



Materials Research Science and Engineering Center

UNIVERSITY OF MINNESOTA

Driven to DiscoverSM

Summer Undergraduate Research Expo

August 8, 2013

McNamara Alumni Center

Memorial Hall

4:00-6:00pm



Undergraduate Poster Presentations
Listed Alphabetically by Presenting Author

1	<p>Brandon Adams <i>Synthesis, Characterization, and Mechanical Testing of Poly(lactide-b-ethylene-co-ethylethylene) multiblock copolymer</i> Advisor: Frank Bates Department or Program Sponsoring Summer Research: Center for Sustainable Polymers Home Institution: Virginia Commonwealth University</p> <p>Abstract: In order to enhance the properties of polylactide, a biodegradable and renewable polymer, it was polymerized with hydrogenated butadiene to synthesize multiblock copolymer. The synthetic reaction consisted of two steps, the first step, a ring opening polymerization producing a Triblock polymer, then a coupling reaction that bonded different Triblock chains together in order to form multiblock polymers. After both the multiblock and Triblock were obtained blends made up of various amounts of both polymers were made. Size exclusion chromatography was test on the multiblock and Triblock as well as all of the blends, the results showed that the multiblock and polymers with the most multiblock eluted first due to their large size. Tensile testing determined that increasing average block number contributed to ductility while decreasing the average number of blocks yielded brittleness. Differential scanning calorimetry showed an increase in both crystallization and melting temperature in polymers with higher multiblock amounts.</p>
2	<p>Nicolas Alvarado <i>Structural Analysis of Fibronectin Ligand Proteins</i> Advisor: Benjamin Hackel Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Puerto Rico-Mayaguez</p> <p>Abstract: This project aims to determine the three-dimensional structure of small molecules, specifically fibronectin domain-mutants using x-rays crystallography. The laboratory has previously engineered fibronectin domain-mutants that bind with high affinity and specificity to molecular targets for clinical and biotechnology utility. We try to produce high yields of these domain mutants that consist of the core amino acids and minimal extraneous tags. To achieve this, we prepare DNA plasmids that encode for the fibronectin domain with removable purification tags. Multiple fibronectin mutant genes are moved into this DNA expression vector to then successfully produce and purify multiple fibronectin domains. Finally, attachments to these molecules are removed by breaking the protein into two smaller peptides. Future aims will consist of identifying the right conditions in which fibronectin domains will form consistent crystals useful for structural determination. X-ray diffraction information will be collected to identify the crystal structure of the fibronectin domains.</p>
3	<p>Travis Arnold <i>Surface Modification of Nylon 6 by Addition of Polyvinylidene Fluoride</i> Advisor: Chris Macosko Department or Program Sponsoring Summer Research: MRSEC Home Institution: Colorado School of Mines</p> <p>Abstract: Nylon 6 (polyamide 6) is a common polymer with various industrial applications, such as in textiles. Polyvinylidene fluoride (PVDF) is a polymer with many desirable properties, such as surface hydrophobicity. These two polymers were melt blended in various proportions. Nylon 6 and PVDF are known to be immiscible, so a graft copolymer of nylon 6 and poly(methyl methacrylate) was prepared to use as a compatibilizer. The uncompatibilized nylon 6/PVDF blends were characterized using scanning electron microscopy and differential scanning calorimetry. Future work will involve preparing and characterizing nylon 6/PVDF blends with compatibilizer, and then melt blowing the blends into nonwoven fibers. The hope is that the PVDF will migrate to the surface of the fibers, producing fibers with a hydrophobic surface. Such fibers could be used as an effective filtration medium.</p>

