic polymerization of vinyl ethers.

95. **Jackson Trom**
Interaction Of Natural Organic Matter With Adsorption Of Iron II Onto Hematite
Advisor: Lee Penn
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota-Twin Cities
Abstract: Iron oxide nanoparticles provide a useful mechanism to remove potentially toxic chemicals from the environment: adsorption. Iron II was used to measure how effective hematite is at removing pollutants, along with the interaction between the nanoparticles and organic matter. Fractionation via rotating end-over-end helped contact the particles and the NOM, and the reaction between iron and the particles took place at pH 7 for one hour. After ferrozine assay, the initial concentrations of iron were plotted against the milligrams of iron that were sorbed per gram of hematite. The particles reached their adsorptive capacity with contacting NOM, whereas no contact with NOM continued to climb at higher iron concentrations. The experiment had problems with pH adjusting, as the volume of 5 mL was extremely susceptible to rapid changes. The trials using supernatant were also inconclusive, as the solutions appeared to be gaining iron.

96. **Stefan Wamego**
Phase behavior of architecturally complex bottlebrush block co-polymers
Advisor: Tim Lodge
Sponsoring Program: MRSEC
Home Institution: University of Minnesota
Abstract: Block co-polymers self-assemble into various morphologies some of which include 3D networks (NETs). NETs are triply periodic structures that percolate in three dimensions made up of two chemically distinct domain. This allows us to tune the properties of the material and
incorporating two or more functions such as mechanical and transport properties. These periodic interpenetrating domains give rise to orthogonal properties like ion conduction and mechanical strength. Unfortunately, NETs formation only takes place over a small compositional window. Additionally, accessing domain sized greater than 50 nm becomes difficult as self-assembly kinetics decrease exponentially with increasing molecular weight. Here, we plan to use architecturally asymmetric block copolymers where one block is linear and the other is a
shaped bottlebrush. More specifically we will be focusing on a cone shape, where the bottlebrush block decreases in size from the linear block. Small angle- X-ray scattering will be used to characterize the morphology of the polymers. We will use size exclusion chromatography and 1 H NMR to characterize the polymers. We are looking to explore a variety of ordered morphologies by changing the shape of the brush and studying how the different shapes affect self-assembly behavior.

97. **Arianna Wheeler**
Steric Effects on the Transesterification of Secondary Acetates
Advisor: Thomas Hoye
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota - Twin Cities
Abstract: A key aspect of natural product synthesis is the selectivity of reactions, governed by steric and/or electronic factors, on complex molecules containing multiple reactive functional groups. One concept describing the impact of steric factors on reaction rates is Newman's rule of six, describing how the greater the number of six-position atoms relative to a double bond the greater the steric hindrance. In this study, we focused on the relative rates of reaction for acid or base-catalyzed transesterification of secondary acetates with different numbers of six-position hydrogens and methyl groups. Monitoring paired reactions by 1H NMR spectroscopy allowed for the determination of the rate of reaction of each acetate relative to a chosen standard, showing that as each hydrogen atom was replaced by a methyl group, the resulting decrease in rate increased in magnitude. Though this study focuses on secondary acetates, Newman's rule of six broadly applies to double bond-containing compounds, allowing these findings to be generalized to similar reactions on compounds with different double bond motifs.

98. **Ainsley Wilkin**
Scaffold-Free Bioprinting onto a Mesh Substrate for Cryopreservation of Biosystems
Advisor: Michael McAlpine
Sponsoring Program: ATP-Bio
Home Institution: University of California Riverside
Abstract: Stainless steel "cryomeshes" were created to enhance the proficiency of vitrifying biological systems by allowing the removal of cryoprotectant liquid. This approach can be used to maintain organism diversity, sustainable food production, and treatments in healthcare. However, manually dispensing biosystems onto the mesh is inconsistent in the volume dispensed and time consuming. Therefore, we developed a 3D printer with a stepper motor screw-based extrusion head to dispense precise volumes of liquid. Printing parameters were optimized to allow for consistent and fast dispensing. We found that using a printing speed of 10 mm/s, print height of 0.3 mm, a volumetric flow rate of 2.52 µL/s for cryoprotectant solution (22 wt % DMSO and 22 wt % ethylene glycol), and 3.00 µL/s for deionized water created print line widths roughly equal to the inner diameter of the nozzle (0.84 mm). Furthermore, a rectilinear tool path along the mesh surface allowed for more mesh coverage in a shorter amount of time (42 sec.) than a concentric tool path (66 sec.). Knowing these parameters for both liquids allows for even and fast printing of biosystems for vitrification.

99. **Keiona Williams**
Microfluidic Salt and Clay Testing for Cloud Climate Modeling
Advisor: Cari Dutcher
Sponsoring Program: ME
Home Institution: Colgate University
Abstract: Climate models have been used to monitor and predict land, ocean, and atmospheric conditions for over half a century. Clouds, which both affect and are affected by the land, ocean, and atmosphere, are one of the most important and difficult components of Earth's climate to understand. Clouds are essentially mixtures of water and ice that contain microscopic inorganic and organic materials like dust and bacteria etc. They form dependent on these particles suspended in the air, otherwise known as aerosols. The purpose of this summer's research is to manipulate one of these microscopic components of cloud formation (salts and clay) with the goal of filling in gaps towards more comprehensive aerosol-cloud-climate interaction modeling.

100. **LeighAnna Zielske**
Data Analysis for ZTF SCoPe
Advisor: Michael Coughlin
Sponsoring Program: Physics REU
Home Institution: Pacific Lutheran University
Abstract: The Zwicky Transient Facility Source Classification Project (ZTF SCoPe) is a machine learning project aiming to generate a public catalog of astronomical sources and corresponding informative labels. Using light curves from the ZTF telescope, a variety of numerical features (e.g. mean, period) are generated for each source. These features are input into the machine learning classifiers, which then determine the likelihood of that source belonging to certain categories. There are 44 such categories for which each source is tested, including phenomenological classes such as variable, periodic, and eclipsing, as well as ontological classes like pulsator and binary star. Two machine learning algorithms are used: a deep neural network (DNN) and a decision tree based algorithm called XGBoost (XGB). In this project, the performance of the two algorithms for each of the 44 classifiers was analyzed and compared through a variety of metrics. Informative visualizations were created to aid in fine-tuning the algorithms and understanding their strengths and weaknesses prior to publication.