Materials Research Science and Engineering Center

University of Minnesota
Driven to Discover℠

Summer Undergraduate Research Expo

August 7, 2019
McNamara Alumni Center
Memorial Hall
4:00-6:00pm

Undergraduate Poster Presentations
Listed Alphabetically by Presenting Author

Presenters should be at their posters at the following times:
4:00 - 5:00 even numbered posters
5:00 - 6:00 odd numbered posters

1. **Erik Aadalen**
Pitching Wind Turbine Blades to Capture More Wind Energy
Advisor: Kim Stelson
Sponsoring Program: CCEFP
Home Institution: University of Minnesota
Abstract: The objective for this program was to construct a mechanism that could pitch an airfoil in an oscillating motion at amplitudes of 2, 5, and 10 degrees at 2 Hz. The wind tunnel in the St. Anthony Falls Lab was used to simulate both steady and unsteady airflow across the airfoil. Additionally, a 6-direction load sensor was placed in the airfoil to collect data that was used to calculate lift, drag, and moment coefficients each experiment. The goal of this study was to determine whether the additional wind energy captured by oscillating the blades was greater than the energy used to oscillate the blades in the first place.

2. **Ibrahim Abdalla**
Examining Src family kinase and Spleen tyrosine kinase activity using an enzyme-linked immunosorbent assay
Advisor: Dr. Laurie Parker
Sponsoring Program: Northstar STEM Alliance
Home Institution: University of Minnesota - Twin Cities
Abstract: Syk (Spleen tyrosine kinase) and SFKs (Src family kinases) are two groups of enzymes that often interact and whose regulation is disrupted in many types of cancer. Some of the main SFKs include Src, Fyn, Btk, and Lyn. The function of Src family kinases in cells includes growth, angiogenesis, and cell signaling; whereas, the function of Syk within cells includes but isn't limited to cellular adhesion, immune recognition, and vascular development. Src family kinases are expressed especially high in certain diseases such as chronic myeloid leukemia (CML), acute myeloid leukemia (AML), and acute lymphoblastic leukemia (ALL), and in many instances are upstream regulators of Syk. In this experiment, the activity of SFKs was assessed using a biosensor assay, a western blot, and an enzyme-linked immunosorbent assay (ELISA). The purpose of these assays was to measure SFK activity in different types of blood disorders (AML, CML, etc.). Hydrogen peroxide (H_2O_2) and Phorbol 12-myristate 13-acetate (PMA) have been shown to increase SFK activity and treatment with each served as two of the four experimental conditions that were investigated. Through these methods it was also possible to examine how Syk activity was affected by H_2O_2 and PMA.

3. **Abdullahi Abdullahi**
Using Hyper spectral imaging drone to write crop prescription
Advisor: Ce Yang
Sponsoring Program: Northstar STEM Alliance
Home Institution: University Of Minnesota
Abstract: Using a Hyperspectral image camera equipped to a drone our goal was to fly over corn field to analyze images in order to write a fertilizer prescription farmers could use. We tested the flow of run off water using a flow sensor with an IoT. It would send data at a frequency of 30 minutes letting us know the gal/min flowing and how much nitrogen is in it. Our goal was to take the data and use artificial intelligence to enhance decision-making and make it less subjective

4. **Curtis Adams**
Annealing Doped and Undoped SSO Films
Advisor: Bharat Jalan
Sponsoring Program: MRSEC
Home Institution: University of Maryland, Baltimore County
Abstract: Thin film nanomaterials are used to improve the electron mobility of semiconducting devices. A common manufacturing method for thin films is Molecular Beam Epitaxy (MBE), which allows the semiconducting material to be grown at a high quality on the surface of a substrate. Atomic Force Microscopy (AFM) scans reveal an uneven surface that reduces the conductivity of the material. Observations with X-ray Diffraction (XRD) reveal rocking curves with poorly defined peaks which indicates low quality crystal structure in the material. Limited electron mobility of 60cm2V-1s-1 suggests that the structure of the material might be restricting the potential conductivity of the film. This research focuses on improving the quality of doped and undoped strontium stannate (SrSnO3) films by annealing samples over a temperature range of 900 - 1200°C. AFM and XRD scans were performed after each 50°C temperature increase to observe how increasing temperature impacts the structure of the sample. The resistivity of the film was measured to observe any changes in the electron mobility of the film after each temperature step in the annealing process. The results of this research may lead to the improvement of the MBE process and consistently produce higher quality thin films for semiconducting devices.

5. **Sam Adeniyi, Austin Hayes**
Using Augmented Reality to Determine Potential Routes for Drone Navigation
Advisor: Evan Suma Rosenberg
Sponsoring Program: Computer Science
Home Institution: Simpson College, University of Maryland, College Park
Abstract: User interfaces for task-oriented robotics are often complex and unintuitive, requiring voice commands and/or esoteric controls to operate the system. An augmented reality user interface for unmanned vehicles could greatly diminish the cognitive load on the user by implementing natural-gesture based controls. Our interface allows the user to pinpoint locations on a virtual map, creating a waypoint layout to be followed and navigated by a drone. To accomplish such a goal, our approach requires aligning the coordinate systems of multiple tracking devices and breaking down the physical environment to compute the most optimal path to be followed by the drone.

6. **Fernando Aguilar Ortega**
Bacterial Leaf Streak of Wheat: How Identifying Resistant Varieties and Rapidly Detecting the Pathogen Contribute to Managing the Disease
Advisor: Rebecca Curland
Sponsoring Program: Northstar STEM Alliance
Home Institution: University Of Minnesota Department Of Plant Pathology
Abstract: Bacterial leaf streak (BLS) of wheat, caused by Xanthomonas translucens pv. undulosa, has recently been an economic problem for midwestern farmers due to yield loss. Because BLS is not effectively controlled with chemicals, the best option for farmers is to use wheat varieties with resistance to the disease. To provide farmers with information about the resistance of various wheat varieties, we screened 92 commercially available varieties and advanced breeding lines from local seed companies and breeding programs. Field plots of wheat were inoculated with X. translucens pv. undulosa and rated for disease severity. The disease ratings of the different varieties will be published so that farmers can have this information available to them. Additionally, it is essential to know the identity of a pathogen when developing and instituting control strategies. Different pathovars of X. translucens are known to cause BLS on wheat and barley in Minnesota. As a way to rapidly distinguish among the pathovars of X. translucens causing BLS, we successfully validated a recently published loop-mediated isothermal amplification assay (LAMP) on extracted DNA and plant tissue from infected wheat and barley plots.

7. **Brian Almaraz**
Marine Oil Dispersion - Understanding the Fundamental Chemistry Behind the Dispersion Process
Advisor: R. Lee Penn
Sponsoring Program: Project SEED
Home Institution: Washington Technology Magnet High School
Abstract: Oil spills have devastating effects on the surrounding environment for years after the initial spill, which is why it is critical to obtain an environmentally friendly remediation method. A food-grade dispersant composed of the surfactants lecithin and Tween 80 (LT) has recently been shown to have comparable effectiveness to current commercial dispersant formulation (e.g. Corexit) and it is expected to be environmentally friendly. In spite of this comparable effectiveness, however, little is understood about the interfacial phenomena that make this surfactant mixture an effective dispersant. LT blends do not display the general characteristics that are exhibited by effective dispersants, suggesting other phenomena have a role in explaining the effective dispersion process. It is hypothesized that there may be a correlation between dispersant effectiveness and ternary phase behavior in dispersant-oil-water (DOW) systems, and this research focuses on testing this hypothesis. Further, this work also focuses on characterizing the nanostructures of LT blends at the oil-water interface with the use of light scattering techniques. This work is expected to help elucidate the effectiveness and synergy of LT dispersants, both of which will provide information on how the current LT system works and how to optimize this dispersant for future commercial use.

8. **Rachel Anderson**
Check Valve Study for a Wave Energy Converter
Advisor: James Van de Ven
Sponsoring Program: CCEFP
Home Institution: University of Minnesota - Twin Cities
Abstract: In a proposed design for a wave-powered reverse osmosis (RO) desalination plant, a wave energy converter (WEC) drives a seawater-based power take-off that simultaneously pressurizes seawater for the RO process and generates electrical power to support plant functions. A rectifier composed of four poppet-style check valves directs flow from the WEC-driven actuator and feed water intake through a switch-mode power transformer. An additional check valve allows flow to bypass the switching valve when necessary. The dynamic behavior of these check valves may significantly impact the overall plant dynamics, so a mathematical model of a poppet-style check valve was developed using fluid dynamic principles and solved numerically for the poppet position over time. The valve model was studied with the downstream pressure held constant and the upstream pressure as a square wave of varying frequency. To validate the model, an experiment was designed using a solenoid-operated three-way, two-position valve to vary the upstream pressure and a laser triangulation sensor to measure the poppet position. Once validated, this model will be incorporated within a full system model of the plant where it can be used to determine if the check valve dynamics have a significant impact on the plant dynamics.

9. **Menen Argaw**
The role of oral contraceptives in the change of blood pressure through the stimulation of group III/IV afferent nerves.
Advisor: Manda Keller- Ross
Sponsoring Program: Northstar STEM Alliance
Home Institution: University of Minnesota , Twin Cities
Abstract: During exercise, two major mechanisms have been proposed for the regulation of cardiovascular function--central command, a response from the motor cortex and the ergo-reflex response from the skeletal muscles. These two mechanisms enhance the sympathetic nervous system. The effects of sympathetic nervous system are increased heart rate, blood pressure, and ventilation. The afferents of the ergo-reflex are the mechanically sensitive group III and metabolically sensitive group IV nerves. However, the ergo-reflex feedback is not fully understood, and in several patient populations, this mechanism can be blunted. Although both mechano- and metabo-receptor activity contribute to the reflex feedback, it is still not known which specific one is contributing to the increased cardiovascular response. In addition, there is evidence of a blunted ergo-reflex response in women during the follicular phase of the menstrual cycle. In addition, women taking oral contraceptives (OC) have low estrogen levels in plasma and an elevated resting blood pressure during the low and high hormonal estrogen phase. Therefore, studying women in the follicular and luteal phases depending on whether they are taking oral contraceptives or not will provide further insight to how differences during the menstrual cycle and the use of oral contraceptive influence the ergo-reflex response.

10. **Diana Augustin**
Staining for C-fos: Rat Striatal Tissue
Advisor: Jocelyn Richard
Sponsoring Program: Northstar STEM Alliance
Home Institution: Carleton College
Abstract: C-fos is a protein commonly used as a marker for neuronal activity. In terms of alcohol dependence and cue sensitivity, the localization of C-fos gives a sense of the neural circuitry crucial to the cue sensitivity involved in models like ethanol vapor exposure. In this experiment, we ran a series of immuohistochemistry protocols to label the C-fos expressed in the brains of alcohol dependent vapor/air exposed perfused rats. We imaged rat striatal tissue incubated in three different primary antibodies at 20x magnification and found that _____ with a concentration of 1:5000 is the best dye for optimal C-fos staining.

11. **Paul Bailey**
Nonlinear Magnon Scattering Observations Via MOKE
Advisor: Paul Crowell
Sponsoring Program: Physics REU
Home Institution: Brigham Young University
Abstract: Nonlinear Magnon Scattering is observed in Yttrium Iron Garnet (YIG) thin films. Nonlinearity is excited in the YIG thin films by high power microwave pumping. The magnetization of the films due to the microwave pumping is then observed through the Magneto Optical Kerr Effect (MOKE). Well-defined thresholds of the linear and nonlinear regimes are examined by ferromagnetic resonance measurements using this setup.

12. **James Bamford**
Impacts of Graft Block Polymer Architecture on Mechanical Properties
Advisor: Frank Bates
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Georgia Institute of Technology
Abstract: We synthesized, processed, and characterized Poly(4-methyl caprolactone)-b-(l,d-Lactide) graft block polymers in order to study the impacts of polymer architecture on mechanical properties and processability. Graft block polymer synthesis has lead to the development of sustainable plastics with increased toughness. However, the impacts of changing structural properties such as grafting density, backbone length, side chain length, and side chain composition are not well understood. We synthesized diblock linear side chains with poly(4-methyl caprolactone) (PMCL) rubber and polylactide (PLA) plastic via ring-opening transesterification polymerization (ROMP). We then implemented a graft-through approach to connect these side chains together in a ring-opening metathesis polymerization (ROMP). Through extensional rheology, we found that bottlebrush polymers with 10kDa molecular weight side chains and 70% volume fraction PLA experienced more strain hardening as grafting density was reduced to as low as 25%. This result suggests that an optimal grafting density exists in the loose comb (LC) regime for bottlebrush interdigitation – a phenomenon hypothesized to explain graft polymer strain-hardening. Through tensile testing, we also found reduced strength and increased elongation at break for graft block polymers that were melt-pressed at lower temperatures. This trend suggests different extents of microphase ordering that occur at different processing temperatures.

13. **Jeremy Barakos**
Intermolecular Interactions in the Crystal Structure of a 1,2,4-Oxadiazole
Advisor: William Ojala
Sponsoring Program: University of St Thomas- Chemistry
Home Institution: University of St. Thomas
Abstract: As part of a study of the solid-state structures and reactivity of benzonitrile oxides, we have determined the crystal structure of 3,5-bis(2,4-dichlorophenyl)-1,2,4-oxadiazole by single-crystal X-ray diffraction. Unlike any of the 29 diaryl 1,2,4-oxadiazoles previously described in the Cambridge Structural Database, this structure is a hydrate, with water molecules occupying channels extending parallel to the short c-axis in the rhombohedral structure. In the crystal, the molecular conformation is nearly planar in spite of the presence of the large chloro substituents in the ortho aryl ring positions. The ortho C-Cl bonds point in nearly opposing directions. Molecules engage in crystallographically centrosymmetric Cring-H...O intermolecular pairwise interactions of which there is only one other example among the 29 CSD 1,2,4-oxadiazoles; in contrast, three of those structures feature pairwise interactions in which at least one of the atoms is an oxadiazole nitrogen atom. Contacts to the oxadiazole ring in our structure differ from those in two analogous structures, the published structure 5-(2,4-dichlorophenyl)-3-(4-nitrophenyl)-1,2,4-oxadiazole (NUQVIF in the Cambridge Structural Database) and our previously determined 3,5-bis(4-nitrophenyl)-1,2,4-oxadiazole. The pairwise interaction involving the oxadiazole ring oxygen atom in our bis(2,4-dichlorophenyl) compound is replaced by individual Cring-H…N contacts involving the nitro-substituted aryl rings in the two analogous compounds.

14. **Johnathan Barkei**
Improving the Efficiency of a Hydromechanical Transmission Using Cam-based Valve Timing
Advisor: Perry Li
Sponsoring Program: CCEFP
Home Institution: University of Minnesota-Twin Cities
Abstract: Hydromechanical transmissions (HMT's) are often found in off-road vehicles such as snowmobiles or ATV's. The HMT has a power-split architecture which combines the variable transmission ratios found in a hydraulic transmission with the efficiency of a mechanical transmission for efficient and continuously variable power transmission. However, inefficiencies still occur due to throttling losses through valves, and could be improved by controlling valve timing to pre-compress and decompress each piston before pumping. To that end, this research investigated implementing partial stroke piston pressurization (PSPP) using variable valve timing, which was achieved by designing a cam with a variable cross-section. Simulations of individual pistons showed improved efficiency, and simulations of the full transmission showed increased efficiency for certain transmission ratios. Cam-based valve timing also has the benefit of simplicity and ruggedness, both of which are important in off-road vehicles.

15. **Melissa Barrera,** Shu Xu
Synthesis of Renewable Polymers from Bioderived Furan-Based Pyrrolinones
Advisor: Thomas Hoye
Sponsoring Program: Center for Sustainable Polymers
Home Institution: New York University
Abstract: Our current reliance on petroleum-derived plastics continues to contribute to harmful greenhouse gas emissions and accumulation of waste pollution. It is integral to research new syntheses of biorenewable alternatives to these petrochemical materials. We investigated polymer syntheses using 5-methylene-2-pyrrolinones as monomers via RAFT polymerization. We followed a one-pot procedure for the syntheses of pyrrolinones from furfuryl acetate, which can be produced from xylitol, a sugar abundant in corn husks. The syntheses of pyrrolinones started with electrophilic bromination, followed by in situ addition of a primary amine to produce various N-substituted monomers. These monomers were radically polymerized, and their subsequent polymerization progression was monitored by 1H NMR analysis. The structures of these polymers are novel, as they have the rigid spirocyclic 5-membered anhydrolactams embedded in the backbone of repeat units. The thermal properties of these polymers were studied with thermal gravimetric analysis and differential scanning calorimetry which suggested that these polymers are thermally stable up to 200°C. Different substitutions on the amide group of the repeat units in these homopolymers modulated the thermal properties of these resulting polymers, observing glass transition temperatures ranging from 10°C to 140°C. In the future, we plan to study the mechanical properties of these homopolymers.

16. **Hunter Bashaw**
Autonomous Environment Monitoring: Watching over our Waterways in the Age of Robotics
Advisor: Junaed Sattar
Sponsoring Program: Computer Science
Home Institution: Clarkson University
Abstract: Environmental monitoring is a major undertaking, it requires expensive sensors, frequent expeditions, and trained professionals. The monitoring of freshwater lakes is a common case of this problem, and it proves to be even more difficult in collecting data other than surface measurements. Data Diver, our robot, is a novel approach for solving this problem with modern autonomous underwater vehicles (AUVs). Data Diver takes advantage of a low energy buoyancy based control system, low power computers, and off the shelf parts to provide a cost effective, long duration solution for the departments of natural resources around the country. Data Diver allows for more frequent data collection than existing methods, and more detailed and accurate measurements of lakes.

17. **Omar Beesley**
Study of the Hadronic Activity of Neutrons in the NOvA Experiment
Advisor: Gregory Pawloski
Sponsoring Program: Physics REU
Home Institution: Hamilton College
Abstract: The agreement in the hadronic activity of neutrons between data measured by the NOvA experiment and activity predicted by Monte Carlo simulation was analyzed by developing and studying a sample with high quasielastic (QE) purity. This QE pure sample was made by first selecting events using well-understood muon kinematics, then reducing QE suppression at low squared four-momentum to improve agreement, and finally making selections using hadronic activity. By selecting using hadronic activity last, the introduction of modeling bias was minimized. We found that the hadronic activity of neutrons was modeled relatively well with agreement increasing with QE purity, and that discrepancies were potentially the result of improper meson exchange current (MEC) modeling.

18. **Alessandro Benadia**
Usage of Labview-Based Control System in Magneto-Optical Kerr Effect Measurement for the Improvement of Data Storage
Advisor: Pinshane Huang
Sponsoring Program: MRSEC
Home Institution: University of Florida
Abstract: Data storage is an important part of modern technology. With increasing volumes of data to be stored, more storage space is needed. The density of data has increased over time, but current two-dimensional magnetic recording cannot get much more space-efficient than it currently is due to magnetic interference. Heat Assisted Magnetic Recording is currently being researched and uses a diode laser to selectively and quickly heat up individual bit grains. By rapidly heating and then cooling the bit it becomes easier to write data. This allows bit size to become smaller, thereby fitting nearly five times as much storage per unit volume of drive. To advance this technology, ideal materials for the bits must be researched. Extensive testing of the thermal and magnetic properties of different materials when exposed to the laser pulses of the HAMR is necessary. The current testing setup does not allow for accurate testing, and a better digital control is needed. I have created a control system in Labview that allows for precise tests to be done. This system communicates with the magnet, power supply, and laser system to perform programmed experiments, collect data, and process the data.