4	<p>Dan Bakke <i>Optimization of Iron Oxide Nanoparticles by Density Gradient Centrifugation and Surface Modification</i> Advisor: Christy Haynes Department or Program Sponsoring Summer Research: Heisig/Gleysteen Summer Fellowship Home Institution: University of Minnesota Abstract: Iron oxide nanoparticles have wide potential for biomedical applications, including MRI contrast, drug delivery, and magnetic fluid hyperthermia for cancer treatment. Of great need for these applications are quality particles with the proper size, surface chemistry, and magnetic heating properties. In this work a method for size separation by centrifugation through a density gradient was adapted for iron oxide nanoparticles. Samples from this separation show a change in size distribution and, correspondingly, significantly increased heating capabilities that match with theoretical heating behavior. Preliminary results in synthesis of a biocompatible silica coating are also presented. These methods are geared toward creating high-heating, colloidally stable, biocompatible iron oxide nanoparticles to meet the needs of implementation.</p>
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5	<p>Danesh Bankwala <i>Refining the Interaction Model</i> Advisor: Victor Barocas Department or Program Sponsoring Summer Research: UROP Home Institution: Biomedical Engineering Abstract: We refined a preexisting computational model to replicate the experimentally observed stress strain curve for collagen fibrin gels. Our Matlab model stretches interpenetrating, interacting collagen-fibrin networks generated with varying degrees of percolation at varying ratios of collagen to fibrin.</p>
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6	<p>Rachel Beck <i>HEK-293 eGFP Transfection: PAMAM Dendrimers' Effectiveness as a Delivery Agent as Measured by Cell Toxicity and Gene Expression</i> Advisor: Dr. Lisa Prevette Department or Program Sponsoring Summer Research: Chemistry Home Institution: University of St. Thomas Abstract: The polyamidoamine (PAMAM) dendrimer has surfaced as a favorable vector for non-viral gene delivery. PAMAM dendrimers' effectiveness towards delivering a plasmid which when transcribed and translated produces a green fluorescent protein, eGFP, was studied in HEK-293 mammalian cells. We aim to find the optimum composition and concentration of dendrimer-DNA polyplex which is compatible with cellular proliferation and provides effective cellular uptake. A series of polyplex compositions and concentrations was studied using a lactose dehydrogenase (LDH) cell toxicity assay following treatment with the polyplexes. Transfection efficiency as a function of time will be quantified by the percentage of cells that fluoresce. It has been determined that polyplexes with PAMAM concentrations lower than 0.13 mg/mL complexed with DNA concentrations lower than 5 µg/mL are not toxic to the cells.</p>
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7	<p>Nick Benish <i>Cell Penetrating Compounds Selectively Bind Vesicles Composed of Anionic Lipids</i> Advisor: Dr. Lisa Prevette Department or Program Sponsoring Summer Research: UST Chemistry Home Institution: University of St. Thomas Abstract: It is hypothesized that interactions between cell penetrating compounds (CPCs) and cell surface glycosaminoglycans (GAGs) are a crucial part of the drug delivery process. If the binding affinity of CPCs to the plasma membrane lipid bilayer is equal to or greater than that to the GAGs, the above hypothesis would need to be altered heavily. Lipid vesicles were made unilamellar and of uniform size by extrusion. Isothermal Titration Calorimetry (ITC) was then used to determine the binding thermodynamics between three CPCs (polyamidoamine dendrimer, polyethyleneimine and Tat peptide) and lipid vesicles of various composition.</p> <p>Although strong binding was seen for CPCs and vesicles composed of dipalmitoylphosphatidylglycerol (DPPG), there was no significant interaction with vesicles of biologically relevant compositions. More importantly, the affinity of CPCs for these lipids bilayers was weaker than that for GAGs. These findings show that GAGs may play an important role in the mechanism of CPC cell uptake.</p>
8	<p>Yakov Boyko <i>Anisotropies, Ferromagnetic Resonance and Spin Damping in Co₂MnSi/GaAs and Fe/GaAs Heterostructures</i> Advisor: Paul Crowell Department or Program Sponsoring Summer Research: Physics REU Home Institution: Hillsdale College Abstract: After emerging from discoveries made in 1980's, the field of spintronics has seen a waterfall of activity and development in the past decade. This field carries an important practical purpose with it – use of the fourth, spin degree of freedom of electrons in electronics. In our project, we study the ferromagnetic resonance (FMR) in Co₂MnSi/GaAs and Fe/GaAs thin film heterostructures. We discover that both films exhibit strong in-plane anisotropies. The calculated resonance spectrum based on the measured anisotropies was confirmed by FMR measurements. We find that the two films have substantially differing spin damping.</p>
9	<p>Kristin Braden <i>Charge Density and Stereochemistry Affect the Interaction of PAMAM Dendrimer with Glycosaminoglycans</i> Advisor: Dr. Lisa E. Prevette Department or Program Sponsoring Summer Research: Chemistry Home Institution: University of St. Thomas Abstract: Cell-penetrating compounds, such as polyamidoamine (PAMAM) dendrimer, are often attached to drugs to induce cellular uptake. We hypothesize that electrostatic interaction occurs between the positively charged primary amines of PAMAM and negatively charged glycosaminoglycans (GAGs) found on all cell surfaces to different extents. The interactions between generation 5 PAMAM dendrimer and four GAGs have been studied using isothermal titration calorimetry (ITC), dynamic light scattering (DLS), and gel electrophoresis. ITC experiments revealed the binding thermodynamics. DLS was used to confirm complex aggregation. Competitive displacement of DNA cargo from PAMAM by the individual GAGs was studied using gel electrophoresis. It has been determined that PAMAM-GAG affinity is dependent upon GAG charge density and stereochemistry. GAGs can disrupt PAMAM-DNA complexes, which has implications at the cell surface.</p>

10	<p>RiAnna Butler <i>Construction of Transistors Using Self-Assembled Zirconium-Phosphonate Monolayers</i> Advisor: Aaron Massari Department or Program Sponsoring Summer Research: Heisig/Gleysteen Fellowship Home Institution: University of Minnesota Abstract: Molecular self-assembly is a method of chemical synthesis that provides control of intermolecular organization, density and orientation of atoms in a material. Using spontaneous bonding forces to achieve high precision at an atomic level serves as an attractive technique useful in a variety of fields including microelectronics. Diphosphonated perylene diimide (diphos-PDI) was first synthesized, then used in addition to zirconyl chloride octahydrate to create self-assembled zirconium-phosphonate monolayers. The layered material was monitored by UV-Vis spectroscopy to determine the relationship between number of layers and absorbance. The charge carrier mobility and threshold voltage were determined using electric characterization methods and ellipsometry was used to investigate the thickness of the layers.</p>
11	<p>Katelyn Caron <i>Synthesis of Isoprenoid Diphosphate Substrates for PFTase</i> Advisor: James Wollack Department or Program Sponsoring Summer Research: Organic Chemistry Home Institution: St. Catherine University Abstract: Protein Farnesyltransferase (PFTase) is an enzyme that incorporates farnesyl groups into proteins and peptides that end in a certain amino acid sequence. Previously, non-natural substrates have also been transferred by PFTase. These substrates could subsequently undergo bioconjugation reactions via copper catalyzed click chemistry. Because of copper's cytotoxicity, these substrates are not compatible with in vivo applications. Presented here are two bioorthogonal substrates that do not require the use of a copper catalyst for subsequent bioconjugation reactions. The first contains a norbornene ring to initiate a tetrazine ligation reaction and the second contains a vinyloxybenzene for a photoreaction on a diaryl tetrazole. Both substrates are predicted to be PFTase substrates that will allow for the eventual incorporation of new properties such as fluorescence on targeted proteins.</p>
12	<p>David Carroll <i>Properties of Magnetoresistive Thin Films</i> Advisor: Prof. Chris Leighton Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Wisconsin - Whitewater Abstract: A substrate of strontium titanate (STO) was coated with a thin film (several nanometers) of lanthanum strontium cobalt oxide (LSCO). Via spin-coating, the sample was then coated with a mixture of polystyrene and polylactate; due to the properties of these materials, the polylactate approximately formed cylinders within the polystyrene; the cylinders were forced into a regular vertical pattern via solvent annealing. The polylactate was then removed via a chemical etching process, resulting in a polystyrene pattern of anti-dots atop the LSCO film. Ion milling was used to simultaneously remove the polystyrene layer and create the same pattern in the LSCO layer, resulting in a sample composed only of the STO and LSCO layers, with the LSCO layer patterned with a regular anti-dot array. A superconducting quantum interference device will then be used to observe the electromagnetic behaviour of the sample under differing temperatures and magnetic fields.</p>

13	<p>Diana Cedillo <i>PROGRESS TOWARDS SYNTHESIS OF RUBRENE DERIVATIVES FOR SINGLE CRYSTAL ORGANIC FIELD-EFFECT TRANSISTORS</i> Advisor: Christopher J. Douglas Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Texas-Pan American Abstract: Rubrene, an organic semi-conductor, is known to demonstrate advantageous physical and electronic properties as an organic field-effect transistor, most notably with its high calculated charge carrier mobility at room temperature. Previously observed beneficial attractive interactions between electron-rich and electron-withdrawing aryl substituents on rubrene's tetracene core are believed to contribute to exhibited pi-stacking in each rubrene derivative's solid-state, an essential aspect in electron transport in a single-crystal device. However, an exact relationship between molecular and crystal structure, and resulting effects on charge transport in rubrene has not yet been fully established. In this study, congeners of rubrene with aryl substituents containing methoxy (electron-donating) and trifluoromethyl (electron-withdrawing) groups are synthesized via an eight-step process from known 1,4-Napthoquinone. Efforts of this synthesis of rubrene derivatives are directed largely toward crystallization and charge-transport studies in single-crystal organic field-effect transistors in attempt to expand knowledge and understanding of a structure-property relationship.</p>
14	<p>Katie Cornille <i>Incorporation of an Alkyne-Modified Farnesyl Diphosphate Analog in Live Mice</i> Advisor: Dr. Mark Distefano and Dr. Ling Li Department or Program Sponsoring Summer Research: LANDO Home Institution: Allegheny College Abstract: Protein prenylation occurs when an isoprenoid is covalently attached to a protein. Here, a C15 isoprenoid probe derived from farnesyl diphosphate and modified with an alkyne group was used to observe prenylation in living mice treated with combinations of the C15 compound and simvastation. Prenylation in brain, kidney, spleen, and liver lysate was studied using two methods. The first method qualitatively visualized prenylation using gel electrophoresis. Secondly, the prenylated proteins were isolated using biotin pull-down method and are currently submitted to undergo mass spectrometry. Both methods utilized a copper-catalyzed click reaction. TAMRA-PEG-azide fluorophore was used for electrophoresis and biotin azide was used to pull-down the prenylated proteins. The liver and kidney had significant labeling with the C15, and statin treatment was shown to increase labeling. These results suggest that this probe could be used to monitor prenylation in living animals and provide insight into relationships between prenylation and various diseases.</p>
15	<p>Felipe Correa Netto <i>Poly(Urea Ester)s: A New Polymer Family Exhibiting Biodegradability and High Tm</i> Advisor: Chris Macosko Department or Program Sponsoring Summer Research: MSROP Home Institution: University of Minnesota Abstract: In this study, we are aiming at developing new polyesters that exhibit both biodegradability and a high melting temperature (Tm), to fill the gap between aliphatic and aromatic polyesters. The strategy to this aim is introducing a urea group in the aliphatic polyester chains, namely poly(urea ester)s (PUEs). A series of PUEs were successfully synthesized by reacting N,N'-bis(2-hydroxypropyl)-urea (UPnO) with different aliphatic diesters, namely dimethyl succinate, dimethyl adipate, and dimethyl pimelate by transesterification. Through comparison with a normal aliphatic polyester - poly(decylene succinate) (pDSu), it is found that the corresponding succinate PUE (pPnUSu) shows a higher Tm (~70 °C for pDSu vs. ~130 °C for pPnUSu). In these PUEs, the Tm increases with the decrease of the CH2 length in the diesters, e.g., the pPnUSu has the highest Tm while the pPnUPI displays the lowest.</p>

16	<p>Lindsay Davis <i>Polymeric Sutures in the Teaching Lab: Synthesis, Degradation, and Mechanical Testing</i> Advisor: Dr. Jane Wissinger Department or Program Sponsoring Summer Research: Center for Sustainable Polymers Home Institution: Langston University Abstract: The variety of polymer properties that scientists are able to design are highlighted in this new study developed for incorporation into high school and college level chemistry laboratory curricula. One dimension of the research includes the opportunity to study both synthesis and properties of triblock copolymers as examples of materials that can be designed to have the strength, flexibility, and desired degradation properties of medical sutures. Polycaprolactone, a pre-purchased diol, was reacted with different ratios of the endblocks (D,L-Lactide and L-Lactide) to make triblock copolymers of different compositions. The reaction was catalyzed with Sn(Oct)₂ and heated for various times depending on composition. The triblock copolymers prepared will then be characterized by NMR, SEC, and DSC. The strategic use of Polycaprolactone as the midblock and D,L-Lactide or L-Lactide as the end blocks, demonstrates how scientists are "mixing" the properties of different polymers to obtain a final polymer with desirable physical properties.</p>
17	<p>Carlos E. Pérez De Jesús <i>Complexation of Silver ions by Natural Organic Matter as Studied Using Fluorous-Phase Ion-Selective Electrodes</i> Advisor: Philippe Bühlmann Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Puerto Rico at Mayagüez Abstract: Silver nanoparticles (AgNPs) are used extensively in both medical and consumer industries as antimicrobial agents. The antibacterial nature of AgNPs is primarily due to ionization and dissolution of these particles and release of Ag⁺ into the environment, which can bind to proteins, enzymes and DNA and disrupt normal cell function. Therefore, it is critical to understand the extent and kinetics of dissolution to Ag⁺ and the environmental effects on the released Ag⁺ to understand AgNP toxicity. Natural organic matter, NOM, which originates from remaining of living organisms and is abundant in surface and ground water supplies, can interact with the released Ag⁺ resulting in silver ion speciation, decreased bioavailability and altered toxicity. Therefore, understanding chemical equilibrium between Ag⁺ and NOM is critical for a correct assessment of toxicity and environmental impacts of AgNPs. Fluorous-phase Ion-selective Electrodes provide selective measurements for Ag⁺. These will be used to study the interaction of NOM and Ag⁺. Unlike hypothesized in many studies, findings suggest no significant binding between Ag⁺ and NOM at environmentally relevant conditions. Moreover, pH dependence of complexation of NOM and Ag⁺ was investigated. It was shown that at basic pH weak complexation between NOM and Ag⁺ can be observed whereas at acidic and neutral pH there is no significant complexation of NOM and Ag⁺.</p>
18	<p>Jacob Edwards <i>Design and Synthesis of Activity-based Probes for Inflammatory Pathways</i> Advisor: Daniel Harki Department or Program Sponsoring Summer Research: Heisig/Gleysteen Chemistry Program Home Institution: University of Minnesota Abstract: Sesquiterpene lactones are a class of natural products that have a variety of biological activities. Helenalin (Hel), a naturally-occurring sesquiterpene lactone, inhibits the NF-κB pathway, which is responsible for controlling the inflammatory response within the human body. The exact mechanism of inhibition, however, is unclear. Activity-based protein profiling can help elucidate the mechanism by which Hel inhibits this pathway. Activity based probes are designed to covalently bind to amino acid residues of the proteins. Protein pull down experiments allow for covalently modified proteins to be analyzed by mass spectrometry to determine the identity of the proteins with which the probe interacts. A non-functional probe based on a previously synthesized Exocyclic Methylene Butyrolactone Alkyne (EMBA) was synthesized, featuring a reduced exocyclic methylene group, which is responsible for Hel's biological activity. In addition, several alkyne probes based on Hel's structure were successfully synthesized.</p>