19. **Mafanta Berete**
Investigating the Interaction between phosphorus accumulating fungi and soybean for improved P uptake.
Advisor: Bo Hu
Sponsoring Program: Northstar STEM Alliance
Home Institution: Minnesota State University
Abstract: The study explores the uptake of phosphorus (P) in plant growth and fungi. The symbiotic relation between fungi and plant with the support of P-Uptake help with growth and development of new tissues. Phosphorus plays a significant role in energy transfers, nutrient movement, and photosynthesis. P uptake from soil and harvest removal can cause P deficiency, allowing other phosphorus to replace the harvest one. In the experiment, a liquid media was used to plant the seeds instead of soil. The propose of this experiment was to study the novel association of phosphorus accumulating fungi and plants (soybean) to characterize the symbiotic relationship linking fungi and soybean by adding phosphorus for p-uptake.

20. **Isabella Bettner**
E-STAND (Epidural Stimulation After Neurological Damage)
Advisor: Jessica Cameron
Sponsoring Program: Northstar STEM Alliance
Home Institution: Carleton College
Abstract: Paraplegia has been a devastating injury that has scarce research to try to find a cure. Recent studies in spinal cord stimulation have led to vast improvements in the lives of paraplegics and their families. Epidural stimulation through a small device implanted in the spinal cord of a patient suffering from chronic complete motor spinal cord injury has allowed for some volitional, autonomic, and sexual function to be restored. This breakthrough research has enabled these people to have a higher quality of life as the stimulator's settings are optimized monthly for their own preferences in function.

21. **Renuka Bhatt**
Deposition of Germanium Telluride Nanoparticle films
Advisor: Vivian Ferry
Sponsoring Program: MRSEC
Home Institution: Oregon State University
Abstract: GeTe has a high refractive index, making it very useful for photonic applications. Additionally, GeTe is a phase change material that can switch between the amorphous and crystalline phase, with a corresponding change in refractive index. Thus, the capability to switch between phases would be advantageous as it could enable switchable photonic structures. In this work, GeTe will be synthesized colloidally through the hot injection method. The hot injection method allows for a precursor to be injected into a solution to initialize the growth of nanocrystals. Transmission electron microscopy will be performed to measure the size and shape of the particles. Succeeding the synthesis, we will explore ways to make smooth nanoparticle films. A smooth film formation of the GeTe nanoparticles will prevent unwanted scattering and inhomogeneities within the film. A smooth film of the GeTe solution will form through the modifications of the following aspects of the method: concentration, particle size, the evaporation rate of the solvent, and the speed of the spin coater. These films will additionally be characterized using dark field imaging measurements using an optical microscope.

22. **Eric Biddulph-West**
A Numerical Model of a Reed Valve for the Hydraulic Free Piston Engine's Scavenging Pump
Advisor: Keyan Liu
Sponsoring Program: CCEFP
Home Institution: Carleton College
Abstract: To account for the high force from combustion, we explored the uni-flow scavenging process in the combustion chambers of the Hydraulic Free Piston Engine (HFPE). The intake ports of the combustion chamber are covered by reed valves, each of which were simulated as an Euler-Bernoulli Beam. Using the free-response of the modeled reed valve, we found the behavior profile of the mass flow into the combustion chamber. This work will contribute to the understanding and tracking of piston dynamics in the HFPE.

23. **Alison Block**
Effect of Molecular Weight on Fragmentation Kinetics of Block Copolymer Micelles in Ionic Liquids
Advisor: Tim Lodge
Sponsoring Program: MRSEC
Home Institution: Carleton College
Abstract: Diblock copolymers are able to self-assemble into spherical micelles in the presence of selective solvents. A greater understanding of the dynamics of these micelles in solution is important for improving usage in applications including drug delivery, nanoreactors, nanolithography, and viscosity modification. As such, the kinetics of non-equilibrium fragmentation with respect to varying molecular weights was studied in one ionic liquid. This was achieved by the direct dissolution of five molecular weights of poly(1,2-butadiene)-block-poly(ethylene oxide) (PB-PEO) in the ionic liquid 1-ethyl-3-methylimidazolium bis-(trifluoromethyl sulfonyl)imide ([EMIM][TFSI]). The kinetics of fragmentation were monitored via temperature-jump dynamic light scattering (T-jump DLS) and liquid-phase transmission electron microscopy (LP-TEM). It was found that copolymers with lower molecular weights led to micelles closer to the equilibrium size, reducing the overall time needed for the system to equilibrate.

24. **Maria Bondy**
Investigation of the Effect of Walking on Ceiling Height Judgement Accuracy in Virtual Rooms
Advisor: Victoria Interrante
Sponsoring Program: Computer Science
Home Institution: University of Minnesota Twin Cities
Abstract: Application of virtual reality (VR) in various fields (e.g., medicine, military, architecture) is currently limited by user's inability to accurately perceive distances in virtual environments. A possible solution was demonstrated in a study by Kelly et al. (2013) which found receiving visual feedback while walking in a virtual environment can improve an individual's judgement of distance. We extend their findings by exploring if walking can also improve a user's judgment of height. In this study, participants were asked to complete three tasks before and after the walking intervention. Accuracy of height judgment was measured in the first two tasks: A verbal reporting of their ceiling height estimate, and walking that estimate. The third task, walking to a temporarily marked location, was included to confirm the efficacy of walking on distance judgments. The effect of walking on height judgments will be determined by comparing individuals' performances before and after the intervention.

25. **Lyuben Borislavov**
Machine learning predictions of molecular dynamics trajectories
Advisor: Donald Truhlar
Sponsoring Program: UMN Chemistry - CTC
Home Institution: University of Sofia
Abstract: Machine learning (ML) is a powerful technique for data-driven modelling on a wide variety of systems. In many cases ML approaches to quantum chemistry and molecular dynamics problems are less computationally expensive than direct quantum mechanical approaches.
Simulations of photodissociation dynamics are expensive if one uses direct dynamics, ensemble averaging (i.e., if one requires a large number of trajectories), and an accurate potential, especially if the dissociation process is not ultrafast, so the development of a less expensive method to run such trajectories would greatly speed up the investigation of photochemical problems. Molecular dynamics trajectories are exponentially divergent, which makes their ML prediction a challenging problem. The present study aims to develop an ML method to predict the final properties, such as state, internal energy, momentum, or lifetime of photodissociation trajectories given the corresponding initial conditions. Several ML approaches were applied to this challenge. The best results were obtained by using an echo state network (ESN), which is a type of recurrent neural network known to perform relatively well on exponentially diverging spatiotemporal systems. Ongoing work is being done to determine ideal input representation, ESN hyperparameters and ESN architecture.

26. **Elizabeth Breen**
Enhancement of Superconductivity by Parallel Magnetic Field in Polycrystalline Lead Films
Advisor: Allen Goldman
Sponsoring Program: Physics REU
Home Institution: Hiram College
Abstract: The enhancement of the superconducting transition temperature in polycrystalline lead films was investigated. Perpendicular magnetic fields are known to destroy superconductivity above a critical field value. Amorphous lead films have been shown to have a higher transition temperature when placed in a parallel magnetic field. This property is known to be an intrinsic property of the lead rather than a result of defects. Polycrystalline films were made by evaporation after several attempts with different substrates and tested in parallel magnetic fields.

27. **Amelia Broman**
Multi-Block Copolymers for Recycling of PET/PE Multilayer Films
Advisor: Chris Ellison
Sponsoring Program: Center for Sustainable Polymers
Home Institution: Carleton College
Abstract: Multilayer films for food packaging are a significant source of plastic consumption. These packages are difficult to recycle because they contain multiple varieties of plastics. Our work focuses on developing multi-block copolymers (MBCP) as adhesives and compatibilizers in poly(ethylene terephthalate) (PET) / polyethylene (PE) multilayer films to enhance recycling potential. The first component of the project is the synthesis of dihydroxy PE for later use in MBCP synthesis. The synthesis consists of ring-opening metathesis polymerization (ROMP) of polycyclooctene, followed by end-group modification and chemical hydrogenation. The success of the synthesis was confirmed by nuclear magnetic resonance (NMR) spectroscopy. The molecular weights obtained from NMR and size exclusion chromatography (SEC) were consistent. The project's second component examines the properties of PET/PE/MBCP blends for varying concentrations of MBCP. Tensile test analysis demonstrated that the addition of 0.5 wt% MBCP significantly increases strain at break from (2.4 ± 0.7)% to (300 ± 90)%. Atomic force microscopy showed that 0.5 wt% MBCP decreases average domain size from 4.1 μm to 1.7 ± 0.7 μm. This work demonstrates that MBCP, in amounts as small as 0.5 wt%, could serve as a compatibilizer to significantly enhance mechanical properties and reduce domain size in recycled PE/PET blends.

28. **Maya Butler**
Synthesis of Cs4Sb2CuCl12 Perovskite Nanoparticles for Solar Cell like Applications
Advisor: Lee Penn
Sponsoring Program: UMN Chemistry- Lando
Home Institution: St. Catherine University
Abstract: Due to their optoelectronic and photovoltaic properties, perovskite materials have a high potential for use in solar cells and other optoelectronic devices. The power conversion efficiency of perovskite solar cells has reached as high as 20 %. However, many perovskites are unstable in ambient conditions and contain lead. Due to concern over lead toxicity and a desire to improve perovskite stability in light and moisture, the development of alternative lead-free perovskite materials has been a recent subject of intense study. A layered (n = 3) double perovskite, Cs4Sb2CuCl12, was the target of interest in this study. This study focused on developing a bottom-up synthesis using earth abundant elements to produce nanoparticles of a stable and nontoxic perovskite that could eventually be incorporated into devices. Several parameters were tested including the reaction stir time, precursor concentrations in solution, and the use of oleylamine. Powder X-ray diffraction patterns and transmission electron microscopy images were used to characterize the dark purple product.

29. **Meghan Cahill**
Investigation of the Interactions between Lithium Cobalt Oxide Nanoparticles and Bacterial Cell Surfaces
Advisor: Christy Haynes
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: Nanotechnology has enabled the creation of more efficient and higher-performing batteries. Nanoscale lithium cobalt oxide (LCO) is currently used in the cathodes of many lithium ion batteries.1 In time, as these nanoparticles are produced in higher quantities, they will likely make their way into the environment and interact with the various species, potentially perturbing the ecosystem. This study investigated the toxicity of LCO nanoparticles toward Shewanella oneidensis MR-1, a Gram-negative bacterium that is globally distributed and plays a key role in geochemical cycling processes.2 Through a high throughput growth-based viability assay, LCO was determined to be highly toxic to S. onedensis MR-1, with a 6.25 ppm dose resulting in only ~50% of bacterial cells to remain viable and a 100 ppm dose resulting in less than ~15%. To determine if surface association of LCO is the key mechanism for this toxicity, flow cytometry was conducted. Although increased cell surface interactions with increasing doses of LCO was observed, the overall binding was minimal, which suggests LCO impacts S. oneidensis viability not necessarily by direct surface attachment.

30. **Adam Cahn**
Solvent effects on size and aspect ratio of NU-1000, a metal-organic framework
Advisor: Lee Penn
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Metal-organic frameworks (MOFs), crystalline materials comprising metal nodes and organic linkers, are promising candidates for catalysis, both independently and as supports. The effect of solvent identity on size and aspect ratio of NU-1000, a versatile and thermally stable zirconium-based MOF, was studied. Previous work on NU-1000 tunability has suggested that the properties of the solvent used during synthesis affect its crystal morphology. Microscale NU-1000 was synthesised in N,N-dimethylformamide (DMF), N,N-diethylformamide (DEF), and N,N-diisopropylformamide (DIPF) to test this hypothesis. X-ray powder diffraction and nitrogen sorption analysis were used to measure the crystallinity and porosity, respectively, of each sample. Transmission and scanning electron micrographs were captured to measure the particle dimensions and to observe their morphologies. The average aspect ratios increased from 3.2 in DEF (N = 1050) to 6.9 in DIPF (N = 550), with DMF samples being characterised at the time of writing. Thus, larger solvent molecules are proposed to preferentially induce growth at the ends of the particle. The results of this investigation will allow for systematic control of NU-1000 sizes and aspect ratios and offer additional information regarding the catalytic activities of varying crystal morphologies.

31. **Thomas Calascione**
Effects of Material, Sample Shape, Infill Orientation, and Infill Percentage on Magnetic Properties of 3D Printed Parts
Advisor: Brittany Nelson-Cheeseman
Sponsoring Program: University of St. Thomas - Engineering (Materials Science)
Home Institution: University of St. Thomas
Abstract: Fused deposition modeling (FDM) is a 3D printing process that extrudes viscous material in 1-dimensional lines to create 2-dimensional layers that build up to a 3-dimensional part. FDM is common with rigid materials, but flexible composite material is especially of interest, as the flexible nature of elastomeric material would allow exploration of 3D printable magneto-mechanical components. While previous work by this group has shown the significant effects that printing parameters have on magnetic properties, this hasn't been characterized with a flexible composite filament. Here, we explore this topic with a stock composite magnetic elastomer filament consisting of TPU (thermoplastic polyurethane) polymer and either 20wt.% or 40wt.% iron compared to a rigid filament consisting of PLA (polylactic acid) polymer and 40wt.% iron. These filaments were used to print magnetic samples of varying material, length, width, infill percentage, and infill print orientation. A vibrating sample magnetometer (VSM) was used to obtain magnetic hysteresis loops in order to compare the magnetic susceptibilities between the different parameters. Results will be presented that highlight how each parameter influences the magnetic properties of the printed parts. These results allow further development of utilizing an FDM process in magneto-mechanical applications.

32. **Anna Campbell-Sowden**
Parasitic Capacitance in Floating Gate Electrolyte Gated Transistors (FG-EGTs)
Advisor: Daniel Frisbie
Sponsoring Program: MRSEC
Home Institution: Allegheny College
Abstract: Biosensing has come far with new techniques and technological advances. Floating gate, electrolyte-gated transistors (FG-EGTs), show promise for advancements in the field due to their portability and ease of fabrication. FG-EGT sensors are devices where one side of the floating gate is functionalized with bioreceptors, acting as the sensing pad, and is capacitively coupled to the EGT. Upon a binding event, the FG-EGT elicits a response based on a potentiometric change at the sensing pad. The transistor's response is transduced into an electrical signal and then processed to provide an electronic readout, detailing the binding of the analyte of interest at the sensing pad. This project will focus partly on altering the sensing pad size to see how device response is affected, and partly to investigate ways to reduce parasitic capacitance between the floating gate and substrate. Parasitic capacitance causes less polarization of the electrolyte due to trapped charges at the gold/silicon interface, necessitating a larger gate voltage to turn on the transistor. By changing the substrate to glass, an insulating material, parasitic capacitance can be eliminated.

33. **Elif Cetin**
Data Analysis of Graphs Obtained from FTIR Spectroscopy of Proteins
Advisor: Jeong-Hyun Cho
Sponsoring Program: URS
Home Institution: College of Science and Engineering
Abstract: The purpose of the research project was to create a computer program that accomplishes the data analysis of outputs obtained from FTIR Spectroscopy of protein structures. The FTIR spectroscopy produces an output graph based on the percentage of transmission of infrared rays through a solution of the protein. These graphs obtained reveal critical information about the structure of the sub-proteins the protein is comprised of. However, these distinct peaks in the graphs are difficult to observe due to extensive overlapping of the constituent graphs. The program created in Matlab automates what is called the second derivative graph to make the peaks distinguishable. I also performed deconvolution of the resulting second derivative using a software called Origin, which allowed us to observe the distinct constituent graphs for the sub-constituents of the protein, which could then be used to calculate the percentage contribution of each constituent. The information obtained about the structure of the protein and contribution of the sub-constituents can then be used to reveal critical information about any abnormalities that may be present in the patient which can lead to diagnosing various ailments.

34. **Isabella Chaffee**
Pupil Trajectories in the Operating Room
Advisor: Stephen Guy
Sponsoring Program: Computer Science
Home Institution: Carleton College
Abstract: While measures currently exist to determine the competency of surgeons throughout residency, such as Board certification or the number of hours spent in operation, improvements can be made when assessing surgeons in training. By using eye trackers, we can record both pupil trajectory and velocity and determine if there are differences in low and high-velocity periods across residency levels. By plotting pupil velocities we can create metrics to determine the focus of residents during select portions of operation as well as overall measures of concentration. By breaking down the larger concept of pupil motion into multiple sub-problems, we can first understand velocity patterns in one surgeon, then ultimately develop the capability to evaluate two surgeons working simultaneously, specifically, finding gaze concurrence in small operating fields. With our proposed metrics, future surgeons can feel more prepared for operations and teachers will have evaluative tools to determine if residents are performing as they should or whether their eyes suggests that focus could be improved.

35. **Alejandra Chapa**
Reactive Amphiphilic Block Copolymers as Scaffolds for The Synthesis of Polycationic Micelles
Advisor: Theresa Reineke
Sponsoring Program: MRSEC
Home Institution: The University of Texas Rio Grande Valley
Abstract: Polyelectrolyte complexes are formed spontaneously when oppositely charged polyions are mixed. The study of these materials is driven by standing fundamental questions about their formation process and structures, as well as their use in water treatment, adhesives, and genetic therapies. In specific for genetic therapies, complexation and protection of nucleic acid cargos ensures efficient therapies. Amphiphilic cationic block copolymers self-assemble into nanoscopic particles called "micelles" that serve as model templates for studying nucleic acid complexation. This summer, we focused on synthesizing a scaffold diblock copolymer in which one of the blocks is hydrophobic and the other is a reactive ester that can be chemically altered into a polycationic block, thus allowing us to prepare a library of amphiphilic cationic block copolymers. We prepared these diblock copolymers by either starting with the reactive block or the hydrophobic block, showing that the latter allows the synthesis of diblock copolymers with low dispersity and controlled block sizes. These reactive diblock copolymers will be modified into a family of cationic micelles, and to study their complexation with different nucleic acids to understand the effects of the cationic block in the stability and structure of the complexes.

36. **Jessica Chiu**
Processing Spatially Gradient Nanocrystal Films
Advisor: Vivian Ferry
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Integration and application of colloidal quantum dots (QDs) to optoelectronic devices requires solid state film fabrication of solution-phase QDs. Normal processing of films results in polydispersity, or variation of particle size. Due to the strong dependence of bandgap energy on particle size, polydispersity can lead to the trapping of energy at particular locations. This project aims to direct energy flow in a solid-state film by grading the bandgap energy, via single-step processing of spatially gradient nanocrystal (NC) films. A film with a gradient in bandgap energy is interesting for its potential to direct the transport of charge in materials for optoelectronic applications, such as photodiodes, LEDs, and heterojunction bipolar transistors.