19	<p>Jacob Edwards <i>Greening the Organic Chemistry Laboratory through Solvent Reduction and Safer Reagents</i> Advisor: Professor Jane Wissinger Department or Program Sponsoring Summer Research: Heisig/ Gleysteen Home Institution: University of Minnesota Abstract: The objective of this project was to improve a traditional column chromatography experiment and a newly developed solvent-free Diels Alder experiment to more closely follow green chemistry principles. More specifically, the column separation of ferrocene and acetylferrocene was retooled to utilize a single elution system rather than two different elution solvents which substantially reduced the amount of solvent required and improved the pedagogical value of the experiment. In addition, a range of greener solvents was explored for column sample application to replace methylene chloride. Meanwhile, the scope of the solvent-free Diels Alder reaction between tetraphenylcyclopentadienone and styrene, recently developed at the University of Minnesota, was investigated with the goal of finding an alternative dienophile for styrene and potentially a new diene. The ideal reaction would have multiple possible products, thus retaining the guided-inquiry approach, stereochemistry suitable for ¹H NMR study using the Karplus relationship and introduction of the X-ray crystallography.</p>
20	<p>Samantha Ferguson <i>The Effects of PFOS on Membrane Permeability</i> Advisor: Prof. Paige Novak Department or Program Sponsoring Summer Research: MRSEC Home Institution: Oberlin College Abstract: Perfluorocarbons (PFCs), used in domestic and industrial applications, have been found as contaminants in surface water, ground water, sediment, and some birds and mammals. Due to their surfactant nature, PFCs could increase lipid bilayer membrane permeability. Limited research on the effects of PFCs has been conducted in mice. I examined the effect of perfluorooctanesulfonic acid (PFOS), a widely-used PFC, on membrane permeability of Nitrosomonas bacteria. This is important because increased membrane permeability could allow co-contaminants to infiltrate these bacteria. Permeability can be tested with and without PFOS using an artificial black lipid membrane (BLM) to simulate a lipid bilayer. The membrane permeability can be examined by measuring the flow of protons across the BLM. Future research includes testing ions such as chloride and larger hydrophobic substances such as naphthalene. These findings complement experiments that are fluorescently tagging toxins to monitor whether the presence of PFOS increases permeation in Nitrosomonas.</p>
21	<p>Matthew Folstad <i>The Synthesis and Characterization of Pyridine Triazolylidene Based Ligands for the Luminescence of Lanthanide Ions</i> Advisor: Dr. Marites Guino-o Department or Program Sponsoring Summer Research: UST Chemistry Department Home Institution: University of St. Thomas Abstract: Lanthanide ions have unique fluorescent properties that can be used in a variety of applications, such as bioimaging and luminescent tags for cell imaging. In order for this group of ions to be useful in these applications, they need to interact with ligands. Lanthanide ion's electrons are not easily excited, so therefore require an excited electron from a ligand that can relax back to its ground state to produce light. The ligand not only has to be able to donate excited electrons, but it must also be able to shield the lanthanide ions from solvent molecules. This shielding allows uninhibited interaction between the ligand and ion for optimal electron transfer. This research project focuses on synthesizing an organic ligand that will be a good electron donor while stabilizing the Lanthanide ion. By modifying a previous synthetic route, we hope to synthesize and test its capabilities in interacting with lanthanide ions.</p>

22	<p>Danielle Francen <i>Quantification of Free Polymer Associated With the Formation of Polymer-DNA Complexes</i> Advisor: Lisa Prevette Department or Program Sponsoring Summer Research: Chemistry Home Institution: University of St. Thomas</p> <p>Abstract: Gene therapy requires the delivery of foreign DNA to cells. Cell penetrating compounds (CPCs), such as Tat peptide, polyethyleneimine (PEI), and polyamidoamine (PAMAM) dendrimer, are polycations that have been shown to facilitate DNA delivery through the formation of polymer-DNA complexes defined by specific +/- charge ratios. At each charge ratio (+/- 10, 5, and 1) a different amount of "free" polymer is present. Using the 2,4,6- trinitrobenzenesulfonic acid assay for amine concentration, free polymer present after complexation and separation by ultrafiltration was quantified. It was found that both Tat peptide and PAMAM dendrimer follow expected trends of complex stoichiometry being approximately 1:1. Due to the long, linear structure of PEI, a new separation method, size exclusion chromatography, must be used to determine the amount of free PEI present after formation of the PEI-DNA complexes. These results lead to new interpretations of cell uptake mechanisms of these gene delivery complexes.</p>
23	<p>Mark Frommelt <i>Kinetics of Polyaspartic Coatings</i> Advisor: Dr. Tom Ippoliti Department or Program Sponsoring Summer Research: UST Chemistry Department Home Institution: University of St. Thomas</p> <p>Abstract: Polyaspartic polyurethane coatings are used to protect bridges, stadiums, and other structures from environmental damages. These coatings have been found to cure extremely quickly during periods of high humidity. The current research is aimed at discovering the reason for this decreased drying time, and to potentially develop an amine analog that does not display variable drying times due to environmental humidity. Relative reaction rates of various secondary amines have been determined via H NMR spectroscopy. Additionally, work has been done to determine the effect of water on these reactions and has proven the catalytic effect of water on this drying reaction. Future work will involve further investigation into the mechanism for this water catalysis, and seeking out different secondary amine analogues that would not be susceptible to this enhanced rate in humid conditions.</p>
24	<p>Cooper Gates <i>Toughening Polylactide with Blending</i> Advisor: Chris Macosko Department or Program Sponsoring Summer Research: Center for Sustainable Polymers Home Institution: Oregon State University</p> <p>Abstract: Polylactide (PLA) is strong but brittle and prone to deforming above its glass transition temperature of 60-65 degrees centigrade. Polypropylene is a good polymer to blend with it because it has roughly the same melt viscosity, is more flexible and can take more heat. However, they are immiscible in the melt. Lotader was the first compatibilizer Yewen and I tried, but it has not been doing as well as the triaziridine branching agent.</p> <p>We plan to treat the Triaziridine-reacted PLA as just a branched PLA and blend it with polypropylene and Lotader to see if we get any performance increases from that combination. It would be nice if the branched PLA from the Triaziridine could perform well enough on its own, as very little triaziridine is needed to make it, and Lotader is expensive. Although some properties of the blends are improved relative to PLA alone, PLA alone has the highest extensional modulus at room temperature. This seems to follow a sort of trade-off, with the more brittle materials still needing more force to break, even though they are less flexible.</p>

25	<p>Cameron Ginocchio <i>Investigating a Greener Synthesis for 6-bromo-4-(chloromethyl)-7-hydroxycoumarin, an Important Photolabile Protecting Group</i> Advisor: Jane Wissinger Department or Program Sponsoring Summer Research: MSROP Home Institution: University of Minnesota- Twin Cities Abstract: Because of its importance as a photoremovable protecting group, the synthesis of 6-bromo-4-(chloromethyl)-7-hydroxycoumarin (Bhc) was investigated. In the 2311 teaching laboratory, a similar reaction is performed in which students synthesize 4-methylumbelliferone, a different coumarin. In order to provide students a connection with an active research program, it was desired that students be able to run the synthesis of Bhc, a molecule of interest to the Distefano research group. In order to create a new experiment for teaching lab, it was necessary to find a greener synthesis of Bhc. The current method of synthesis involves environmentally unfriendly conditions using 12-15 equivalents of a strong acid, which is not ideal for running on a teaching lab scale. Experiments with various green catalysts and conditions for a Pechmann reaction between 4-bromoresorcinol and ethyl-4-chloroacetoacetate to produce Bhc were performed. The results showed that the brominated phenol that is essential to the photolability properties of Bhc proved to complicate the synthesis. Currently a new synthesis strategy is being investigated to add the bromo group after the Pechmann reaction. A greener synthesis for Bhc would both provide students a connection with real world research and an environmentally friendly pathway to create a molecule that is valuable to cancer drug research.</p>
26	<p>Alexander Gulachek <i>Steady State Studies of Ferrocenylsubphthalocyanines</i> Advisor: David Blank Department or Program Sponsoring Summer Research: Volunteer Home Institution: University of Minnesota Abstract: Solar cells are a potential clean energy source suited to replace fossil fuels. Organic solar cells, with an increased efficiency and longevity, provide a cost effective alternative to the current silicon solar cells. Ferrocenylsubphthalocyanines are potential candidates for use in solar cells due to their ability to create charge separated states. The samples vary in the group linking the ferrocene and the subphthalocyanine, which can affect excited state dynamics. This project aims to understand the energy transfer dynamics of these molecules through various spectroscopic techniques. The fluorescence and absorption spectra of five subphthalocyanine complexes were collected, and quantum yields were calculated. This gives us information on how the ferrocene and the linking group affect emissive behavior. Because the efficiency of photovoltaics is dependant on the excited state lifetime, time correlated single photon counting was performed to determine the lifetimes of the excited state of the subphthalocyanines.</p>
27	<p>Suman Gunasekaran <i>Fabrication of nanofluidic devices for DNA confinement</i> Advisor: Kevin Dorfman Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Program Home Institution: Harvard Abstract: Obtaining sequence information from entire genomes is highly desirable for many biomedical applications. However, genomic DNA in free solution exists as tangled coils that are impossible to analyze. But, if the DNA could be confined in a nanochannel with dimensions similar to that of the DNA, it would be forced to exist in a fairly linear configuration. This would facilitate simple and accurate genome sequence analysis. With this aim, I fabricated nanofluidic devices that would allow for efficient confinement of genomic DNA. During the fabrication process, numerous issues were addressed, such as modifying etch parameters to reduce nanochannel roughness in order to limit the DNA from sticking to the nanochannels during device loading. Once a robust fabrication process is developed, we can begin to understand and model how the DNA behaves in the nanochannels which will help enable large-scale use of nanofluidic devices for genomic mapping technologies.</p>