37. **Nancy Chu**
Synthesis and Complexation of 1,3-bis[(2- pyridyl)methyl]-1H-imidazolylidene with Divalent Calcium and Europium Cations
Advisor: Marites Guino-o
Sponsoring Program: MRSEC
Home Institution: University of St. Thomas
Abstract: Magnetic Resonance Imaging (MRI) technique depends on contrast agents to enhance the visibility of the image. MRI currently uses Gd(III)-based contrast agents, however, Eu(II) ions have the potential to replace Gd(III) because Eu(II) has a faster water exchange rate which provides a positive contrast enhancement in MRI. However, Eu(II) ions will oxidize to Eu(III) in the presence of air. To control the oxidation, Eu(II) ion can be coordinated to ligands to stabilize the oxidation state of the metal center. Due to the strong σ-donating abilities of N-Heterocyclic Carbenes (NHCs) towards metals, our group will employ NHCs as our ligand. This project focuses on the NHC 1,3-bis[(2- pyridyl)methyl]-1H-imidazolylidene. The paramagnetic nature of Eu(II) ions makes NMR solution tracking of Eu(II)NHC complexes difficult so a Ca(II)NHC analog was synthesize as a model complex. Herein we present the synthetic routes of our Ca(II)NHC complexes that can be applied to Eu(II) ion. We also report the NMR spectra for all our synthetic routes.

38. **Louis Crisci**
Doping Graphene Through a Protective Layer
Advisor: Jeong-Hyun Cho
Sponsoring Program: MRSEC
Home Institution: University of Connecticut
Abstract: Graphene has the potential for many applications in the electronics and bio-sensing fields. In order to fulfill these roles, the electrical properties of graphene must be precisely modulated which can be accomplished through doping. The possibility of doping graphene through a protective layer was explored by depositing aluminum oxide onto monolayer graphene. The samples were then exposed to nitric acid vapor, which acted as a dopant. Through Raman spectroscopy, the shift of characteristic graphene peaks was monitored after being exposed to the dopant. From this, we found that it is possible to dope graphene through layers of aluminum oxide with thicknesses exceeding 200 nm. This layer can protect graphene from damage during a standard plasma etching process while maintaining the ability to chemically modify its properties. This observation provides a beneficial insight on integrating graphene into standard fabrication processes.

39. **Nathan Davies**
Sticky Plates: Using Models to Improve Control of Hydrostatic Wind Turbine Test Bed
Advisor: Kim Stelson
Sponsoring Program: CCEFP
Home Institution: Macalester College
Abstract: The power regenerative hydrostatic wind turbine test bed uses variable-displacement axial piston pumps to transfer power around the test platform. A hydrostatic drive (HSD) spins a rotor at slow speeds with high torque. Then the hydrostatic transmission (HST) converts this power in order to spin an electric motor at high speeds with low torque. The difference in speed between the rotor and the motor is dependent upon the flow rate for both the HSD pump and the HST pump. The flow rate is controlled by the angle of the swash plate within the pump. Ideally, the pumps would move smoothly from one position to the next; however, the pumps installed on the test bed exhibit a sticking behavior. Instead of moving smoothly, they will slow down multiple times before moving again when given a command signal. This sticking has led to control issues within the system. In order to help improve control, data was taken on these sticking swash plates, exponential models were made, then a Laplace transform was performed in order for the model to be used by the computer controller.

40. **Adonica De Los Santos**
Synthesis of Black Arsenic Phosphorous Thin Films
Advisor: Stephen Campbell
Sponsoring Program: MRSEC
Home Institution: University of Texas Rio Grande Valley
Abstract: A new frontier in black phosphorus crystal synthesis research is to alloy black phosphorus with varying arsenic compositions. The increase of Arsenic in b-AsxP1-x materials shows a band gap decrease from 0.3 eV to 0.15 eV which allows this material to be used for mid-infrared photodetector devices. One advantage of this 2-D semiconductor material is increased resistance to surface oxidation degradation which is a serious limitation of black phosphorus devices. Currently, black arsenic devices are fabricated by mechanical exfoliation processes which is not scalable to an industrial level. The aim is to synthesize the black arsenic phosphorus directly onto a silicon wafer in a highly crystalline, uniform, and large area vapor deposition process. For us to determine the crystal structure of our black arsenic phosphorous an X-Ray Diffraction will be used. The thin flakes found on the wafer had a decrease of oxidation degradation compared to previous samples made and had 35 to 40 percent arsenic in the crystal shown in the Auger Electron Spectroscopy results. On the surface less tin was found on the surface of the sample compared to the amount on pure black phosphorus using the starting reactant ratio that is optimized for thin film black phosphorus.

41. **Kevin Doku**
Radiolysis and Knock on Damage Mitigation on Metalorganic Frameworks from Transmission Electron Microscope
Advisor: Andre Mkhoyan
Sponsoring Program: MRSEC
Home Institution: New York University
Abstract: Metal-Organic Frameworks (MOFs) are crystalline substances that consist of metallic atoms bonded together by organic linkers. Metal-Organic Frameworks (MOFs) are crystalline substances that consist of metallic atoms bonded together by organic linkers. MOFs are electron beam sensitive material and are easily damaged by the method of analysis (Transmission electron Microscopy or TEM). However, because of these organic linkers, when exposed to an electron beam at energies of 100 keV or (1.602 x10-14 J), the bonds begin to break and the results that are obtained are not representative of the parent structure, which is known as radiolysis. In addition, the breaking of bonds in MOFs can result in undesired side products and consequently; the damaged parent substance as a whole has a different diffraction pattern than the pre-damaged parent substance. Metal-Organic Frameworks are also susceptible to a different type of electron beam damage. When the energy of a Transmission Electron Microscope/Microscopy is reduced, so is the chance of radiolysis. However, there are times when an atom is pushed out of position by the onslaught of electrons by the beam; which is called knock-on damage. This displacement of the atom reduces the atomic structural integrity of the substance.

42. **Jerrick Edmund**
Effect of Allylation on Gelation Behavior of Aqueous Methylcellulose Solutions
Advisor: Frank Bates
Sponsoring Program: UROP
Home Institution: University of Minnesota-Twin Cities
Abstract: Methylcellulose (MC) is a water-soluble cellulose ether formed by the partial substitution of hydroxyl groups with methoxy moieties, called the degree of substitution (DS = 1.6-2.1) per anhydroglucose repeat unit (AGU). MC is a thermoreversible gel that phase separates and gels at ~60 °C and forms fibrils of diameter ~15 nm upon heating. In this project, the effect of allylation on the gelation behavior of MC solutions (Mw = 150 kg/mol) was studied. Allylated MCs were synthesized by reacting with various amounts of allyl bromide under room temperature and basic conditions. The amount of allyl groups substituted per AGU (mol allyl/mol AGU) was characterized through 1H-NMR spectroscopy. The gelation behavior of 2 wt% solutions of the allylated MCs was determined from the cloud point (Tcloud) and gel point (Tgel) temperatures using optical transmittance and rheology, respectively. Results show that Tcloud is similar to Tgel for all solutions and both decrease as mol allyl/mol AGU increases, indicating that allylation causes the early onset of phase separation, gelation and fibril formation due to an increase in the hydrophobicity of MC. Future work will include doing more trials, using other characterization techniques and grafting onto MC through thiol-ene click chemistry.

43. **Kavinraaj Elangovan**
Ion gel gating of epitaxial stannate thin films with hafnium oxide buffer layer
Advisor: Bharat Jalan
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Alkaline earth stannates have become an integral part of semiconductor technology due to their optical transparency and high room temperature carrier mobility. Previous experiments have shown that using an ion gel as a gate material is an effective method to induce carriers in epitaxial thin films in an electrostatic reversible manner. The ion gel (a combination of an ionic liquid and a block copolymer) acts as a dielectric and generates strong electric fields which induce a high carrier density at the thin film surface. However, the interaction between the gel surface and the film surface leads to a reduction in the mobility of the carriers. In this experiment, we attempt to optimize the effect of the ion gel by adding a layer of hafnium oxide between the gel and the film. Due to the similarity in the structures of the film and the hafnium oxide layer, it is predicted that the mobility of the carriers would increase due to lack of mismatch at the interface. The thin films were grown using Hybrid MBE and transistor devices were fabricated on it. The hafnium oxide layer was deposited on it using atomic layer deposition and electronic transport measurements were performed.

44. **Nathan Fischer,** Jerald Thomas
Increasing the Anisotropy of Magnetorheological Elastomers through Magnetic Annealing for Enhanced Performance
Advisor: Brittany Nelson-Cheeseman
Sponsoring Program: University of St Thomas- Mechanical Engineering
Home Institution: University of St. Thomas
Abstract: Magnetic elastomers are smart materials with the ability to physically deform while under a magnetic field; applications include soft robotics, artificial muscle, and magnetic sensors. Anisotropy (defined as being different along different directions) has been shown to increase the performance of these materials. This project focuses on making magnetic elastomers for 3d printing, whereby the internal meso-structural anisotropy created from printing should enhance magnetoactive properties. Here, we focus on using magnetic annealing to further influence the anisotropy on the microstructural level in order to lead to even greater performance. Non-annealed filament samples are made by mixing an elastomer matrix with iron particulate and then extruding. Annealed samples use a similar process, but filament passes through a permanent magnet setup immediately after extrusion (while still partially viscous). Mechanical properties of filament samples were measured using an MTS tensile testing machine via stress-strain curves. Magnetic properties were recorded using vibrating sample magnetometry (VSM) via hysteresis loops. The results were compared between annealed and non-annealed samples to seek trends in increasing anisotropy. Preliminary tests show magnetically annealing samples increases both directional mechanical and magnetic properties, suggesting that the internal structure can be manipulated in ways that allow for greater magnetoactive deformation.

45. **Thomas Fisher**
A Novel VR Navigation Algorithm using Trapezoidal Decomposition
Advisor: Evan Suma Rosenberg
Sponsoring Program: Computer Science
Home Institution: University of Notre Dame
Abstract: Redirected walking answers the fundamental problem of locomotion in VR in such a way that allows natural navigation via walking while still making efficient use of the limited available physical environment. By applying imperceptible gains to the user's motions which decouple their physical and virtual movements and position, redirected walking seeks to steer users toward certain targets in the physical world, i.e. away from obstacles or walls. Some prominent algorithms suggest steering the user toward the center of the physical space at all times or in a wide ring around the space. However, these approaches break down in non-convex or obstacle-containing environments, such as an average user might have available to use as their VR space. In this project, we are implementing a novel redirected walking algorithm proposed in 2018. This algorithm borrows approaches from robotics motion planning and involves first constructing a trapezoidal decomposition of the 2D walkable space, then steering the user along a road map formed by the centers of the polygons and borders produced. Simulations are ongoing to test this new algorithm's performance against state-of-the-art redirected walking techniques, including those mentioned above.

46. **Lucas Fluegel**
Alkoxysilanes as Versatile Functional Groups in the Hexadehydro-Diels-Alder (HDDA) Reaction
Advisor: Thomas Hoye
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: The hexadehydro-Diels-Alder (HDDA) reaction is a powerful synthetic method for the creation of complex benzenoid products through an ortho-benzyne intermediate. In this formally [4+2] thermal cyclization process, a 1,3-diyne is trapped by another alkyne, a "diynophile". The power of this reaction lies in the inherent customizability of the benzyne and the relatively mild nature of the reaction conditions. In the current study, the inclusion of a versatile alkoxysilane (-SiR¬2OR) functional group into the HDDA process is examined. Such moieties are known to undergo a wide variety of synthetically useful transformations, such as Tamao-Fleming oxidation or Hiyama-Denmark coupling. The presence of this functionality would allow for even greater customizability of the HDDA process, in addition to opening doors to classes of products which are currently difficult to access through HDDA procedures, such as phenols. Creation of the necessary alkoxysilane-containing triyne precursors has proven unexpectedly difficult. In particular, hydrolysis of the alkyne-silicon bond has been a consistent theme.

47. **Isaac Gilfeather**
Calcium Copper Titanite Nanoparticles produced via Flame Spray Pyrolysis
Advisor: Christopher Hogan
Sponsoring Program: MRSEC
Home Institution: Montana Technological University
Abstract: Calcium Copper Titanite (CCTO) is an electro-ceramic material valued for its incredible dielectric properties. CCTO has a pseudo-cubic perovskite-related structure with the chemical formula $CaCu_3Ti_4O_{12}$. This material exhibits a low dielectric loss, high thermal stability, and a high dielectric constant. This makes CCTO an excellent dielectric material for applications in capacitive sensors and actuators. The focus of this research will be on the synthesis and characterization of CCTO produced via flame spray pyrolysis (FSP). The FSP system has two inlet flows; a methane gas fuel source used to sustain the flame and an atomized precursor solution. The output of the system is an aerosol that contains CCTO nanoparticles which are then collected by a filter. X-ray diffraction (XRD) was then used to investigate the composition and crystal structure of the CCTO.

48. **Hari Gopalakrishnan**
Intranasal Delivery Device for Two-part BZD-producing Formulation
Advisor: Ronald Siegel
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota, Twin Cities - College Science and Engineering
Abstract: A device capable of administering an atomized benzodiazepine (BZD)-generating solution intranasally is being developed for rapid outpatient seizure treatment. The current functional prototype is a pneumatically-actuated single-use dual-chamber drug cartridge. However, there may be other methods of actuation and reloading capable of mixing the liquid (buffer) and solid (lyophilizate) components of the formulation that are both functional and reusable. Both a spring-loaded and manually-operated syringe pump design was investigated, aided by 3D printing. A plastic push-fit installation of the reusable liquid compartment appeared to create an adequate seal for perpendicular suction of water, using a Luer diaphragm valve to prevent backflow. While friction impeded spring-loaded syringe actuation, mix testing of the manual and an altered pneumatic prototype is planned. A secondary experiment was conducted to compare the two versions of the formulation: to support prior data showing midazolam (MDZ, a benzodiazepine) production by base-catalyzed ring closure (circumventing the need for enzymatic cleavage), the data was compared to the prodrug-enzyme system originally employed. The reactions were monitored from 290nm to 400nm, with precipitation expected at around 1.15-1.16mM MDZ, the critical concentration found for the base-catalyzed ring-closure reaction. Results are inconclusive, though the concentration range is being widened to account for error.

49. **Hameem Gorabi**
Refinement of Amorphous Boron-Doped SiGe Film Post-Process Annealing
Advisor: Uwe Kortshagen
Sponsoring Program: MRSEC
Home Institution: University of Texas Rio Grande Valley
Abstract: In order for solar panels and waste heat recyclers to convert heat into electrical energy, they require that thermal energy be absorbed but not conducted through them while retaining their electrical conductivity. Amorphous SiGe films are capable of this when their grain size is between 10 and 100 nm, but do not have a majority of grains within this range upon deposition via plasma. An annealing process is necessary to bring the microstructure within this range as well as improve the structure to be more conducive to the material's thermoelectric needs. This project refines the annealing process used to bring plasma deposited amorphous SiGe substrates (deposited on quartz because it can withstand the annealing process as opposed to something like glass) to a 10-100 nm range grain size, allowing them to scatter phonons (thermal energy) but conduct electrons (electrical energy). Currently samples are treated at 650 degrees Celsius for 10 hours or at 1000 degrees for 1 hour; these are used as the baseline to deviate from in experimentation, as well as the control treatments.

50. **Ebba Green**
The Chemical Abundances of Spiral Galaxies
Advisor: Evan Skillman
Sponsoring Program: Physics REU
Home Institution: Colorado College
Abstract: The CHAOS Project uses the Multi-Object Double Spectrograph in the Large Binocular Telescope to observe star forming regions in several spiral galaxies. Measurements of temperature-sensitive auroral emission lines have been gathered from these HII regions, which allow for electron temperatures to be measured. We can then derive "direct" abundances from these electron temperatures and see abundance gradients in spiral galaxies. Galaxies measured so far include M101, M51, and NGC628, and all of these galaxies show a radial metallicity and temperature gradient. A strong correlation has been found between T[N II] and T[S III] with a small dispersion and consistency with the photoionization models. A correlation has been found between T[S III] and T[O III], with significant dispersion and significant inconsistency with the photoionization models. There is general agreement between T[N II], T[S II], and T[O II] with significant dispersion.

51. **Grace Gretz**
Determining Extent & Effect of Charge Transfer in Organic Electron Donor/Acceptor Crystal Pair via ATR-FTIR & VSFG Spectroscopy
Advisor: Aaron Massari
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: When donor crystal, nickel phthalocyanine (Ni(Pc)), comes into contact with electron acceptor crystal, tetrafluoro-tetracyanoquinodimethane (F4TCNQ), charge transfer occurs spontaneously. In this study, Attenuated Total Reflectance - Fourier Transform Infrared (ATR-FTIR) spectroscopy was used to determine the extent of charge transfer occurring between FnTCNQ (n=0, 2, 4) acceptor crystals and Ni(Pc) to identify the best acceptor for NiPc and the extent of charge transfer over different ratios of Ni(Pc) and F4TCNQ. Organic vapor deposition was then used to prepare a sample in which Ni(Pc) and FnTCNQ crystals were placed at varying distances with an interlayer dielectric material in order to test the distance dependence of electron transfer. This novel sample will be investigated by Vibrational Sum Frequency Generation Spectroscopy (VSFG) to monitor the extent of charge transfer due to its unique ability to measure the vibrational spectra of molecules at the interface of a material without interference from the molecules in the bulk of that material. Ongoing work with this technique will measure the vibrational spectra of the donor/acceptor crystal pair to ensure that it is genuinely carrier doping occuring and not some other, outside chemical phenomena responsible.

52. **Danielle Gross**
The Electrostatic Control of Gallium Oxide
Advisor: Bharat Jalan
Sponsoring Program: MRSEC
Home Institution: UW-Madison
Abstract: : β-gallium oxide is the most stable form of gallium oxide and has a large bandgap of 4.8 eV, electron mobility of 300 cm2Vs, breakdown field of 8 MVcm, and a dielectric constant of 10 in the bulk. These high values are what makes gallium oxide of interest to study as a possible replacement for conventionally used silicon. Thin films of gallium oxide were synthesized using metal organic chemical vapor deposition (MOCVD). Its structure-property relationship will be probed by electrostatic gating techniques by transforming the material into a hall-bars device using ion gel in order to understand the mobility limiting mechanisms and intrinsic transport properties with the physical property measurement system (PPMS) at different carrier concentrations. Another goal is to decipher whether the ion gel has purely an electrostatic effect on the substance or if it also has an electrochemical effect by permanently changing the electronic properties of Ga2O3. After identifying the intrinsic properties of gallium oxide, the goal is to find the applicability of ion gel gating on the material for use as a transistor in electronics.