28	<p>Harold Haldren <i>FDTD Simulations of Faraday Rotation in Magneto-Optic Garnet Waveguides</i> Advisor: Bethanie J.H. Stadler Department or Program Sponsoring Summer Research: Electrical and Computer Engineering REU Home Institution: Liberty University Abstract: Optical isolators make use of garnet films which have an anisotropic magneto-optic effect known as Faraday rotation. When linearly polarized light travels through a Faraday rotator, the polarization angle of the light rotates in proportion to a magnetic field that is applied in the direction of propagation. However, commercial isolators are discrete components with light traveling through the thickness of the garnet film. In this project, garnet waveguides of various size, shape, and anisotropic properties were simulated using finite-difference time-domain (FDTD) in order to optimize Faraday rotation of guided light. In particular, it was shown that structural birefringence can inhibit rotation but can be overcome by alternating the materials within the waveguide to alternate the direction of Faraday rotation. Additionally, alternating garnet with a magnetically inactive material produced a similar, but less efficient, effect. Finally, the bandwidths of the Faraday rotators were determined within the fiber optic wavelength range.</p>
29	<p>Matt Hauwiler <i>Ultrafast Pump Probe Studies of ferrocenylsubphthalocyanines</i> Advisor: Professor David Blank Department or Program Sponsoring Summer Research: Heisig/Gleysteen Summer Fellowship Home Institution: University of Minnesota Abstract: With the ever-increasing energy demand and growing awareness regarding environmental consequences of fossil fuels, solar energy has emerged as an exciting alternative to existing energy sources. Donor-acceptor hybrids, like the ferrocenylsubphthalocyanine dyads investigated in this study, have potential in artificial photosynthetic devices. Efficient harvesting of solar energy requires the formation of long-lived charge separated states which are probed on the femtosecond and picosecond timescales using ultrafast pump probe spectroscopy. Through varying of the distance and nature of the linker connecting the subphthalocyanine acceptor and the ferrocene donor, the relationship between long-lived charge transfer states and the identity of the linkers can be investigated.</p>
30	<p>Brianne Herlitzke <i>Solid-State Intermolecular Interactions in 3-Chlorobenzaldoxime</i> Advisor: William H. Ojala Department or Program Sponsoring Summer Research: UST Summer Research Home Institution: University of St. Thomas Abstract: We are beginning a study of the thermal solid-state dimerization of nitrile oxides, compounds known as useful synthetic intermediates but whose solid-state reactivity has not been examined in detail. Nitrile oxides form three possible dimers in solution; we wish to determine the influence of nitrile oxide crystal structure on dimerization in the solid. As part of a study of 3-chlorobenzonitrile oxide, we have determined the crystal structure of one of its synthetic precursors, 3-chlorobenzaldoxime, by single-crystal X-ray diffraction. Intermolecular O-H...N H-bonds link the molecules into chains along the b-axis. In addition, pairs of molecules linked by a cyclic H-bonding interaction (oxime C-H donor, hydroxyl O acceptor) are themselves linked by close Cl...Cl interactions (halogen bonding). Although the H-bonding interactions will be absent from 3-chlorobenzonitrile oxide, we intend to use any Cl...Cl interactions present to influence the packing arrangement of the nitrile oxide and the course of its solid-state dimerization.</p>

31	<p>Oliver Heywood <i>A flexible resonating cavity for solid state lasers</i> Advisor: James Leger Department or Program Sponsoring Summer Research: ECE REU Home Institution: Carleton College Abstract: We are developing a novel resonator cavity design for a side-pumped Nd:YAG laser that allows customizable modal discrimination of the output beam. While beam shaping is commonly accomplished with optics outside the laser cavity itself, our intra-cavity approach is quite rare. By replacing the traditional back mirror with a reflective spatial light modulator which uses liquid crystals, we can shape the wave front within the cavity itself. The flexibility of this technique should allow us to correct a wide array of problems in laser design, including maximizing power output by increasing the overlap of the beam and the pumped region, and correcting aberrations caused by thermal lensing. However, the primary application which we explore is using GRIN (gradient index) optics within the laser to produce modal discrimination. While these would traditionally introduce aberrations in the beam profile, our programmable resonating cavity can correct such aberrations.</p>
32	<p>Danielle Hinkley <i>Synthesis of Novel Photochromes</i> Advisor: Dr. J. Thomas Ippoliti Department or Program Sponsoring Summer Research: University of St. Thomas Chemistry Department Home Institution: University of St. Thomas Abstract: The goal of this summer research was to synthesize a molecule that has photochromic properties. The molecule contains a functional group that absorbs ultraviolet radiation causing a structural rearrangement to a molecule that absorbs in the visible region. This gives the molecule properties allowing for a color change to appear while being exposed to UV light. The molecule of interest is a derivative of benzo-1,4-dioxane. The synthetic route leads to several isomeric naphthols being formed, all of which could give molecules that display photochromic properties. Thus far only one of the four isomers have been isolated and converted to a photochromic molecule.</p>
33	<p>Noah Holzman <i>Characterization of Transfer Artifacts of CVD-Grown Graphene Monolayers</i> Advisor: David J. Flannigan Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Wisconsin-Stout Abstract: Graphene was the first two-dimensional material to be isolated and studied. Made entirely of carbon atoms arranged in a honeycomb-like sheet, its unique electrical, mechanical and optical properties make it a promising material for applications in electronic devices. Chemical vapor deposition (CVD) provides a route to industrial-scale production of graphene, but necessitates transfer from the catalytic metal on which the film is deposited. The transfer process can introduce defects on otherwise pristine graphene, which severely limit the potential of graphene-based technology. The transfer artifacts are studied with optical, confocal Raman and transmission electron microscopy to evaluate the quality of suspended films transferred via a polymer-mediated method. These techniques reveal polymer residue, metal nanoparticles, folds, wrinkles and tears. Transfer methods are tested and modified to produce a graphene monolayer suspended on carbon-coated TEM grids with micron-range continuity.</p>

34	<p>Salman Ikramuddin <i>H3K27 Demethylation Results in Pancreatic Cancer Cell Death</i> Advisor: Dr. Ashok Saluja Department or Program Sponsoring Summer Research: GCD-Directed Research Home Institution: University of Minnesota-Department of Surgery Abstract: Pancreatic cancer has been linked to the H3K27 methylation state. H3K27 methylation is catalyzed by histone-lysine N-methyltransferase EZH2. We evaluated the ability of GSK126, an EZH2-methyltransferase inhibitor to cause pancreatic cancer cell death in vitro using pancreatic cancer cell lines derived from primary (MIA PaCa-2) and metastatic (S2-VP10) patient-tumors. The efficacy of GSK126 was compared to triptolide. Minnelide, a water-soluble derivative of triptolide, is a novel therapy for pancreatic cancer. MIA PaCa-2 or S2-VP10 cells were treated with varying concentration of GSK126 (0-20UM) in combination with triptolide (50nM) for 24-72 hours. Cell viability was measured using a CCK-8 assay. Treatment with 20μM GSK126 resulted in significantly reduced cell viability at 48hrs (S2-VP10) and 72hrs (MIA-PaCa-2). The decrease in cell viability by triptolide alone was greater than that of GSK126 alone, this suggests that H3K27 demethylation is just one mechanism by which triptolide induces pancreatic cancer cell death.</p>
35	<p>Shyam Iyer <i>Tuning the reactivity of Bio-inspired non-heme iron catalysts with acetic acid</i> Advisor: Prof. Lawrence Que Department or Program Sponsoring Summer Research: Heisig/Gleysteen program Home Institution: University of Minnesota - Twin Cities Abstract: Bio-inspired non-heme iron catalysts have the ability to perform hydrocarbon epoxidation and cis-dihydroxylation using hydrogen peroxide as an oxidant. One such catalyst, FeII(β-BPMCN) (BPMCN = N,N'-bis(2-pyridylmethyl)-N,N'-dimethyl-trans-1,2-diaminocyclohexane), shows interesting catalytic reactivity under acidic reaction conditions. A systematic study showed that the ratio between epoxide and cis-dihydroxylation products can be tuned using different amounts of acetic acid. Furthermore, competition studies show that the catalyst selectively oxidize electron-poor olefins in the absence of acid and electron-rich substrates in the presence of a large excess of acid, providing new insights into the reactivity of similar model complexes.</p>
36	<p>Eric Johnson <i>Studying Delayed Genetic Regulatory Networks with a Weighted Ensemble Stochastic Simulation Algorithm</i> Advisor: Jorge Vinals Department or Program Sponsoring Summer Research: Physics REU Home Institution: New York University Abu Dhabi Abstract: While many modifications have been proposed for Gillespie's Stochastic Simulation Algorithm (SSA), none has been applied to the problem of genetic regulatory networks that include delayed reactions. Recent discoveries in the studies of these regulatory networks are demonstrating that delayed reactions can play an important role in regulatory behavior. In particular, the phenomenon of the "biological clock", whereby stochastic oscillations and delayed reactions combine to produce a regularly oscillating population of proteins within a cell, is very interesting. In my work this summer, I modified the weighted ensemble approach to simulating stochastic systems such that it could model delayed reactions as well as instantaneous ones without making any additional assumptions or approximations about the system. The results of analysis performed on simple networks corroborates earlier work investigating the effects of delay, as well as demonstrates the transition to oscillatory behavior that is not observed without delay.</p>

37	<p>Michelle Johnson <i>Theoretical investigation of the mechanism for the catalytic hydrogenation of carbon dioxide by mononuclear ruthenium polypyridyl complexes</i> Advisor: Dr. Christopher J. Cramer Department or Program Sponsoring Summer Research: Heisig/Gleysteen Chemistry Program Home Institution: University of Minnesota - Twin Cities Abstract: The burning of carbon rich fossil fuels in the past centuries' has led to an unprecedented increase in atmospheric CO₂. Atmospheric CO₂ is considered a major contributor to global warming and climate change and as such, methods that exploit CO₂ as a chemical feedstock have been increasingly sought. A family of ruthenium polypyridyl complexes has shown promise in the catalytic hydrogenation of CO₂ to formic acid, an important chemical intermediate. Theoretical methods were previously employed to establish a plausible mechanism for this catalytic system. Density functional theory is employed to further probe the established mechanism to understand the degree to which steric factors influence the overall mechanism and specifically the rate-limiting steps and their corresponding transition-state structures. Further calculations will establish the degree to which an external ammonia base</p>
38	<p>Khomson Kerati-thamkul <i>Surface Characterization and Modification of Silica Nanofibers</i> Advisor: Dr. Vivian Feng Department or Program Sponsoring Summer Research: Undergraduate Research and Graduate Opportunity (URGO) Home Institution: Augsburg College Abstract: In this study, we examined electrospun silica nanofibers as scaffolding material for model PC12 cells growth. Two different surface functionalization chemicals, namely poly-d-lysine (PDL) and 3-aminopropyltriethoxysilane (APTS), were compared for amino group surface densities for cell adhesion using fluorescence microscopy. The dissolution of silica nanofibers under physiological condition was clearly observed over the course of 12 days with scanning electron microscopy, and the dissolved silica was quantified with silicomolybdate blue method. In addition, dissolution occurred via collapsing and flattening of the SNFs before thinning out, possibly due to the porous structure of the material.</p>
39	<p>Aakriti Kharel <i>Ionic liquids as solvents for methylcellulose</i> Advisor: Dr. Timothy Lodge Department or Program Sponsoring Summer Research: Chemistry LANDO Home Institution: Wesleyan College Abstract: Methylcellulose (MC) is a commercially important cellulose derivative that has been widely used in food, cosmetics, pharmaceuticals and building materials. To date, only a few aqueous solvent systems have been found effective for the dissolution of MC. The goal of the project was to explore the solubility of MC in variety of ionic liquids (IL). It was found that 1-butyl-3-methylimidazolium chloride (BMIMCl) was able to dissolve MC (M_w = 150,000 g/mol) at concentrations ≤ 1 wt%. Rheological experiments on solutions comprising 1 wt% MC in BMIMCl revealed liquid like behavior between 20 °C and 100 °C. The absence of a gelation event is drastically different than MC in water, which exhibits gelation at elevated temperatures. Static light scattering was used to probe the chain confirmation in solution.</p>