53. **Beatrice Gulner**
Current Relaxation in Amorphous Semiconductor Alloys
Advisor: James Kakalios
Sponsoring Program: Physics REU
Home Institution: St. Olaf College
Abstract: Amorphous semiconductors could provide a more cost effective and more easily manufactured alternative to crystalline semiconductors, notably for use in solar cells. The physics of these amorphous semiconductors however is far less understood than their crystalline counterparts. One phenomenon observed in amorphous semiconductors is a characteristic change in the conductivity of the material as a function of time, referred to as current relaxation. This summer, I studied current relaxation in boron-doped alloys of amorphous silicon and germanium. I constructed and debugged a system to maintain the sample under vacuum and at a controlled temperature with an applied voltage while monitoring the current running through the sample. The resulting data indicated that, contrary to past studies of pure amorphous silicon and pure amorphous germanium, the current relaxation deviated from the model of stretched exponential relaxation. One possible explanation suggests a transition in the time dependence between short and long time scales. More study will be required to determine the physical explanation for this unexpected behavior in these amorphous semiconductor alloys.

54. **Austin Hayes,** Sam Adeniyi
Using Augmented Reality to Determine Potential Routes for Drone Navigation
Advisor: Evan Suma Rosenberg
Sponsoring Program: Computer Science
Home Institution: University of Maryland, College Park, Simpson College
Abstract: User interfaces for task-oriented robotics are often complex and unintuitive, requiring voice commands and/or esoteric controls to operate the system. An augmented reality user interface for unmanned vehicles could greatly diminish the cognitive load on the user by implementing natural-gesture based controls. Our interface allows the user to pinpoint locations on a virtual map, creating a waypoint layout to be followed and navigated by a drone. To accomplish such a goal, our approach requires aligning the coordinate systems of multiple tracking devices and breaking down the physical environment to compute the most optimal path to be followed by the drone.

55. **Emma Henshaw**
Preparation of Silica Nanoparticles with Various Surface Roughnesses: Effect of Surface Roughness on Gram-negative Bacteria, Shewanella oneidensis
Advisor: Hyunho Kang
Sponsoring Program: Center for Sustainable Nanotechnology
Home Institution: University of Minnesota - Twin Cities
Abstract: Silica nanoparticles have become increasingly prevalent in nanotechnological studies for applications in the biomedical field, manufacturing, and catalysis due to their tunable chemical and physical properties and generally low toxicity. The surface area of SiO2 NPs can be increased, creating nanopores where other functional nanomaterials may bind, enhancing synthetic utility. In this experiment, we tuned the degree of the outer surface roughness of nonporous SiO2 NPs via hydrolysis and polycondensation of tetraethyl orthosilicate in the presence Pluronic F127, a crucial polymer in forming the porous structure. Three different particles were characterized using transmission electron microscopy, scanning electron microscopy, dynamic light scattering, zeta potential analysis, and BET nitrogen adsorption analysis to ensure consistent colloidal properties. Once characterized, the particles were suspended in biological media with Gram-negative bacteria, Shewanella oneidensis MR-1, to investigate the effect of the physical surface properties of the NPs on bacterial growth behavior. For the surfaces achieved to date, roughness had no significant effect on the viability of bacteria, suggesting that higher surface area is not a major factor and silica may not be toxic enough to draw a relationship between surface roughness and toxicity. Further surface functionalization and exploration into the process of surface roughing is necessary.

56. **Martin Herrera**
Efficient, Compact, and Smooth Variable Propulsion Motor
Advisor: James Van de Ven
Sponsoring Program: CCEFP
Home Institution: University of Miami
Abstract: Hydrostatic drives consisting of variable displacement pumps and a fixed displacement motor are a common power transmission for off-highway vehicles. The state-of-the-art motor for these transmissions is a fixed displacement low-speed, high-torque (LSHT) radial piston motor. Using a variable displacement motor allows the pump size to be reduced, improving the overall efficiency of the system. A commercially available option is a high-speed, low-torque variable displacement motor with a gearbox, which is bulky and expensive. The Variable Displacement Linkage Motor (VDLM) is a LSHT motor consisting of a multi-lobed cam and pistons. It is continuously variable and displacement dense, while offering high efficiencies and low torque ripple over its operating range. The focus of this project was assisting with the detailed design of a single-cylinder prototype VDLM. The parameters of the motor were selected from an optimization with the objectives of maximizing efficiency and minimizing torque ripple and motor size. The mechanical design was performed as an iterative process that included the analysis of linkage and adjustment displacement mechanisms, fluid routing, and rotating components. The results of this REU project are a CAD model and a 45% scale 3D printed demonstration prototype.

57. **John Hoefler**
Lanthanide-TREN-MAM Complexes for Phosphate Binding
Advisor: Valerie Pierre
Sponsoring Program: UMN Chemistry- Lando
Home Institution: St. Lawrence University
Abstract: The effectiveness of the complex Gadolinium- 2,2',2''-(((nitrilotris(ethane-2,1-diyl))tris-(azanediyl))tris(carbonyl))tris(4-oxo-4H-pyran-3-olate) (Gd-TREN-MAM) for the selective capture and release of phosphate has previously been shown. To better understand the effect of altering the lanthanide in these complexes, thulium-TREN-MAM (Tm-TM) and ytterbium-TREN-MAM (Yb-TM) were synthesized and bound to a fluorinated phosphonate. The relative lability of these complexes toward the phosphonate at varying lanthanide concentrations was assessed by F-19 NMR through analysis of the shifting of the primary phosphonate resonance away from an unshifted reference peak. This shifting was observed due to the phosphonate's proximity to the paramagnetic lanthanide centers. The greatest degree of shifting for both complexes was observed at complex concentrations of 5 mM, suggesting this is the concentration at which the phosphonate-lanthanide bond is least labile. A simple analyses of Yb-TM spectra containing more than one resonance is also presented as a qualitative indicator of the relative speed of equilibrium between the Yb center and phosphonate at different concentrations of Yb-TM. This enhanced understanding of phosphate-lanthanide bonding kinetics opens the possibility for improving previously reported phosphate binders by alteration of the lanthanide center.

58. **Madeline Honig**
Reproducibility of Solid-Contact Ion-Selective Electrodes with Ferri-Ferrocyanide Redox Buffer
Advisor: Philippe Buhlmann
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Earlham College
Abstract: Ion-selective electrodes are commonly used in clinical laboratories for blood or urine analysis. Calibration-free ion sensors could allow this kind of analysis to be done in-situ as they require less training to operate and can be used to create wearable or single-use sensors. However, calibration-free sensors require a high level of reproducibility between individual electrodes. Our goal is to improve the reproducibility of the standard potential of solid-contact ion-selective electrodes (ISEs) to create calibration-free ISEs using a commercially available cation-exchange membrane and a ferri-ferrocyanide redox buffer in polyvinyl alcohol gel. This project's primary focus has been to assess the effectiveness of the redox buffer in controlling the potential between the cation-exchange membrane and the gold disk electrode. Additionally, we have aimed to identify other sources of variability of the standard potentials of the ISEs that remain in the system by assessing the reproducibility of the individual phase boundary potentials that make up the electrodes.

59. **Amy Howarth**
Evaluation of Nitrification Inhibitor DMPSA and N-fixing organisms effect on N2O and NH3 emissions when supplemented to Urea
Advisor: Rodney Venterea
Sponsoring Program: UROP
Home Institution: University of Minnesota
Abstract: Increased use of synthetic nitrogen fertilizers may be resulting in increased amounts of nitrous oxide (N2O) gasses released into the atmosphere as well as ammonia gas (NH3). NH3 and N2O are two sources of greenhouse gas emissions that are a result of agriculture and could be reduced with better methods and technology. I have worked spring semester and this summer to evaluate DMPSA, NBPT and N-fixing microorganism sources in irrigated potato production grown on sandy soil and corn grown on clay and sandy soils in Minnesota to see if this is a viable solution to reduce the emissions of NH3 and N2O.

60. **Monica Iram**
Quantitative Analysis of Polygenic Risk Score Prediction in the Genes for Good Cohort
Advisor: Matthew Zawistowski
Sponsoring Program: Big Data Summer Institute Research Program
Home Institution: University of Minnesota
Abstract: A promising tool in genetic prognostics is the use of polygenic risk scores (PRS). PRS are the sum of an individuals' disease-associated alleles weighted by estimated effect sizes from a genome wide association study (GWAS) for a trait of interest. Some phenotypes can be predicted to a great degree of accuracy based on the PRS and additional risk factors (e.g. age, sex). In future precision medicine approaches, clinicians may use extreme PRS for certain diseases as an indication for medical intervention. After selecting GWAS summary statistics for several phenotypes, we estimated PRS using the software PRSice for 20,228 individuals in the Genes for Good (GfG) dataset. When conducting ROC analysis on hypertension PRS, we obtained an AUC of 0.697. In our research, we uncovered several limitations of PRS. For example, the predictive ability of a PRS for left-handedness was limited due to the low heritability of the phenotype. We also discovered that a small number of cases in the cohort of interest and a delayed age of onset for the polygenic trait limits the statistical and predictive power of PRS. The results of this study emphasize the predictive potential, along with the limitations, of PRS

61. **Chenyu Jiang**
Understanding the role of dative directing groups in Ti-catalyzed directed alkyne hydroamination
Advisor: Ian Tonks
Sponsoring Program: UMN Chemistry- Lando
Home Institution: The University of British Columbia
Abstract: Hydroamination, the direct addition of an N-H bond across an alkene or an alkyne, is an appealing synthetic method to access amine products which can be often found in the pharmaceutically active compound. Despite great progress has been made in the field of early transition metal-catalyzed hydroamination, controlling regio- and chemoselectivity still remains a critical challenge. In our previous study, we reported the first example of Ti-catalyzed directed alkyne hydroamination which achieves 100% regioselectivity with the aid of dative directing groups. Intrigued by this observation, herein, we report a kinetic study of Ti-catalyzed alkyne hydroamination mediated by heteroatoms to explore the origin of the regioselectivity.

62. **Elaine Kappel**
Synthesis of Nitrogen Doped Carbon Dots Using Precursors found in Common Cleaning Products
Advisor: Christy Haynes
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: In recent years there has been an increase in the engineering of fluorescent, water soluble nanomaterials. Traditional quantum dots have been used for drug delivery, photocatalysis, and photo-electronic devices. However, they can be expensive, labor intensive, and require environmentally hazardous material. An alternative material is carbon dots; carbon dots are also fluorescent nanomaterial, about 10 nm in size with a quasi spherical morphology. Carbon dots have a green advantage over traditional quantum dots because of the ease of synthesis, their relative low cost, and they are biocompatible. This project aimed to synthesize carbon dots using precursors from common cleaning products that exhibit low toxicity. A series of carbon dots were synthesized from two different carbon sources and two different nitrogen sources. The reaction time, temperature, and carbon to nitrogen ratio was varied to optimize carbon dot fluorescence. Fluorescence was examined to determine quantum yield taken at the maximum excitation wavelength. The carbon dots with citric acid and monoethanolamine at short reaction times and lower temperatures lead to the highest quantum yield. These results will be used to determine the optimal carbon dot for uses in signaling cleanliness through fluorescence and binding to bacteria.

63. **Adam Keester**
Efficient Wave Energy Converter Control Using Hybrid Hydraulic Electric Architecture
Advisor: Perry Li
Sponsoring Program: CCEFP
Home Institution: University of Minnesota
Abstract: Ocean wave energy is an up and coming field in the renewable energy sector and can make a significant contribution to the world's electrical grid in the near future. However, wave energy is an early technology and major roadblocks include highly efficient devices and effective control strategies. WEC-Sim is a MATLAB/Simulink-based National Lab program used to customize and simulate wave energy converters and is used in this research. Here, the point absorber and oscillating surge WEC described in Sandia National Lab's Reference Model Project are investigated. Utilizing a hybrid hydraulic-electric architecture as the power take-off system, wave power can be absorbed more efficiently than with current technology. The hybrid hydrualic electric architecture shows good tracking performance when used in conjunction with a PI controller for power absorption.

64. **Mazzin Khidir**
An analysis of the applications of the Minnebot Unreal Simulation
Advisor: Junaed Sattar
Sponsoring Program: Northstar STEM Alliance
Home Institution: Interactive Robotics and Vision Lab
Abstract: Through the use of the open source tools gazebo, unreal engine, robot operating system, the minnebot simulation is able to provide an environment for the testing of the minnebot's functionalities.

65. **Carrie Kistler**
Features of Online Community Charitable Actions
Advisor: Lana Yarosh
Sponsoring Program: Computer Science
Home Institution: University of Minnesota
Abstract: CaringBridge is a non-profit Online Health Community (OHC) where members can share their needs with friends and families and connect with people going through similar difficulties. Being a non-profit organization, the money necessary for upkeeping and improving the site comes through donations, often from users of the site. It is important for organizations that function primarily online to be able to focus efforts on receiving donations where those efforts will be most useful. To do that it is necessary to analyze the user data to find features of users who are more likely to donate and pages that are more likely to bring in donations. To do this, features of donors were analyzed to find which ones most heavily correlate to a donation being made. A machine learning algorithm was then applied to predict which users would be most likely to donate in order for the company to market more directly to those users.

66. **Katie Kitzinger**
Investigations into Reaction Rates of Fluoride-mediated Benzyne Formation
Advisor: Thomas Hoye
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Lawrence University
Abstract: Recently, benzyne chemistry has become of increasing importance and scope, gaining popularity in the synthesis community through its notable formation in hexadehydro Diels-Alder (HDDA) reactions. Benzyne's high reactivity and impressive selectivity in reactions with multifunctional compounds make it an appealing intermediate for generating complex molecules under mild reaction conditions. Conveniently, benzyne can be accessed through a variety of precursors. One of the most popular classical benzyne precursors is the Kobayashi precursor, an o-trimethylsilylphenyl triflate. The Kobayashi precursor is particularly useful because it generates benzyne under mild reaction conditions and can be obtained easily through a concise synthesis. Despite their prominence, we can find no reported investigations into the rates of benzyne formation from the Kobayashi precursor or analogs of it. Here, we present the beginnings of a study on the rates of fluoride-mediated benzyne formation from these common precursors. Fundamental insight regarding benzyne formation rates from these precursors will serve to mitigate the time-consuming process of trial-and-error precursor screening and guide synthetic chemists in identifying the most advantageous precursor for their applications.

67. **Corey Knutson**
Edgebot - A low cost Underwater Autonomous Vehicle
Advisor: Junaed Sattar
Sponsoring Program: Computer Science
Home Institution: University of Minnesota - Duluth
Abstract: Autonomous robotics research in underwater environments is inaccessible for many labs due to high entry costs and limited choices of underwater robots. The most common autonomous underwater vehicle (AUV) is Aqua 2 - a very expensive and very custom piece of tech. Aqua 2 is a respectable AUV, but the 6-figure price tag and limited configuration can make it difficult for researchers to perform their experiments. This REU project continues work on a low cost and open source AUV, dubbed Edgebot. Edgebot is designed to run deep learning and computer vision algorithms, with the flexibility to swap electronics to suit the type of research being performed. All parts of the robot are either off the shelf or 3D printed to ensure design accessibility and reduce cost. Every step of the design and build process is documented so researchers can configure, assemble, and repair their own AUV.

68. **Abby Kohut-Jackson**
Development of a protocol to measure pupillary dynamic responses during preparation of self-initiated and cued eye movements in Parkinson 's disease.
Advisor: Colum MacKinnon
Sponsoring Program: Independent Research
Home Institution: University Of Minnesota - Twin Cities
Abstract: A saccade is a quick movement of both eyes between two fixation points. Cued saccades are preceded by a stereotypic sequence of pupil constriction and dilation; thus pupil size measurements can be used to assess saccade preparation. In people with Parkinson's Disease (PD) preparatory pupillary responses preceding cued saccades are reduced. Self-initiated arm and leg movements are impaired in people with PD but can be improved through the use of external cues. To date, no study has compared the effects of cueing (self-initiated vs. cued) on the preparation of saccades. The goal of this study was to develop a protocol to compare preparatory pupillary dynamics associated with cued and self-initiated saccades. We hypothesize that preparatory constrictions and dilations will be smaller in self-initiated eye movements than in cued movements. Sixteen healthy young adults will be tested across 4 conditions of 112 trials each: reactive cueing (fixed timing, saccade direction given at "go" cue), planned cueing (direction specified early, fixed timing of "go" cue), self-initiated timing (direction specified) and self-initiated all (timing and direction chosen by subject). Here, we present our protocol for data acquisition and analysis, preliminary data from 3 participants, and discuss challenges that have been faced.

69. **Vasiki Konneh**
Observation of Quantum Hall Ferromagnetism in Ultrahigh Quality hBN/Gr/ CrI_3/hBN van der Waals Heterostructures
Advisor: Ke Wang
Sponsoring Program: Physics REU
Home Institution: Colby College
Abstract: A nascent field in condensed matter physics, van der Waals materials has attracted significant research interest for its unique possibilities of observations of transport and other phenomena in the true 2-dimensional limit. The reduced dimensionality leads to suppressed screening, which heightens electron-electron interactions. This, coupled with the ability to encapsulate 2D graphene with hexagonal boron nitride for ultrahigh quality samples, allows sensitive probing of the quantum Hall effect in the low disorder regime. One then observes broken symmetry states from electron-electron interactions. This leads to quantum Hall ferromagnetism, a Landau level spin-splitting yielding quantum Hall plateaus at integer spacing of the conductance quanta as opposed to the $\frac{4e^2}{h}$ spacing associated with spin and valley degeneracy. By tuning the Fermi level, one can have larger fillings of a certain spin, thus having a nonzero magnetization as in ferromagnetism. A further study of this could consist of examining the Landau level spectra in the case of strong spin-orbit coupling to see how this alters the distribution of Landau levels. One means of this was recently achieved in our group by encapsulating a graphene/CrI_3 heterostructure, where CrI_3 has a strong spin-orbit coupling imparted to the graphene by proximity-induced hybridization.

70. **Caleb Lachinski**
Multielement ICP-OES Analysis of Drinking Water from the Communities of Bocas del Toro, Panama
Advisor: Edgar Arriaga
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: During the dry season, water can become a scarce resource for the people of the Bocas del Toro region of Panama since rainwater and aquifers are their main sources of water. Additionally, within the communities there are concerns that the water that is available is not necessarily suitable for consumption. In order to assess the safety of the available drinking water, samples were taken from seventeen sources, consisting of rainwater catchment systems, wells, aquifers, and desalinated water. The samples were tested in the field for pH, conductivity, turbidity, and bacteria. However, the field tests do not test for the potential presence of harmful inorganic metals. In order to obtain a more comprehensive level of inorganic analysis, the samples were returned to the University of Minnesota. On campus, the samples were analyzed both qualitatively and quantitatively with the use of inductively coupled plasma optical emission spectra (ICP-OES). The selected analytes include As, Ba, Be, Cd, Cr, Cu, Hg, Pb, Sb, Se, Tl, all of which can lead to negative health effects if found in high enough concentrations, and Ag, Al, Ca, Fe, Mg, Mn, Na, P, S, and Zn, which can affect the cosmetic quality of the water.

71. **Sebastian Laureano**
Uptake of fatty acids by ZSM-5
Advisor: Paul Dauenhauer
Sponsoring Program: Center for Sustainable Polymers
Home Institution: University of Minnesota Duluth
Abstract: The study of adsorption of fatty acids and solvent in HZSM-5 will help to understand the acylation reaction between furans and fatty acids using zeolites for the creation of oleo-furan sulfonate surfactants.

72. **Joseph Lee**
Striving to Achieve Self-Sensing for the Dual Push-Pull Solenoid System
Advisor: Perry Li
Sponsoring Program: CCEFP
Home Institution: University of Connecticut
Abstract: This research experiment deals with the testing and validating of different models for fitting the data derived from a dual push-pull solenoid configuration. The data is comprised of the input voltage values, the output current values, and also the position values. The objective of the model is essentially to predict the current, given the voltage. The final model that proved to produce the best results is a 3rd order system, which is comprised of resistors and an equivalent inductance from a transformer. The transformer takes into account the induced eddy currents from the solenoids, ensuring accuracy at even high frequency AC voltages. The model successfully predicted not only AC voltages, but also DC voltages, chirp signals, ramp inputs and random inputs alike. Even when the dual solenoid system was subject to manual movements, this 3rd order system model performed with a high degree of accuracy and precision. Eventually, using this model, it is desired for the solenoid system to identify its position given only the values for voltage and current, thus eliminating the need for the position sensor.

73. **Qer Lee**
Swarm Robotics Foraging Tasks
Advisor: Maria Gini
Sponsoring Program: Computer Science
Home Institution: University of Minnesota Twin Cities
Abstract: Currently, software such as simulators and metrics are heavily used as part of the Robotics and Artificial Intelligence (AI) researches. Studies of foraging behaviors originally from swarms are useful to solve some real-world problems. I conducted experiments of different foraging tasks using Swarm Robotic simulator for visual observations and metrics to collect countable data. Through comparison of simulated data with different algorithms and methods used on each task, the results identified some tasks are more efficient than others on various conditions.

74. **Thomas Lee**
Porous Magnetic Elastomer Composites via Solvent Casting/Particulate Leaching
Advisor: Brittany Nelson-Cheeseman
Sponsoring Program: UROP
Home Institution: University of St. Thomas
Abstract: Our research focuses on the processing and properties of porous magnetic polyurethane elastomer scaffolds created via a solvent-casting/particulate leaching (SCPL) technique. Increasingly, porous scaffolds prove useful for applications where their low density, high compliance, and other possible properties such as permeability and biocompatibility may be leveraged in place of a traditional solid polymer. The incorporation of magnetic particulate into porous scaffolds allows for new possibilities involving remote actuation, sensing, and soft robotics. Porous scaffolds were produced using the standard SCPL method. This involved dissolution of polyurethane in solvent, addition of a porogen and composite material, reconstitution of the polymer via evaporation of solvent, and leaching the porogen out of the matrix, leaving behind a porous scaffold. For our purposes, dimethylformamide was used as a solvent, salt was used as a porogen, and iron or magnetite particulates were used as a composite material. Multiple scaffolds were created in order to determine the effects of initial polymer solution concentration, size of salt particulate, and presence of a composite material on the mechanical and magnetic properties of the produced scaffolds. We found that by manipulating each of these variables, it was possible to create scaffolds with a wide range of properties.

75. **Ziqing Lin**
Metal-to-metal charge-transfer transitions in Prussian blue analogues using Localized Active Space Self-consistent Field
Advisor: Riddhish Umesh Pandharkar
Sponsoring Program: UMN Chemistry - CTC
Home Institution: Mount Holyoke College
Abstract: Understanding metal-to-metal charge-transfer transitions that can lead to meta-stable states is important for electronics and information storage. Simple ground state calculations cannot be used to study these systems. Generally, methods like TD-DFT are used for these calculations. We study the metal-to-metal charge-transfer transitions in Prussian blue analogues (PBAs) using localized active space self-consistent field (LASSCF). The single binuclear unit of the PBA used contains transition metal ions Cr2+ and Cr3+ linked by cyanide ligands with Cr2+ bound to the nitrogen and Cr3+to the carbon. The charge transfer energy found by LASSCF is compared to literature.

76. **Kathryn Liu**
Voltammetric Detection of Perfluorinated Compounds using a Graphite Three-Phase Electrode
Advisor: Philippe Buhlmann
Sponsoring Program: UMN Chemistry
Home Institution: Wayzata High School
Abstract: Perfluorinated compounds (PFCs), originally manufactured for consumer products, pose a widespread threat to health due to toxic contamination in drinking water. To measure levels of PFCs in water solutions, this project will use voltammetry to detect the transfer of a perfluorinated anion from an aqueous phase to a fluorous phase. With a three-phase electrode set up, the working electrode is developed by melting pencil graphite in the tip of a Pasteur pipette to create a cheap and structured electrode. Preliminary tests with the graphite electrode provided results in accordance to those in literature, so this design was used for further experimentation using the fluorous phase in place of the typical organic phase. The graphite, aqueous phase, and fluorous phase meet to form a three-phase junction where the anion transfer occurs. A fluorophilic redox probe is needed in the fluorous phase to undergo oxidation and to drive the transfer of PFC into the fluorous phase, which maintains charge neutrality and allows for voltammetric detection. Without highly fluorinated redox probes commercially available, we aim to synthesize ferrocene with fluorous ponytails to readily facilitate the anion phase transfer.

77. **Bronson Lynn**
The Correlations Between the Right-Handed W Boson and Leptoquark Searches
Advisor: Jeremiah Mans
Sponsoring Program: Physics REU
Home Institution: East Tennessee State University
Abstract: The standard model is undoubtedly the foundation of modern particle physics. However, the standard model does not answer all the questions the world has provided such as neutrino oscillations and the force of gravity. These omissions, among others, fuel the search for so called "extensions" to the standard model to hopefully bring it closer to becoming a grand unified theory or a "theory of everything." One such extension is known as the Left-Right Symmetric extension or simply LRS. One peculiar feature owing to one of the three forces-strong, weak and electromagnetic-included in the standard model is the antisymmetric nature of the W-Boson, the mediator of the weak force. This particle is thought to only come in the left-handed variety, though searches for a right-handed counterpart are currently underway. This search relies on identifying its decay products, a combination of leptons and jets, since the particle itself is too short lived to be directly detected. This can be problematic, however, as another extension known as the Leptoquark occupies the same footprint as that of the Right-Handed W Boson. This analysis looks at the possibility of deriving statistically significant Right-Handed W Boson results that are identifiable from the Leptoquark background.

78. **Christopher Martínez Tirú**
Strategies using multiple -omics techniques for understanding nanoparticle resistance in bacteria
Advisor: Erin Carlson
Sponsoring Program: Center for Sustainable Nanotechnology
Home Institution: University of Puerto Rico at Cayey
Abstract: Nanoparticles are of great importance due to their unique chemical properties, which promote their application in energy storage, display technology, and medicine. They could benefit society greatly, but also present high risk for environmental release. One nanoparticle, lithium nickel manganese cobalt oxide (NMC), is under investigation due to potential environmental release. To assess the toxicity of this material, we chose to study a globally-distributed and environmentally-critical bacteria, Shewanella oneidensis MR-1. Recently, S. oneidensis was discovered to become resistant to NMC after chronic exposure. Currently, we are using multiple -omics techniques to determine the biological pathways that have changed to produce this novel resistance. It is crucial to obtain molecular-level data that connects these changes throughout the central dogma to provide fundamental understanding of the molecular underpinnings of resistance. With next-generation sequencing, we can locate DNA mutation(s) responsible for NMC resistance and use PCR to determine differential gene expression. To complement this approach, we are also harnessing the power of activity-based protein profiling to study changes in protein activity caused by nanoparticle resistance. Through this work, we can determine how to reduce the environmental toxicity of nanoparticles and develop generalizable trends to predict nanoparticle toxicity and resistance in other organisms.

79. **Andy McCabe**
Selective Arylation and Umpolung Chemistry via NHC and Palladium Metal Catalysis
Advisor: Nicholas Race
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Ithaca College
Abstract: N-Heterocyclic Carbenes have long been known to be useful as both highly coordinating 2-electron donor ligands for metal catalysts and as minor organic catalysts for chemistry involving an inversion of reactivity. This inversion has since become known as umpolung. The mechanism by which this occurs was first proposed by Breslow and has since been termed the Breslow Intermediate. Almost all NHC chemistry is characterized the creation of new carbon-carbon bonds between aldehydes and activated alkenes. The use of a simultaneous Palladium Metal catalyst will hopefully allow for the activation of alkenes in situ. Umpolung chemistry also allows for selective arylation of certain conjugated alkenes. Our goal is to expand the known chemistry involving these NHCs and discover new catalytic pathways.

80. **Maria Mikhailenko**
Applying projection-based correlated WF into DFT embedding for MIL-53 MOF calculations.
Advisor: Jason Goodpaster
Sponsoring Program: UMN Chemistry - CTC
Home Institution: ITMO University, St. Petersburg, Russia
Abstract: In the recent years mixed-metal MOFs have become a promising catalyst materials due to their flexibility in design and reactivity, in particular with respect to the methane to methanol oxidation catalysis [1,2]. It has been reported that Al-based MIL-53 with Fe monomeric and dimeric sites can give rise to pronounced activity in the C-H activation. The mechanism of such oxidation has been investigates with periodic DFT calculations and the hypothesis regarding the nature of catalytic activity in such sites has been put forward [3]. The hypothesis requires further verification using higher-level WF methods due to the potential multiconfigurational character of the intra-MOF Fe sites. Projection-based correlated wave function into density functional theory embedding for periodic systems is a promising method for confirming the existent hypothesis [4]. In the current work the feasibilityof projection-based correlated WF into DFT for calculations on MIL-53 has been investigated. Understanding the electronic structure of the defect Fe sites within mixed-metal MOF structures is necessary for investigating the fundamental principles underlying their reactivity and ultimately for defining design criteria for the next generation catalytic materials.

81. **Tommy Millunchick**
Towards the Synthesis of ssDNA-based SuFEx Probes Targeting APOBEC3B DNA Cytosine Deaminase
Advisor: Daniel Harki
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: Department of Chemistry, University of Minnesota
Abstract: Apolipoprotein B mRNA editing enzyme, catalytic polypeptide-like 3B (APOBEC3B, A3B) catalyzes cytosine-to-uracil (C-to-U) deamination in single-stranded (ss)DNA. A3B is overexpressed in various cancer types and is a source of genomic mutations that result in tumor evolution and the development of drug resistance. Recently, a co-crystal structure of A3B with a ssDNA substrate has been solved, indicating a tyrosine, Tyr315, near the active site of A3B is in close proximity to C5 of the target cytosine in ssDNA. We have hypothesized that a nucleoside probe bearing a sulfonyl fluoride functionality at C5 could undergo nucleophilic attack by Tyr315 using the Sulfur Fluoride Exchange (SuFEx) click reaction resulting in the formation of an A3B-ssDNA covalent adduct. In order to deliver the sulfonyl fluoride to the active site of A3B, I propose incorporating a nucleoside analogue containing this functional group into a short ssDNA strand with a sequence known to bind to A3B, 5'–ATTATGTCGTATT–3'. Once formed, a fluorescence-based deaminase assay developed in the Harki lab will be used to evaluate the efficacy of our probe for inhibiting A3B enzymatic activity. This poster will highlight recent efforts in the development and synthesis of a ssDNA SuFEx probe.

82. **Erica Mitchell**
Multiconfiguration pair-density functional theory and its application to the Diels-Alder reaction
Advisor: Donald Truhlar
Sponsoring Program: UMN Chemistry - CTC
Home Institution: Taylor University
Abstract: Multiconfiguration pair-density functional theory (MC-PDFT) combines a modified density functional theory, a multiconfigurational wave function, and the on-top pair density to calculate the energy of a system. Although it has been applied to a wide variety of systems, including pericyclic reactants, it has not been used to study cycloadditions in depth. The Diels-Alder reaction of 1,3-butadiene and ethylene is of interest due to the history of conflict in determining its mechanism. This study will analyze the barrier heights and reaction energies in their relation to these past studies.

83. **Bonsa Mohamed**
Denitrification
Advisor: Nouf Aldossari
Sponsoring Program: Northstar STEM Alliance
Home Institution: land and atmospheric science umn
Abstract: Storm water, drainage, agricultural runoffs are the main contributor to our water source contamination. Spraying fertilizers result in high level of contamination of receiving waters both surface and underground causing Eutrophication. The excessive richness of nutrients in water body, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.
Microorganisms such as denitrifying fungi, nitrifying archaea play important role in. cleaning nitrates . NO3- to NO2- to NO to N2O.

84. **Ella Morone**
Lewis Acid-Base Contacts in Bridge-Flipped Benzylideneanilines: Crystal Structure of 4-Iodo-N-(4-pyridinylmethylene)benzenamine
Advisor: William Ojala
Sponsoring Program: University of St Thomas- Chemistry
Home Institution: University of St. Thomas
Abstract: We designate as "bridge-flipped isomers" those pairs of molecules that differ only in the orientation of a bridge of atoms connecting two major parts of the molecules. Examples are found among the benzylideneanilines, where the isomerism is Ar-CH=N-Ar' vs. Ar-N=CH-Ar', and among the phenylhydrazones, where the isomerism is Ar-NH-N=CH-Ar' vs. Ar-CH=N-NH-Ar' (Ar = aryl). We are searching for isomorphous pairs of bridge-flipped isomers using single-crystal X-ray diffraction, following the premise that similar chains of molecules linked by Lewis acid-base interactions between halogen atoms and nitrogen atoms in the two isomers might encourage their isomorphism. We have now determined the crystal structure of 4-iodo-N-(4-pyridinylmethylene)benzenamine, a benzylideneaniline incorporating both a Lewis acidic (iodine atom) and a Lewis basic (pyridine nitrogen) moiety. Our crystal structure analysis confirms the presence of such chains in this isomer. Unlike most other benzylideneanilines, the molecule is nearly planar, a conformation it maintains in two mercury complexes reported in the Cambridge Structural Database. Because many non-isomorphous benzylideneanilines conformationally differ in the sense of their twist out of planarity, the planarity in this molecule may facilitate its isomorphism with the bridge-flipped isomeric benzylideneaniline. Preparation of this bridge-flipped isomer with the goal of obtaining its crystal structure is in progress.

85. **Alyssa Moy**
Iron-oxide loaded polymeric scaffolds for non-invasive localized heating of metastatic ovarian cancer cells
Advisor: Samira Azarin
Sponsoring Program: MRSEC
Home Institution: University of Michigan
Abstract: Metastatic cancer is the spread of tumor cells from their primary site of origin to other areas of the body. There are few therapeutic options for its treatment because metastasis often remains undetected until the burden of disease is too high. Microporous scaffolds composed of poly(ε- caprolactone) (PCL) have the ability to capture metastatic cells when implanted into the body. To improve the therapeutic potential of these scaffolds, the Azarin Lab aims to use thermal therapy to destroy the tumor cells that accumulate within the scaffolds. Iron oxide (Fe_3O_4) was incorporated into the scaffolds to give them the ability to generate heat through electromagnetic induction by a magnetic field. The Fe_3O_4 particle size, Fe_3O_4 loading amount, and magnetic field strength parameters were first optimized to achieve ideal heating. Cancer cells were then seeded into the scaffolds and tested in the magnetic field. The *in vitro* results showed the iron oxide particles are nontoxic to cell proliferation and the heated PCL-iron oxide scaffolds were able to effectively destroy infiltrated tumor cells. These results give promise of the modified scaffolds as a successful metastatic cancer therapeutic. Further studies will investigate the therapeutic capabilities of the PCL-iron oxide scaffolds *in vivo*.

86. **Jackson Muehlbauer**
Synthesizing Near-Infrared Emitting Copper Indium Sulfide (CIS) Quantum Dots
Advisor: Vivian Ferry
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Copper indium sulfide (CIS) quantum dots are a promising material for use in luminescent solar concentrators (LSCs) due to their low toxicity and tunable luminescence to the near-infrared region. LSCs consist of embedded quantum dots (QDs) within a polymer that absorb sunlight from a wide range of wavelengths and angles. After light absorption, the QDs emit spectrally narrow light which is trapped inside the polymer by total internal reflection and concentrated to the edges of the device where a solar cell can be mounted. The focus of this study is to shift the emission of the CIS QDs to the near-infrared region to match the bandgap of silicon solar cells and to increase the quantum yield (QY) of the CIS QDs. To achieve these goals, the QD growth times have been increased which has resulted in both an increase in the quantum yield from 1.9% to 9.5% and a redshift of 18 nanometers. The quantum yield has also been improved by shelling the CIS QDs with zinc sulfide resulting in a QY of 42.3%. Elemental sulfur has been tested as a very reactive sulfur precursor intending to limit the number of surface defects and increase quantum yield.

87. **Emma Murphy**
Synthesis of [24]azacyclacene Via a Nitrogen-Doped Macrocycle
Advisor: Chris Douglas
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota
Abstract: Polyaromatic hydrocarbons (PAHs), particularly acene-derived materials, have been studied as organic semiconductive materials for low-cost electronics due to their unique optoelectronic properties. Cyclacene, a conjugated macrocycle consisting of laterally fused benzene rings, is a theoretical aromatic belt that would be the shortest zigzag carbon nanotube (CNT) with unique predicted electronic properties. It was first proposed in 1954 and while many attempts have been made, cyclacene has yet to be synthesized. An analogous heterocyclacene could be synthesized as a doped semiconductor and precursor for hetero-CNTs. One such heterocyclacene would be [24]azacyclacene, a nitrogen-doped acene macrocycle, which might be used as an n-type organic semiconductor since nitrogens would lower the energy of the lowest unoccupied molecular orbital of the □-system. As a never-before-synthesized aromatic belt, the synthesis of [24]azacyclacene would allow for investigation of its predicted electronic and physical properties. We plan to synthesize [24]azacyclacene through a nitrogen-doped macrocyclic precursor assembled from curved macromolecular building blocks via palladium-catalyzed Buchwald-Hartwig amination. Through a chiral assisted synthesis (CAS) strategy, using enantiopure starting material, we hope to promote a selective macrocyclic formation by directing chain growth towards a macrocycle. Via a double decarbonylative irreversible conjugation event, the macrocycle will be converted to the target azacyclacene.

88. **Emily Ness**
Investigating the order-to-disorder transition temperature for asymmetric core-shell bottlebrush copolymers
Advisor: Mahesh Mahanthappa
Sponsoring Program: MRSEC
Home Institution: Pacific Lutheran University
Abstract: Polymers are a growing field of interest in material science and engineering for their ability to self-assemble into varied microstructures with tunable domain sizes. Diblock and triblock copolymers are of particular interest in nanolithography and microchips due to their potential to reach sub-14-nm. This project seeks to investigate how molecular architectures effects order-to-disorder transition temperatures (T_{ODT}) and χN values by covalently pre-ordering triblock copolymers into core-shell bottle brushes (csBB). We are targeting hexagonally closed packed cylinders and then analyzing the transition to the disordered phase using temperature dependent SAXS studies. This csBB polymer structure is synthesized using a difunctional norbornene to initiate a sequential ring-opening transesterification polymerization (ROTEP) of ε-decalactone and lactide, followed by a ring-opening metathesis polymerization (ROMP) of the macromonomer to afford a poly(norbornene) backbone densely grafted with poly(ε-decalactone-*b*-lactide) arms.

89. **Mikayla Newby**
Synthesis and complexation of 1,3-bis [(2-pyridal)methyl]-1H-benzimidazolylidene with Eu(II), Ag(I), and Ca(II) ions
Advisor: Marites Guino-o
Sponsoring Program: University of St. Thomas
Home Institution: University of St. Thomas
Abstract: Magnetic Resonance Imaging (MRI) technique currently employs Gd(III) as a contrast agent due to its ability to shorten the relaxation state of water molecules. However, Eu(II) is being investigated as a replacement to Gd(III) due to its faster water exchange rate, which would give a better contrast. However, Eu(II) ions needs to be protected from O2 to prevent oxidation. Ligands that have strong donating abilities can help do this. Thus, the group's focus is to use N-Heterocyclic Carbenes (NHCs). In addition, only a few pathways exist towards the synthesis of Eu(II) organometallic species, so two separate routes are being explored here, the first being a direct oxidation using Ca(II) and the second, a redox transmetallation using Ag(I). Ca(II) and Eu(II) have similar reactivities, but Eu(II) is paramagnetic, so it is not ideal to be tracked through NMR spectroscopy. Diamagnetic Ca(II), however, can be studied through NMR solution studies and was synthesized as an analog model. Herein, we report our synthetic pathways coupled with the characterization results.

90. **Thai-Son Nguyen**
Lithium Hexaoxometalates - Potential Cathode Materials for Lithium-Ion Batteries
Advisor: Andreas Stein
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Augustana University
Abstract: The specific capacity of advanced anode materials for lithium-ion batteries exceeds 1000 mAh/g, but the specific capacity of cathode materials is limited to 150–200 mAh/g. Therefore, it is very important to increase the specific capacity of the cathode to improve the overall performance of Li-ion batteries. Previous work in our lab suggested Li_8ZrO_6 as a high capacity cathode material due to its high lithium content, a pseudolayered crystal structure that promotes efficient delithiation, and an unusual charge storage mechanism involving oxidation and reduction of oxygen. However, Li_8ZrO_6 is limited to low-power applications due to its poor conductivity. To address this limitation, we studied two high-lithium compounds, Li_7NbO_6 and Li_7TaO_6, as potential cathode materials that possess similar properties as Li_8ZrO_6 but have higher conductivity. Metal oxides (Nb_2O_5, Ta_2O_5) and lithium precursors were pyrolyzed under different conditions to yield nanosized Li_7NbO_6, Li_7TaO_6, and Li_7NbO_6/C and Li_7TaO_6/C nanocomposites with enhanced conductivity and minimal impurity phases. Galvanostatic charge-discharge tests of half-cells assembled using our nanocomposite cathodes showed reversible cycling, suggesting hexaoxometalates as potential cathode materials.

91. **Caitlin O'Callaghan**
Using AI to Reduce the Gender Disparity in Wikipedia Contents
Advisor: Haiyi Zhu
Sponsoring Program: Computer Science
Home Institution: University of Texas at Austin
Abstract: Despite Wikipedia's objective of being an encyclopedia with neutral perspectives, research has demonstrated that the user-contributed content does not adequately represent the diversity of society. Due to Wikipedia's primarily male demographics, the gender content gap has attracted much attention. This gap is reflected in Wikipedia articles of women's topics that lack adequate coverage, lack appropriate quality including unbiased perspectives, and are linked to by fewer articles in relation to those of men's topics. The goal of this research is to lessen the gender content gap in Wikipedia, which will positively influence those who use Wikipedia content directly, or indirectly through applications such as Google. Ultimately, the project seeks to achieve this by creating an AI tool that can give editing recommendations that identify content impacted by the gender gap and, in turn, maximize editing power and promote gender diversity.

92. **Kovic Odhiambo**
Geospatial Distribution of Cyanuric Acid Hydrolase and its Possible Benefits to our Natural Environment
Advisor: Larry Wackett
Sponsoring Program: Northstar STEM Alliance
Home Institution: University of Minnesota
Abstract: Cyanuric acid hydrolase is an enzyme that breaks down cyanuric acid, a chemical that is found in atrazine based fertilizers and other s-triazine pesticides. This enzyme breaks down cyanuric acid into carboxybiuret which is then broken down through either a decarboxylation to produce biuret, or a deamination reaction to produce dicarboxyurea. Both of these products are broken down into allophante which is then broken down into urea. This study explores the abundance of cyanuric acid hydrolase in natural environments previously explored by The Wackett Lab of bioremediation and biodegradation. With a privatized dataset containing over 50,000 amino acid sequences from different bacterial samples, it was found that cyanuric acid can be most commonly found in bacteria hosted by soybean and corn (2.2% and 1.2% abundance respectively. Cyanuric acid is also used in pool water to stabilize the chlorine levels necessary to keep the water in optimal conditions. Cyanuric acid hydrolase can therefore be used to keep cyanuric acid levels from increasing to harmful levels and increasing the amount of time pool water can last before replacement.

93. **Precious Ogiamien**
Discovery of Bacterial Antibiotic Producing Zones In Metro-Minnesota Topsoil.
Advisor: Jessica Bell
Sponsoring Program: Northstar STEM Alliance
Home Institution: Metropolitan State University
Abstract: AMR (antimicrobial resistance) is becoming a growing concern not just in the western hemisphere but on a global scale as a public health crisis. World wide, researchers are finding that the microorganisms (fungi, bacteria, viruses, parasites) in the soil are proving to be more resistant to antibiotics due to antibiotic residues entering the soil. This resistance has led to an increasing production of superbugs. As many as 700,000 people globally die from superbugs each year. Even new studies suggest an alarming death expectancy of 10 million people around the world each year by 2050 due to the spreading of drug-resistant diseases and new infection. According to the United Kingdom's government, these new infections would cost the world up to $100 trillion dollars. Antibiotics are a crucial factor needed to help humans, animals, and livestock fight against bacterial infectious like UTI's, pneumonia, strep throat, skin infections, and most ear infections. Efforts are being made worldwide to create a database of information from a collective student body to help solve the antibiotic crisis.

94. **Ruth Olson**
Ionic strength and polymer charge effects on flocculation performance in Taylor-Couette flow
Advisor: Cari Dutcher
Sponsoring Program: MRSEC
Home Institution: Northwestern University
Abstract: The removal of flocs, which are aggregates consisting of solid particulate, from source water is an essential part of the drinking water treatment process. To improve flocculation, salt can be added to increase the solution ionic strength. This creates a charge screening effect, which allows for aggregation of particulate. However, increasing the salt concentration would increase the load on reverse osmosis filters down the line, which is cost prohibitive. The addition of long-chained, charged polymer flocculants makes the flocculation possible without need for excess salt. Flocculation in a treatment tank is subject to a variety of hydrodynamic flow states, and isolating how they affect flocculation is difficult. A Taylor-Couette (TC) cell, which consists of two concentric cylinders where the gap between the cylinders can be filled with fluid, can generate precisely defined flow states at specific rotational speeds. The Dutcher group has built a TC cell with radial injection capabilities from the inner cylinder, therefore flocculation can be captured via image analysis from the start of the process. This TC cell will be used to study how different concentrations of NaCl and percentages of cationic charge on the polymer backbone impact flow dynamics and floc size, growth rate, and configuration.

95. **Chika Onubogu**
AGN Jets in Galaxy Cluster Shock: The Effects of External Magnetism on System Dynamics.
Advisor: Tom Jones
Sponsoring Program: Physics REU
Home Institution: Florida State University
Abstract: This project is an effort to explain the mechanisms behind what is observed in AGN jet processes in galaxy cluster environments. To supplement previous related projects concerning AGN jet interactions with shocked intracluster medium (ICM) material, we enhance this event by adding a uniform magnetic field of strength 2.1 μG to pervade the ambient, pre-shock ICM. By 3D magnetohydrodynamic (MHD) simulation, a pair of bipolar jets are ejected from a nondescript AGN source subsequently forming low density cavities about the jet cylinder. The jets remain active for the duration of the simulation; a time scale of about 230 Myr. Moving in a direction normal to the jet axis, a Mach-4 shock propagates within the plane of the jets, unsettling the previous state of the jets, the surrounding cavity, and the uniform magnetic field in the ICM. Although the implemented magnetic field in the ICM is very weak (similar to real physical conditions), we observe noticeable alterations in the flow dynamics and magnetic components of the jets and nearby AGN material compared to previous variations of this simulation where the ICM is unmagnetized.

96. **Levi Palmer**
Analyzing Plasmonic and Photonic Coupling in Butterfly Wings using Surface-Enhanced Raman Spectroscopy
Advisor: Renee Frontiera
Sponsoring Program: UMN Chemistry- Heisig Gleysteen
Home Institution: University of Minnesota TC
Abstract: Both plasmonic and photonic materials manipulate light by structurally-defined optical properties. While photonic architectures can promote the scattering and reflection of certain wavelengths of light, plasmonic materials have plasmon resonances that confine light at the nanoscale. Coupling photonic materials to plasmon resonances could enhance the plasmonic response via wavelength-dependent interference and confinement properties. Here we explore the use of wavelength-dependent, naturally-abundant photonic crystal structures found in butterfly wings as substrates for plasmonic nanoparticle deposition and probe the plasmonic-photonic interactions using surface-enhanced Raman spectroscopy. To better understand the wavelength dependence of field enhancement and localization of these systems, we examined the SERS responses of plasmonic nanoparticles deposited on four different butterfly wing colors with three excitation wavelengths. We find that excitation at wavelengths most closely matching the butterfly wing color produces the most intense SERS signal, with signal magnitude increases up to an order of magnitude. These naturally abundant photonic structures show potential to create cheaper, wavelength-selective SERS substrates, and they provide quantitative insight on plasmon-photonic crystal coupling.

97. **Danika Partridge,** Anil Pandey, Jorden Johnson
Thiazepane synthesis and development of derivatives with BRD4 activity
Advisor: William Pomerantz
Sponsoring Program: UROP
Home Institution: UMN
Abstract: Methodology for synthesizing thiazepane derivatives was developed and optimized to obtain a library of compounds. Thiazepane probes for bromodomain BRD4 were synthesized using this methodology, and affinities investigated with PrOF NMR and co-crystallization.

98. **Kaelan Patel**
Synthesis of Prazosin Analogs as Next-Generation Hypertensives
Advisor: Yuk Sham
Sponsoring Program: UROP
Home Institution: University of Minnesota
Abstract: 75 million Americans are affected by hypertension (high blood pressure). Mismanagement of hypertension can lead to stroke, vision loss, heart failure, sexual dysfunction, and kidney disease. Alpha-blockers were formally used for the treatment of hypertension. They target peripheral alpha-adrenergic receptors of the smooth vascular muscle, resulting in reduced arteriolar resistance and increased venous capacitance, thus lowering blood pressure. However, alpha-blockers can also affect cardiac alpha-1a adrenergic receptors (a-1AR), that offer cardioprotection and prevent pathological remodeling of the heart, leading to an increased risk of heart failure. Since a-1AR is located primarily on the nuclear membrane of cardiac muscles, re-designing alpha-blockers with reduced cellular permeability can potentially reduce the risk of heart failure. Previously, we have performed homology modeling and molecular dynamics simulation of a-1AR to elucidate the potential mode of binding of Prazosin and other clinical alpha-blockers. In this study, the synthesis of Prazosin is explored for deriving future analogs, which can be evaluated for its functional efficacy as restored second-generation hypertensives.

99. **Samuel Powell**
Localized Active Space Self-Consistent Field treatment of $Cu_2O_2^{2+}$: Accuracy and Affordability
Advisor: Laura Gagliardi
Sponsoring Program: UMN Chemistry - CTC
Home Institution: Ohio Northern University
Abstract: Multi-reference calculations are necessary for accurate descriptions of electronic structure for a large variety of molecules. However, these calculations suffer from exponentially scaling computational cost. Localized Active Space Self Consistent Field (LASSCF) calculations can be used to reduce this cost in systems with multiple fragments with strong correlation within them but only weak correlation between them. LASSCF treats a system's active orbitals by localizing them over several fragments that are treated as unentangled active sub-spaces. Here we investigate $Cu_2O_2^{2+}$-based systems, which are known to have complex electronic structures and are biologically relevant. $Cu_2O_2^{2+}$ species are found in natural metalloenzymes that oxidize various substrates using molecular oxygen.[2] The most accurate theories are often prohibitively expensive for systems even as small as $Cu_2O_2^{2+}$. We investigate the accuracy of LASSCF for this system. The energy differences between the bis-μ-oxo and peroxo structures are calculated using LASSCF and are compared to the corresponding CASSCF energies. Various active spaces are chosen for this comparison and a variety of fragmentation schemes are tested for LASSCF.

100. **Jacob Rankin**
Design and Manufacture of High Force, Soft Robotic Actuators
Advisor: Steven Thomalla
Sponsoring Program: CCEFP
Home Institution: Georgia Institute of Technology
Abstract: Little knowledge exists pertaining to the design and manufacture of high-force, soft robotic actuators. Soft robotic technology has a myriad of potential applications including subterranean burrowing, underwater anchoring, and avalanche rescue. This research focuses specifically on burrowing applications. The objective is to design simple manufacturing and testing methods for radially expanding soft robotic actuators. These actuators consist of an elastic epoxy resin wrapped with inextensible fibers. The angle at which the fibers are wrapped governs the direction in which the actuator expands. The goal was to design, manufacture, and test an actuator wrapped with fibers at such an angle that the actuator expands in the radial direction while its axial length remains constant. Such an actuator would be able to anchor itself in the ground with radial force, making it useful for burrowing applications. The result of our research was a manufacturing method for a simple, robust, radially expanding soft actuator. Future research will entail testing the radial forces generated by the actuators and exploring the usability of the actuators in various robotic mechanisms.

101. **Melissa Rey**
Investigating the Thermosalient Effect of 1,2,4,5-Tetrabromobenzene using Femtosecond Stimulated Raman Spectroscopy
Advisor: Renee Frontiera
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Wesleyan College
Abstract:

102. **Clara Richter**
Touch Interaction Techniques for Hybrid Augmented Reality (AR) Displays
Advisor: Daniel Keefe
Sponsoring Program: Computer Science
Home Institution: Mount Holyoke College
Abstract: Why only look at data representations when you could interact and touch them as well? Large data sets are most often distilled for researchers, such as scientists, engineers, doctors, or even the general public, through complex visual displays, frequently viewed on a computer. This project proposes a more effective means for researchers to interact with large data sets in a physical as well as visual way. We hypothesize the combined interaction of vision and touch will be a more effective means for researchers to interact with large datasets, leading to a better understanding of spatial relationships. This poster demonstrates the specific techniques used to develop a prototype that successfully integrates a touch interaction technique with a software's visual display in the form of particles flowing through a cross-section of a pipe. This technique can be applied to ocean current data. For example, the hybrid AR display could be used to determine, given the direction and speed of ocean currents displayed through AR, how an oil spill would behave in regard to different starting locations, motivated by touching a 3D bathymetry model.

103. **Daniela Rivera Mirabal**
One-pot Synthesis of Telechelic PLLA
Advisor: Marc Hillmyer
Sponsoring Program: Center for Sustainable Polymers
Home Institution: University of Puerto Rico-Mayagüez Campus
Abstract: As environmental concerns rise about plastic use and production, an interest in developing competitive materials from bio-renewable feedstocks has surfaced. This summer a one-pot synthesis of sustainable Poly-L-Lactide (PLLA) with a lactone chain end was studied to access more complex, degradable and biobased polymer architectures (e.g., thermoplastic elastomers). Polymers of molar masses ~2,000 $g.mol^{-1}$ were targeted to have a clear chain-end characterization. Starting from 4-hydroxycyclohexanone (a cyclic ketone) as the initiator, L-Lactide was polymerized in bulk using an organocatalyst (1,8-Diazabicyclo[5.4.0]undec-7-ene, DBU). Polymerization was stopped with acetic acid and the hydroxyl end group was acetylated using acetic anhydride. Samples were analyzed after each step by ^{1}H NMR, chloroform SEC and MALD-TOF. Without purification, the ketone chain-end was then oxidized using 3-chloroperbenzoic acid (mCPBA) in ethyl acetate. After one hour, the complete conversion was obtained, and the purified sample was analyzed by ^{1}H NMR, SEC and MALDI-TOF. This one-pot synthesis significantly reduces solvent usage, leading to a simple and efficient environmentally friendly procedure. This modified PLLA will undergo graph-through polymerization of the lactone chain-end with γ-methyl-ε-caprolactone (MCL) to obtain an industrially competitive, renewable and degradable thermoplastic elastomer.

104. **Denis Rybkin**
Loop-free Resilient Routing Under Arbitrary Network Failures
Advisor: Zhi-Li Zhang
Sponsoring Program: Computer Science
Home Institution: University of Minnesota, Twin Cities
Abstract: Routing is a central problem in many types of networks from communications, transportation to social networks. With the increasing scale of networks, link or node failures are inevitable. Resilient routing, namely, the ability to continue routing operations without forwarding loops under failures is critical. Purely distributed routing algorithms such as Bellman-Ford suffer from the "count-to-infinity" problem, whereas Dijkstra's algorithm requires global topology dissemination and route-recomputation. Much of the recent literature on resilient routing has devoted to how to design proactive routing algorithms with pre-computed routing state (and limited local route exchanges or updates) that are resilient to k link/node failures for a constant k (and often placing topological constraints on the graphs). None of them work under arbitrary link failures. In this poster, we will demonstrate an efficient proactive routing algorithm that attains optimal resiliency, namely, it ensures connectivity between any pair of nodes under arbitrary failures that do not partition a network (graph).

105. **Meena Saechao**
Determining the Effect of Aging on Cholesterol in Rattus L6 Skeletal Muscle Cells Using a Fluorescence based Assay
Advisor: Edgar Arriaga
Sponsoring Program: Project SEED
Home Institution: Washington Technology Magnet High School
Abstract: As people age, health complications occurs due to aging. This results the cells in the body not functioning as well as before. Cholesterol concentration in the cell plays a part of cellular aging: it increases with age. Understanding how cholesterol is distributed and how this can be affected by aging can allow targeting of the aging process. The parts of the cell that were measured were cytosol, mitochondria, and nucleus. Cells were harvested separated into subcellular components and extracted to obtain cholesterol and protein. These samples were used to run the DC- Assay and the Amplex® Red Assay alongside with the standards. The DC- Assay was used to provide protein content information for normalizing the data with the cholesterol concentration from Amplex® Red. Protein content showed the most in the nucleus of the cell compared to the other organelles that were measured. Cholesterol distribution results can later be used to compare with a cellular model of aging to see how cholesterol distribution is affected by aging.

106. **Cole Scholtz**
Rational Design of Small Molecule Inhibitors for BPTF and the Determination of Their Binding Affinity
Advisor: William Pomerantz
Sponsoring Program: UMN Chemistry- Lando
Home Institution: University of Central Missouri
Abstract: Bromodomains are multi-domain proteins involved in binding covalently modified histones, often recruiting external transcription factors as a result. In doing so, bromodomains hold a pivotal role in epigenetic gene expression. Specifically, Bromodomain PHD-finger Transcription Factor (BPTF) has been linked to various diseases, including glioma, inflammation, and leukemia, making it a potential therapeutic target. Small-molecule probes are therefore imperative for furthering our understanding of the biological functions of BPTF. However, few biological probes are known with desirable physical attributes that strongly bind BPTF selectively. Previous work and docking studies have revealed pyridazinone derivatives as potential selective inhibitors for bromodomains that are similar to BPTF. Here, we use rational design to influence the selectivity of pyridazinone moieties towards BPTF. Potential small-molecule inhibitors can then be screened using biophysical assays, including protein-observed ^{19}F (PrOF) NMR spectroscopy and competitive AlphaScreen assays, to determine both their selectivity and binding affinity. These scaffolds can then be used in the development of orthogonal biophysical assays for BPTF, as well as serve as potential therapeutic scaffolds for drug design.

107. **Byron Seth**
Using Multiple RNAi Lines for RNA Binding Proteins to Categorize Phenotypes, and Molecular Assay in Babo Alternative Splicing.
Advisor: Aidan Peterson
Sponsoring Program: Northstar STEM Alliance
Home Institution: Bemidji State University
Abstract: Tgf-beta signaling is a required pathway for developmental activities in the animal kingdom. This is because of the communication between ligands and receptors. In the Drosophila melanogaster activin branch there are three ligands and only one Type I receptor called Babo. The Babo receptor has three spliced isoforms (Isoform a, b, and c). In this research we are seeking to define RNA binding proteins that regulate tissue specific splicing of the Babo transcript. To carry out this experiment we crossed multiple RNAi lines for RNA binding proteins with DA-GAL4 driver which is expressed throughout the whole animal. We are cataloging phenotypes, and molecularly assaying Babo alternative splicing events.

108. **Andy Sheng**
Curved Emergent Dimension from Strong Interactions
Advisor: Aleksey Cherman
Sponsoring Program: Physics REU
Home Institution: Cornell University
Abstract: The SU(3) gauge theory in QCD is difficult to solve due to strong coupling. However, taking a YM-like SU(N) gauge theory on a R3 x S1 geometry and making the circle size small result in weak coupling and a three-dimensional effective theory, allowing properties of the theory to be calculated. One finds, subsequently, that upon taking a large-N limit, a new spatial dimension, different from the pre-existing ones, emerges. Adding fundamental fermion fields to the present adjoint matter causes the fermions to localize on three-dimensional branes in the four-dimensional theory and leads to curvature and horizons in the emergent dimension. Curvature strengths and horizon locations are found to be dependent on the number of fermionic fields added.

109. **Claire Shugart**
Machine Learning of Active Space Selection for Diatomic Molecules
Advisor: Laura Gagliardi
Sponsoring Program: UMN Chemistry - CTC
Home Institution: Carleton College
Abstract: Appropriate active space selection for complete active space self-consistent field and complete active space second-order perturbation theory is necessary for accurate results. Machine learning can be used to select an active space provided that the training set includes appropriate active spaces based on size and accuracy. This project explores active space selection for first and second row diatomic molecules using the representative examples H2 and N2. Illustrated by H2 is a minimal active space that produces a potential energy curve almost identical to that of substantially larger active spaces. N2 Demonstrates active spaces producing poor potential energy curves. Both examples demonstrate the selection of appropriate orbitals to include in an effective active space. For five of 23 diatomic molecules, a sufficient active space can be found using 10 or fewer orbitals. Nevertheless, other active spaces must include even more orbitals. Other active spaces produce seemingly reasonable results but only due to large error cancelation. All of these common and exceptional cases of accurate active spaces are important to a successful machine learning training set so as to make methods involving active space choice more accessible.

110. **Andrew Smith**
H-Bonding Motifs in the Crystal Structures of D-Mannose Schiff Bases
Advisor: William Ojala
Sponsoring Program: University of St Thomas- Chemistry
Home Institution: University of St. Thomas
Abstract: Reaction of D-mannose with anilines tends to yield glycosylamines as the crystalline product, while reaction with phenylhydrazines tends to yield Schiff bases (phenylhydrazones). We have recently prepared the 4-fluorophenylhydrazone, the 2-fluorophenylhydrazone, and the 2-pyridinylhydrazone of D-mannose and have determined their crystal structures by single-crystal X-ray diffraction. The two fluorophenylhydrazones are isomorphous with each other and with the previously reported phenyl and 4-bromophenyl derivatives. All four possess a quadrilateral hydrogen-bonded motif defined by corresponding hydroxyl groups and reported by previous workers to occur also in several other open-chain sugars that crystallize in different space groups and possess different chirality. In contrast, the 2-pyridinyl derivative assumes a different crystal structure that lacks the quadrilateral motif, an absence also noted in the previously reported crystal structure of the open-chain D-mannose oxime. In these two structures the quadrilateral motif is disrupted by H-bonding interactions involving the nitrogen-containing functional group and the terminal (C6) hydroxyl group of neighboring molecules, and a twelve-membered ring motif involving only hydroxyl groups is observed instead. In future studies we will evaluate these and other H-bonding motifs in both the glycosylamines and the Schiff bases for their frequency of occurrence and their potential applicability in crystal engineering.

111. **Alexander Stahl**
Systematic resistivity measurements of NiS_2 crystals as a function of thickness
Advisor: Chris Leighton
Sponsoring Program: MRSEC
Home Institution: Carleton College
Abstract: FeS_2 has been identified as a potential material for thin-film solar cells. In our search of other possible materials for use in thin-film solar cells, we decided to study NiS_2. Relative to FeS_2 not much work has been done on understanding its basic properties. Without a better understanding of the basic properties of NiS_2 any in depth research would be less productive than it otherwise could be. To this end, we have systematically studied the resistivity of NiS_2 single crystals from 10 K - 300 K, as a function of thickness. We have found that polished NiS_2 crystals share the same characteristic transition from bulk to surface conduction around 125 K as they are cooled. These results lead us to believe that there may be possible future uses for NiS_2, as they match those seen in previous FeS_2 studies. From our results, we will remain interested in NiS_2, but still must conduct more fundamental studies of crystalline NiS_2 to gain a proper understanding of the material.

112. **Jeanine Thao**
Learning to Control an Inverted Pendulum using Deep Q-Network
Advisor: Changhyun Choi
Sponsoring Program: Northstar STEM Alliance
Home Institution: Univerisity of Minnesota Twin Cities
Abstract: Robotics and Artificial Intelligence (AI) research are becoming the next big thing as more and more people are researching it. There are many fields of research within the Robotics and Artificial Intelligence ranging from underwater navigating robots to outer space exploration robots. Simpler studies involve movements of robots such as the arms in the case of this research topic. To understand more about the movements of the robot arm, an understanding of Pytorch, Deep Neural Networks, and Deep Q-Network (DQN) is needed in order to program the arm. Pytorch is an AI programming language integrating Python and Torch language, whereas Deep Neural Networks is a deeper concept of neural networks through backpropagation to extract features for representation. DQN is the first deep reinforcement learning. It is an algorithm that deals with unstable learning through 4 different techniques: Replay Memory, Target Network, Clipping Rewards, and Skipping Frames. Hence, in this research Pytorch, Deep Neural Network, and DQN are better understood through an inverted pendulum simulation using AI Gym environment.

113. **Diamond Thlang**
Expression and Development of 5-fluoro-tryptophan CECR2 for Bromodomain Profiling and Small Molecule Affinity Assessments
Advisor: William Pomerantz
Sponsoring Program: Project SEED
Home Institution: Harding Senior High School
Abstract: Bromodomains are protein domains comprised of 110 amino acids and are known for their integral role in post-translational modifications - the ability to recognize acetylated lysine residues on the N-terminus tail of histones. Their role is colloquially termed as "readers" in the histone code hypothesis. Deciphering the multifaceted process of bromodomains in post-translational modifications is key to understanding more about how cells differentiate in diseases - ultimately enhancing the comprehension of epigenetics and site-specific therapeutics. BPTF is a bromodomain of considerably high interest in our lab and the scientific community for its transcriptional regulation in neurodegenerative diseases such as Alzheimers. However, attempting to gain inhibitor selectivity for BPTF has proven to be challenging as BPTF has other closely-related bromodomains such as CECR2. To overcome this, we express unlabeled CECR2 through a 1H CPMG assay followed by an expression of fluorinated CECR2 with a Protein-Observed Fluorine NMR assay. This is followed by an in-house affinity assessment allowing us to test small molecules for CECR2 selectivity. Ultimately, the aim of this research is to facilitate the discovery of BPTF-selective small molecule inhibitors for the development of therapeutic scaffolds and further studies of BPTF in healthy and diseased states.

114. **Alexander Thome**, Cynthia G. Pyles
Charting the Dissociation Pathway of a Manganese-based photoCORM with 2D-IR Spectroscopy
Advisor: Aaron Massari
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Murray State University
Abstract: Carbon monoxide (CO) is toxic when inhaled at high concentrations, but it exists naturally in small concentrations in the human bloodstream as a small biological signaling molecule. Tissue-specific CO delivery could have widespread therapeutic applications; however, the delivery methods require further development. One promising approach under recent investigation is the use of CO-releasing molecules (CORMs). These structures typically contain transition metals complexed with CO ligands that dissociate in response to a trigger, such as light. CORMs and their respective dissociation products must be identified to ensure that there is no cytotoxicity. The current literature has not identified the intermediates of many CORM dissociation pathways. To identify these intermediates, we use two-dimensional infrared (2D-IR) spectroscopy. Specifically, we examine the possibility of vibrational coupling between certain modes that appear during the dissociation of the light-activated CORM fac-[Mn(CO)3(dimethyl-[2,2'-bipyridine]-4,4'dicarboxy)Br]. The 2D-IR spectrum shows clear evidence of vibrational coupling, which will help determine the structures of the corresponding intermediates. If the dissociation products of this molecule are not cytotoxic, this CORM could serve as a model for an effective CO delivery system.

115. **Seth Thompson**
Construction of an Inducible Genetic Cascade Based on the MalT Regulon of E. coli in TXTL
Advisor: Vincent Noireaux
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Modern genetic tools and methods require specific genetic induction for experiments in order to isolate and control conditions for studying kinetic biological systems. The purpose of this study was to construct a synthetic gene regulation mechanism based on an inducible metabolite, maltotriose. Existing synthetic biology methods were used to engineer a genetic cascade that can be activated with maltotriose, based on the malT regulon in native E. coli. This study found that the engineered malT regulon stoichiometrically and specifically responded to the presence of maltodextrins of variable residue lengths directly derivative of maltotriose. The presence of disaccharides structurally similar to maltose and simple monosaccharaides showed little to no induction of the genetic circuit. The understanding of this operon will aid in the progression of the project to create synthetic and minimal cells through use of engineered regulons and will further the understanding of the regulatory actions of transactivator proteins.

116. **Grace Tian**
Oracle Efficient Algorithm for Differentially Private Synthetic Data Release
Advisor: Steven Wu
Sponsoring Program: Computer Science
Home Institution: Harvard University
Abstract: Differential Privacy is a promising field in data science that allows for privacy-preserving data sharing. We present an oracle efficient, differentially private algorithm that synthesizes fake data to answer queries on high dimensional datasets accurately. We solve the query release problem with a game-theoretic approach that combines Follow the Perturbed Leader with Exponential Mechanism. Our algorithm reduces a computational bottleneck to an optimization problem solved with an optimization oracle. The worst case of our algorithm is more sample efficient than the DualQuery algorithm by Gaboardi et al. We prove accuracy and privacy theorems for our algorithm and show that our algorithm works well in practice.

117. **Marina Tschida**
Modeling Behavioral Changes in Soft Material to Mitigate Radiolysis Damage while using Transmission Electron Microscopy
Advisor: David Flannigan
Sponsoring Program: MRSEC
Home Institution: University of Wisconsin - Madison
Abstract: The transmission electron microscope (TEM) has proven to be a powerful tool in quantifying material behavior. Fundamentally, this microscope uses electron scattering to produce contrast images of the sample. This contrast allows for three-dimensional information to be depicted on a two-dimensional image with incredibly high resolution. Despite this, resolution is limited by the damage induced to the sample due to TEM electron interactions with the specimen. Among other mechanisms, radiolysis damage, or the atomic ionization damage caused by inelastic collisions, has proven to be problematic when studying the behavior of soft materials. These collisions alter material behavior– fundamentally preventing a single, isolated variable to be studied. A deeper understanding of these interactions will ultimately aid in mitigating the effects of induced specimen damage. To accomplish this, the behavior of n-hexatriacontane under a TEM electron beam has been studied and observed to exhibit density contour relaxations and eventually lose all contrast: universally meeting Bragg's Law yet maintaining crystallinity. Modeling this behavior allows for the analysis of material behavior changes when exposed to a given electron dosage. Determining a relationship between electron dosage and soft material behavior aids in the development of a TEM methodologies, and thus widens applications of TEM technology.

118. **Nora Vail**
Synthesis of GPCR Ligands Using Allylic Azides
Advisor: Joseph Topczewski
Sponsoring Program: UMN Chemistry- Lando
Home Institution: Ithaca College
Abstract: In my work with the Topczewski group, I have synthesized novel functionalized pyrrolidine compounds that have shown activity against a variety of G-protein coupled receptors (GPCRs). I will be presenting on the compounds we have synthesized over the course of this project. Upon completion of the synthesis, we plan have these compounds assayed against several GPCRs for biological activity.

119. **Viktoriia Vernadskaia**
Computational design of self-assembled amphiphiles to achieve small domain size
Advisor: Ilja Siepmann
Sponsoring Program: UMN Chemistry - CTC
Home Institution: ITMO University, Saint Petersburg, Russia
Abstract: In microelectronics industry, there is a growing need for microprocessors which can accelerate computing speed and enhance storage capacity. To access these properties, miniaturization of feature size below 10 nm must be provided. Smaller domain sizes can be obtained from surfactant with polyalcohol head and alkyl tail self-assembly, due to the dislike interaction between head and tail groups, as well as their much shorter chains than conventional block copolymers. To investigate the microphase separation of amphiphiles, molecular dynamics (MD) simulations in the NpT ensemble using TraPPE-UA forcefield were conducted on amphiphiles with different alkyl chain length and different number of hydroxyl groups under wide temperature ranges. The initial structures were generated via the MC (Monte Carlo) simulations. The observed morphologies agree well with the calculated structure factors and angular distributions of the neighboring alkyl arms. Based on results obtained, ordered lamellae morphology for polyalcohol surfactant with 4 hydroxyl groups and 6-12 carbons in alkyl chain under the temperatures of 450, 500 K was observed. Same morphology was noticed for amphiphile with 3 hydroxyl groups and 10 carbons under 400 K. For structures with 6 and 8 carbons perforated lamellae were obtained under 400, 450 K.

120. **John Vue**
Comparing The Reactivity of Phenyl Hydrazine and O-Phenyl Hydroxylamine with Aldehydes to Develop a Chemical Sensor
Advisor: Philippe Buhlmann
Sponsoring Program: Project SEED
Home Institution: Washington Technology Magnet High School
Abstract: Currently, disease diagnosis techniques are quite invasive to the body and so research is being done to create improved diagnosis methods. Recent research studies have shown that cancer patients have higher concentrations of certain molecules, for example, aldehyde groups are known to be present in higher concentrations in people with lung cancer than your average person. Therefore, developing an aldehyde sensor would help medical institutes diagnose lung cancer in a non invasive way. This research project compares the reactivity of the probes phenylhydrazine and O-phenylhydroxylamine with aldehyde derivatives using NMR spectroscopy to find out which molecule is more suitable in the development of an aldehyde sensor. Throughout experiments, solutions of each probe with specific aldehydes were made and reactions were monitored using a 500 MHz Bruker NMR instrument. The reaction times of both probes were compared and determination of equilibrium and kinetics data was attempted. Both of the probes data progressed in a direction that was desirable though the phenyl hydrazine probe seemed to show a more favorable result thus making it more suited for the development of an aldehyde sensor.

121. **Destiny Weaver**
A comparison of the globus pallidus and subthalamic nucleus as stimulation targets for alleviating gait disturbances in Parkinson's disease: a pilot study
Advisor: Colum MacKinnon
Sponsoring Program: Northstar STEM Alliance
Home Institution: University of Minnesota - Twin Cities
Abstract: Parkinson's disease (PD) is a progressive neurological condition associated with gait disturbances that can be treated with deep brain stimulation (DBS) of the globus pallidus (GP) or subthalamic nucleus (STN)[1]. Increases in gait speed during GP-DBS may be driven by step length and cadence, whereas for STN-DBS, speed may improve via step length changes [2-6]. We examined the influence of DBS on gait speed, cadence, and step length. Temporal and spatial gait data (GAITRite Electronic Walkway, CIR Systems Inc.) were collected from eight participants (STN: four unilateral; GP: two unilateral and two bilateral). Gait was assessed OFF medications under varying stimulation conditions: OFF, ON clinical, and 2 model-based settings (dorsal and ventral contacts). STN participants were additionally assessed prior to surgery ON and OFF medications. Clinically meaningful improvements were seen in gait speed after GP-DBS compared to OFF stimulation. STN-DBS showed variable effects on gait speeds, but speeds did not the reach pre-surgery ON-medication condition. Seventy-seven percent and forty-six percent of the change in gait speed was caused by a change in step length, in STN and GP-DBS, respectively. More participants are required to determine the effect of stimulation location on the relationships between gait speed, cadence, and step length.

122. **Luke Westawker**
Synthetic Tailorability and Conductive Properties of pi-conjugated Molecular Wires
Advisor: Daniel Frisbie
Sponsoring Program: MRSEC
Home Institution: Carleton College
Abstract: Molecular wires are molecules capable of efficiently transporting charge across long distances by utilizing their pi-orbitals. Their ability to transport charge is used in technological applications ranging from OLED displays to solar cells. Molecular electronics are beneficial as their electrical properties can be tailored toward applications using synthetic modifications. I investigate how synthetically misaligning the pi-orbitals in a molecular wire affects the wire's ability to conduct charge. Computational studies show that adding methyl groups to a normally flat molecular wire creates a non-flat wire. The consequential misalignment of the orbitals means that the pi-orbitals stop overlapping, therefore we hypothesize that electrons can no longer easily travel across the molecule thus changing the molecule's method of charge transport from quantum tunneling to hopping. To study this, we grow thin pi-conjugated molecular films on gold substrates and use Schiff base chemistry to create wires with our desired synthetic modifications. FT-IR analysis of the gold substrates allows us to characterize the wire's composition while a customized AFM device characterizes the electronic properties of the different molecular wires. This fundamental research shows how synthetic modifications can be used to tailor the electronic properties of molecular wires allowing for future optimization of molecular electronics.

123. **Carolyn Wood**
Electrochemical Synthesis of Tellurium Thin Films and Nanowires
Advisor: Beth Stadler
Sponsoring Program: MRSEC
Home Institution: Carleton College
Abstract: The synthesis of tellurium nanowires is of particular interest because of their potential applications to topological quantum computing. In our research, we produced nanowires inside a nanoporous anodic aluminum oxide template via an electrochemical deposition procedure. We used an electrolyte solution of tellurium dioxide dissolved in boric acid. We then characterized our nanowires using X-ray diffraction, scanning electron microscopy, and conductance measurements to determine their structural and electrical properties. We found that we were able to grow uniform tellurium nanowires that exhibited quantized conductance, indicating that the wires could be applied to quantum computing.

124. **Peiyao Wu**
First principle molecular simulation of unary adsorption: N2, Ar in zeolite BCR-704 (Ca37Al74Si118O384)
Advisor: Ilja Siepmann
Sponsoring Program: UMN Chemistry - CTC
Home Institution: Emory University
Abstract: The Monte Carlo simulation uses force field based on classical mechanics and incorporates Lennard-Jones 12-6 potential and Coulomb interaction, has been reliable in reproducing most phase equilibria data.
The previous study of N2, Ar adsorption in zeolite BCR-704 using TraPPE TraPPE (Transferable Potentials for Phase Equilibria), however, yielded results that led to improbable explanations. In this study, to account for the polarizability of adsorbate molecules and possible charge transfer between zeolite atoms, first principle molecular simulations were carried out using Density Functional Theory with the functional PBE-D3. This ab initio MD showed more realistic interaction between polarizable adsorbate molecules and zeolite, as well as the possibility for future ab initio GEMC in a large system of many atoms.

125. **Chittra Xiong**
Formation of Nanopores in a Polymer Monolith Through Cleavage of Bulky Side-Groups
Advisor: Marc Hillmyer
Sponsoring Program: Project SEED
Home Institution: Como Park Senior High School
Abstract: Uniformly-sized pores are needed for applications including water filtration and templating for semiconductor fabrication. Conventionally, porous membranes have large variabilities in pore size. Block polymers offer a scalable path to produce materials with nearly uniform pore sizes. These polymers are typically processed to allow microphase separation of the two blocks, followed by fully chemically etching away one of the blocks (e.g., hydrolysis of polyesters). In this study, we explore an alternative strategy in which the pore-forming block is etched by cleavage of reactive, bulky side-groups. In particular, we convert poly(di-boc acrylamide) (PDBAm) with a monomer molar mass of 271 to poly(acrylamide) (PAm) with a monomer molar mass of 71—in total, a 74% mass loss. We use the polymerization-induced microphase separation method to make microphase separated materials. Then ammonia solutions were used to etch the bulky side-groups of PDBAm. The sample is then analyzed using infrared spectroscopy to determine the percent conversion from poly(di-boc acrylamide) to poly(di-boc acrylamide). The scanning electron microscope is also used to examine the arrangement of pores and their diameter. Future work will focus on making functional membranes and test their performance in water filtration.

126. **Qeng Xiong**
Convergent Synthesis: Selective Enzyme Labelling of GGTase and RabGGTase for Prenylation Disease Research
Advisor: Mark Distefano
Sponsoring Program: Project SEED
Home Institution: Washington Technology Magnet High School
Abstract: Protein prenylation is a post-translational modification and attachment of a 15 or 20 carbon isoprenoid to a cysteine at the C-terminus of a protein. Prenylation encompasses three enzymes that carry out this modification on proteins that regulate essential cellular functions: farnesyl transferase (FPPase), and geranylgeranyl transferase type 1 (GGtase) and type 2 (RabGGTase). These enzymes are able to transfer analogues of their native substrates, farnesyl diphosphate (FPP) and geranylgeranyl diphosphate (GGPP) respectively. This has lead to the development of FPP analogues with alkynes for the study of diseases. Unfortunately this analogue is not selective for one enzyme in particular and targeting specifically GGTase and RabGGTase. As GGTase and RabGGTase are suspected to have specific roles in some diseases, finding a way to study them individually will be key in gaining a better understanding of the role of prenylation disease. Developed here is the convergent synthesis of two geraniol based precursors. The first geraniol reaction will go through protection, oxidation, reduction, and chlorination. The second geraniol reaction will go through sulfonation, oxidation, reduction, and protection. By attaching two synthesized geranyl compounds, we can form an TBDMS-C10-TS-C10-OTHP scaffold. This can be further developed into an alkyne containing GGPP analog.

127. **Serdar Yalvac**
A Method to Measure the Electrophilic Activities of Organocatalysts
Advisor: Steven Kass
Sponsoring Program: UROP
Home Institution: University of Minnesota Twin Cities
Abstract: Synthesis in chemistry can make way for useful creations that contribute to our daily lives, especially when reactions are carried out in a systematic and planned way. Species called catalysts are utilized in reactions to attain more efficient results in shorter periods of time. While increasing product selectivity and sustainability, they also decrease costs and energy usage. Thoroughly analyzing the properties of catalysts is essential to optimize their usage. My research focused on improving a method for measuring the reactivity of catalysts with a colorimetric sensor. I tracked the sensor`s sensitivity to a variety of catalysts with different structures via UV-visible spectroscopy. The effect of acidity on the change in absorbance values were reflected on the spectrums, specifying which species are more reactive, and therefore more efficient. However, since very small concentrations were used during the measurements, the accuracy of my results were questionable. By making the necessary adjustments to prevent evaporation and inadequate mixing, I was able to keep the absorbance measurements constant during measurements. This decreased the overall error percentage significantly. Thus, by improving the precision of this method I was able to accurately determine the efficiencies of catalysts, which will be helpful in maximizing their usefulness.

128. **An Yang**
Techniques for the discovery of novel natural products from soil bacteria
Advisor: Erin Carlson
Sponsoring Program: UMN Chemistry- Lando
Home Institution: University of Central Arkansas
Abstract: Natural products are structurally complex small molecules produced by microorganisms, fungi, and plants. They play a vital role in modern drug-based therapy of various diseases, notably 75% of antibiotics are natural products or derived thereof. After the discovery of penicillin and streptomycin, a domino effect began, leading to an expanding library of antibiotics. However, after 1970, the rate of discovery declined progressively due to the rise of antimicrobial resistance and drug rediscovery. Recently, the sequencing of Streptomyces coelicolor genome revealed that each strain can produce 20 or more potential secondary metabolites, while only a low fraction are expressed during standard fermentation conditions. Thus, new methodologies are needed for the activation of these cryptic gene clusters to revive the stalled drug discovery pipeline. One technique studied in this research is through the use of the natural products from the other soil bacteria as elicitors for the triggering of the cryptic gene clusters and thereby, producing potential novel secondary metabolites. Current mass spectrometry-based data shows promising results of activation and metabolite production, but further technique development is underway to identify elicitors. Once the elicitors have confirmed their functionality, their mechanism of action can be studied to further understand bacterial cell communication.

129. **Morgan Young**
Understanding Catalyst Flexibility and its Effect on the Ring-Opening Polymerization of Cyclic Esters
Advisor: Theresa Reineke
Sponsoring Program: Center for Sustainable Polymers
Home Institution: University of Michigan
Abstract: Sustainable alternatives to polymers made from petrochemical materials are a growing need, and polyesters from bio-derived lactones serve as promising substitutes due to their degradability. However, to make sustainable polymers competitive with industrially relevant petrochemical plastics, it is necessary to understand the fundamental aspects of the ring-opening polymerization (ROP) by which these materials are made. Previously, it has been found that altering ROP catalyst parameters such as electronics, sterics and flexibility of the surrounding ligand framework may affect the rate of polymerization. Specifically, salen-Aluminum catalysts have been studied, due to their ability to produce high molecular weight polymers while maintaining control and producing moderate rates that can be easily measured by NMR spectroscopy. While a variety of catalyst alterations have been explored, mononuclear catalysts with increased flexibility (i.e. backbones containing > 3 carbons) have not been thoroughly investigated. As such, the aim of this work is to synthesize salen-Aluminum catalysts with four and five carbon backbones and understand their capabilities for ROP. While making mononuclear species proved a challenge, synthesis and complete characterization of several catalysts were completed. Even more, their ROP reactions toward racemic lactide (rac-LA, a sustainable lactone) under various conditions were accomplished and the subsequent polymers analyzed.

130. **Chen Yu**
Nano-Fabrication and Contact Quality of Two-Dimensional Solution-Grown Tellurium Device
Advisor: Vlad Pribiag
Sponsoring Program: URS
Home Institution: University of Minnesota
Abstract: Researchers have been interested in two-dimensional (2D) materials for their novel electronic transportation properties. Two-dimensional Tellurium, or Tellurene (Te), is a newly introduced member of the 2D material family, and its various properties speak promising nanoelectronic applications. Te has the structure of helical chains that are parallel in trigonal lattice. Te atoms are weakly bonded by van der Waals force. The crystal structure of Te demonstrates inherent anisotropy. As a preliminary research project, we intend to lay foundations for more advanced research by measuring different Nano-fabrication method and metal contact quality.

131. **María Zavala García,** Leslie Xiong, Cedric Caille
Analysis of Brain Morphology Features in Epilepsy Patients
Advisor: Dr. Catarina Saiote
Sponsoring Program: Northstar STEM Alliance
Home Institution: University of Minnesota- Twin Cities
Abstract: Research in biomarkers of neuropsychiatric disorders has used brain imaging techniques, such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET), to improve patient diagnosis and treatment outcome. Epilepsy is often associated with anatomical brain abnormalities and their improved identification can contribute to an understanding of the disease and increased success in surgical resection. In this work, we used brain surface-based parameters, from MRI T1-weighted data acquired from forty-eight epilepsy patients with five different types of diagnosis, that were comparatively analyzed to distinguish which would prove most helpful in identifying anatomical abnormalities in the brain and biological markers to improve surgical outcomes for epilepsy patients. We used software packages FreeSurfer, Freeview, Mindboggle, and BrainVisa to automatically create segmentations, labels, and cortical surfaces based on the anatomical MRI of each patient in addition to calculating morphometric measures such as curvature, sulcal depth, and gray matter thickness. We used R to calculate as well as visualize descriptive statistics of patient data for each gyrus and sulcus for all epilepsy subtypes included in our research. These values can be used in future comparisons with epilepsy surgery candidates.

132. **Zihan Zhang**
Vane Pump Test Stand Build
Advisor: Kim Stelson
Sponsoring Program: CCEFP
Home Institution: University of Minnesota, Twin CIties
Abstract: My main job is to connect the temperature, pressure, flow, and torque sensor with DAQ, and then test them until they can work perfectly. After that, we will use them to collect data during pump operation to see if the pump works properly and record data to measure pump efficiency. In addition, If I have time after finishing the DAQ project, I will use the software called "Solidwork" to draw all parts of the Test Stand, such as the pump, the tank, and so on.

133. **Joan Zheng**
Modelling Personality in Conversational Agents
Advisor: Maria Gini
Sponsoring Program: Computer Science
Home Institution: University of Minnesota, Twin Cities
Abstract: Disability assessors from the Minnesota Department of Human Services are required to interact with a variety of different people and a multitude of special needs and determine which healthcare services they can most benefit from. The ideal training environment for these assessors would involve a realistic simulation of real-life conversational interactions. This project explores a component-based framework for building conversational agents with different personality features in order to create such simulations.

134. **Yan Zhou Chen**
Selective Binding to Carbonic Anhydrase via Fibronectin-Acetazolamide Fusion
Advisor: Ben Hackel
Sponsoring Program: MRSEC
Home Institution: Tufts University
Abstract: Protein therapeutics are continuing to revolutionize biomedical approaches to combat diseases through the utilization of their diverse functionality, empowering precision medicine toward an array of biomarkers. However, important targets like enzymes continue to pose a challenge for protein scaffolds. While small molecular drugs can inhibit enzymes effectively, their poor selectivity often introduces harmful off-target effects. The 10th type III domain of human fibronectin (Fn3) was fused to acetazolamide (AAZ) to combine the specificity of the protein scaffold with the inhibitor properties of the small molecule for selective inhibition of carbonic anhydrase (CA) enzymes. Affinity maturation was conducted on four selected Fn3 clones by way of triple saturation mutagenesis to increase the affinity and selectivity of Fn3 to targets. DNA oligonucleotides were assembled and amplified via polymerase chain reaction (PCR) and then transformed into yeasts through electroporation. Protein-expressing yeasts were fused to acetazolamide and subsequently sorted for binding to target CA2 or CA9 via fluorescent activated cell sorting (FACS). Flow cytometry data showed Fn3-AAZ libraries to have improved, retained, as well as weakened affinity and selectivity to targets. Binding from variants with both strong selectivity and high affinity is expected to yield single-digit nanomolar inhibitor constant for carbonic anhydrase.

Teacher Poster Presentations
Listed Alphabetically by Presenting Author

135. **Jason Belter**
Green Chemistry in PLAin Sight
Advisor: Jane Wissinger
Sponsoring Program: MRSEC
Home Institution: Nova Classical Academy
Abstract: Polylactic Acid (PLA) is a compostable, inexpensive, and readily available renewable polymer. In collaboration with Boston College a lab activity/experiment was developed to highlight one possible use for this polymer: cleaning up oil spills. The experiment involves making thin films of PLA with different characteristics, immersing them in a simulated oil spill and measuring their ability to adsorb dodecane (petroleum stand in). This work investigated the potential of using readily available PLA sources such as 3D printer filament or compostable cups as an alternative to commerical PLA pellets to increase the feasibilty of classroom implementation. Potential extensions of the original protocols were also explored to aid teachers in customizing the experiment to meet their curricular needs. Long term shelf stability of the PLA/solvent mixture was evaluated. The experiment highlights a number of principles of Green Chemistry and sustainability while also giving students hands on experience with polymer chemistry. Natural extensions of the lab would feature discussions of topics such as plastics in our society, their effect on human health and the environment, and engineering design allowing students to engage in real-world problems to be solved.

136. **Brenna Bloome**
Mystery Solved: The Case of the Counterfeit Money
Advisor: Kyle Bantz
Sponsoring Program: MRSEC
Home Institution: Spring Lake Park High School
Abstract: Laboratory experiments provide an opportunity for students to interact with scientific content at a higher level of thinking. Sometimes these laboratory experiments can be isolated from students' daily lives and will only focus on one major unit from the class, which does not reflect real world laboratory situations. Students are more engaged with laboratory experiments that not only ask them to use cross-unit knowledge but also ask them to solve a tangible problem. Herein, we present a counterfeit ink experiment, which allows students to apply their knowledge of spectroscopy, separations, and acid-base chemistry to solve a counterfeit money crime. The structure of this lab is flexible and allows it to be implemented in a number of chemistry courses; Analytical Chemistry, AP Chemistry and High School General Chemistry and will be modified based on student and teacher feedback. Incorporation of a mystery based critical thinking lab will increase student engagement and understanding of the topics covered in the lab.

137. **Melanie Bristor**
An Investigation of Oil Dispersants & Surfactant Chemistry
Advisor: Louis Corcoran
Sponsoring Program: MRSEC
Home Institution: Shakopee High School
Abstract: Oil spills are some of the most high profile of all environmental disasters- and with good reason. They release millions of gallons of toxic crude oil into the environment, causing long-lasting damage to both the environment and economy. Part of the reason is that once released, the clean-up process is exceedingly difficult- but WHY? This lens can be used to introduce high school chemistry students to a range of topics including molecular structure, solubility and mixture separation. The laboratory investigation presented here prompts students to apply the central chemistry concepts described above to a real-world issue: the use of surfactants (dispersants) on oil spills. Students design their own oil dispersant by analyzing marine toxicity and the effectiveness of several potential surfactants. Oil-eating bacteria are then introduced to the dispersed mixtures to determine whether or not dispersion of oil leads to improved bioremediation. Analysis is done without the need for specialized equipment- only a digital camera, making this investigation not only relevant but also practical and inexpensive.

138. **Cassandra Knutson**
Dyeing to Degrade: A Bioplastics Experiment for the College and High School Classroom
Advisor: Jane Wissinger
Sponsoring Program: MRSEC
Home Institution: White Bear Lake High School
Abstract: Although students are familiar with the problem of plastics accumulating in our environment, their understanding of solutions rarely extends beyond the need for recycling. Consequently, few students can conceptualize current strategies to address the lifecycle and sustainability issues of today's plastics. This includes innovations to derive plastics from renewable resources rather than fossil fuels and providing alternatives to recycling in the form of biodegradation. Additionally, high school/college curriculum usually lacks in instruction on the structure and properties of polymers. In contrast, when asked, "where are plastics in your daily life?," students acknowledge the importance of plastics and recognize the accumulation as a problem to be addressed. We developed an experiment which capitalizes on the societal connection of plastics to engage students in learning basic polymer chemistry, laboratory skills, and green chemistry principles. Three biobased polymers are synthesized from combinations of citric acid, glycerol, and tapioca starch. Yellow dye #5 is added to each sample. Each sample is placed in sodium hydroxide and degradation is followed by release of dye. Students time how long each sample takes to degrade or ultraviolet-visible spectroscopy/smartphone colorimetry is used to follow the release of dye at timed intervals.

139. **Elizabeth Myers**
Dye Sensitive Solar Cells
Advisor: Turan Birol
Sponsoring Program: MRSEC
Home Institution: Central High School, St. Paul Public Schools
Abstract: Using the engineering design process (new MN Science Standard 3.2.2) students build and try to improve the voltage of dye sensitive solar cells. Students use their prior knowledge of electric circuits to demonstrate and explain the physical and chemical variables influencing the photoelectric effect.

140. **Mark Szybnski**
The Colorimetry of Iron Oxides
Advisor: R. Lee Penn
Sponsoring Program: MRSEC RET
Home Institution: Mankato West High School
Abstract Iron oxide. Rust. What's there to know?
There are two kinds, iron (II) oxide and iron (III) oxide. Electrochemistry. Thermochemistry. It's used in thermite.
Familiar. However... There are sixteen iron oxides and iron oxyhydroxides. They are produced under various conditions throughout the world and several are used as catalysts and pigments. Hematite (Fe_2O_3) is the most abundant iron oxide and is noted for its red color in soil and is used to make steel. Magnetite (Fe_3O_4) is also used to make steel and is magnetic. However, iron oxides can be made by varying the temperature they are made, the pH of solution they're made in, and the time needed for crystallization. Student learning outcomes will include material synthesis and determining methods for analysis. Students will be instructed of the basic procedures needed to make iron oxides and the iron oxyhydroxide goethite and allowed to formulate their own procedure. Student analysis will include colorimetry using a mobile phone and determination of the percent composition of their iron oxide samples based upon comparisons to standard samples created by students from the University of Minnesota. Further analysis with the University of Minnesota can include XRD (X-ray diffraction) and TEM (transmission electron microscopy).