40	<p>Seung Yeon Kim <i>Fabrication of "Barcode" Nanowires for Multiplexed Detection in Biological Assays</i> Advisor: Prof. Bethanie Stadler Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Program Home Institution: Georgia Institute of Technology Abstract: Specific targeting of cancer cells is critical for effective drug delivery and cancer therapeutics. Here, "barcode" nanowires, composed of multilayers of gold and nickel, were investigated for multiplexed detection and targeting in biological assays. Two types of distinct barcode nanowires were fabricated by sequential electrodeposition of gold and nickel. These wires were characterized by vibrating sample magnetometry (VSM) to have parallel coercivities of 212 and 285 Oe, respectively, with distinct signatures of coercivity versus angle. The dimensions of the nanowires were measured by scanning electron microscopy (SEM). Two types of barcode nanowires successfully conjugated with antibodies that were specific to two cell lines, one cancerous and one non-cancerous. Bright field and fluorescence optical imaging was used to observe successful tagging of these cells. In short, barcode nanowires have much promise for multiplexed detection of cells</p>
41	<p>Nathan Klein <i>Novel Formation of Core-Shell Nanoparticles</i> Advisor: Prof. Christy Haynes Department or Program Sponsoring Summer Research: Department of Chemistry Home Institution: University of Minnesota Abstract: Mesoporous silica nanoparticles have drawn considerable attention for their applications in diverse areas - from biomedicine to heterogeneous catalysis. The widespread utility of these particles has inspired significant research into their synthesis, resulting in tunable pore diameters and large surface areas. A challenge remains in synthesizing mesoporous silica with these characteristics while ensuring the primary particle size is under 200 nanometers, an important property for biomedical applications. In this research, small organic molecules have been used as auxiliary swelling agents to obtain large pore diameters, while maintaining a primary particle size smaller than 200 nanometers. This synthetic strategy has been extended for the formation of core-shell nanoparticles utilizing various metallic cores including silver (Ag) and iron oxide (Fe₃O₄). Both mesoporous silica and core-shell nanoparticles have been characterized utilizing a range of physicochemical techniques, such as dynamic light scattering, nitrogen physisorption, transmission electron microscopy, and powder X-ray diffraction.</p>
42	<p>Edward Kleinsasser <i>Mach-Zehnder Optical Modulator based on BSTO Waveguide</i> Advisor: Anand Gopinath Department or Program Sponsoring Summer Research: Electrical and Computer Engineering REU Program Home Institution: University of Montana Abstract: High bandwidth, low drive voltage, and low loss electro-optic modulators are essential for high-speed communications. Thin film waveguides based on ferroelectric materials such as Barium Strontium Titanate (BSTO) have the potential of low drive, high-speed modulation due to their relatively large electro-optic coefficient. Material factors including loss and high dielectric properties impose bandwidth barriers which limit the performance of these devices. Improvements in modulator performance through optimized design of the driving electrodes and material compositions/combinations are needed to increase the bandwidth and decrease loss. Simulations and design of a modulator in this project are based on a strip loaded polycrystalline thin film waveguide structure in a Mach-Zehnder configuration. The guide layer is a composition of Ba_{0.6}Sr_{0.4}TiO sputtered on a Magnesium Oxide (MgO) substrate with a Silicon Oxynitride (SiON) guide strip. Manufacturing and testing of an actual device will be performed once simulations and modulator design are complete.</p>

43	<p>Ted Kocher <i>Effects of Cellular Architecture on MDA-MB 231 Breast Cancer Cell Motility</i> Advisor: Patrick W. Alford Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Program Home Institution: University of Nebraska-Lincoln Abstract: Over 200,000 women living in the United States will be diagnosed with breast cancer this year. Of those whose cancer metastasizes, wherein the cells migrate away from the initial tumor, only 23% will survive. Cellular mechanics and architecture can drive a wide range of cellular behaviors such as contractility and proliferation. Here, we assessed the role of cellular architecture in breast cancer motility. MDA-MB 231 breast cancer cells were micropatterned into two sizes of four shapes. We investigated cytoskeletal architecture, measured lamellipodia extension as a function of that architecture, and quantified cellular invasion into a collagen gel. Results suggest that cellular architecture plays a role in determining the likelihood of tumor cell metastasis.</p>
44	<p>Stephanie Kong <i>AFM-based Observations of Composite Latex Particles</i> Advisor: Lorraine Francis Department or Program Sponsoring Summer Research: MRSEC Home Institution: University at Buffalo Abstract: Water-borne latex dispersions undergo film formation upon drying as polymer particles coalesce to form a homogenous coating. Particles containing soft polymers with low glass transition temperatures (T_g) easily form a film at room temperature, but these films typically lack desired mechanical properties. Alternatively, particles containing hard polymers with high T_gs are valued for their mechanical strength and stability, but lack the ability to film-form without the addition of volatile additives. Balancing the desirable features of low and high T_g polymer particles can be achieved by engineering composite latex particles. These particles, containing core-shell morphology, combine the mechanical strength of a hard shell (high T_g) with the film-forming abilities of a soft core (low T_g). In this work, the effects of temperature, particle size, and T_g on the extent of film-formation will be studied. Using atomic force microscopy, film-formation was quantified by surface changes in peak-to-peak distances, particle shapes, and peak-to-valley distances. These characterization parameters indicated that small particle latex dispersions form better films. Results also showed that core/shell ratio acts as one of most significant factors in film-formation.</p>
45	<p>Arianna Kooyman <i>A Gold Mine of Surprising Chemistry: C-H Activation at Au(III)</i> Advisor: Dr. Daron E. Janzen Department or Program Sponsoring Summer Research: Chemistry Home Institution: St. Catherine University Abstract: Our main research focused on exploring fundamental aspects of Au(III) coordination chemistry and organometallics. Au(III) was chosen because of its high reactivity and excellent reductive properties. In particular, the coordinating ability of the tridentate 1, 4, 7-trithiacyclononane (9S3) ligand was extensively explored. This ligand was especially interesting because subsequent reactions of Au(III) coordinated to a 9S3 ligand yielded chiral sulfonium salts. These salts are important because they are possible therapeutic agents for synthesizing glycosidase inhibitors, which prevent serious diseases such as diabetes. NMR, Elemental Analysis, and X-ray crystallography were used to characterize reported complexes. Numerous unexpected reaction products were obtained, many of which could only be identified by crystallography. The mechanistic details of these Au(III) coordination reactions with regards to C-H activation are currently being pursued.</p>

46	<p>Shannon Kreuser <i>Polyolcarboxylic acids: An investigation of the the possibility of hydrogen bond networks transmitting the inductive effect at a distance</i> Advisor: Steven Kass Department or Program Sponsoring Summer Research: LANDO/NSF REU Home Institution: Lawrence University Abstract: Hydrogen bonds networks have been shown to increase the stabilization of oxyanions and therefore increase the acidities of polyols. The inductive effect has also been shown to increase the acidity of alcohols and carboxylic acids, but only from a distance of 4 or fewer carbons. Former research in our research group has pointed to the possibility of the inductive effect being transmitted through hydrogen bond networks over longer distances. This project set out to systematically test and synthesize compounds designed to test whether or not CF₃ groups can affect the pK_a's of carboxylic acids in water and DMSO by acting through hydrogen bond networks. So far, pK_a's of butyric acid derivatives show that the effects of a hydrogen bond network and an electron withdrawing group are additive in water.</p>
47	<p>Rebecca Kummer <i>Synthesis of a novel antibacterial compound</i> Advisor: Dr. J. Thomas Ippoliti Department or Program Sponsoring Summer Research: UST Summer Research Home Institution: University of St. Thomas Abstract: Bacteria resistant to frequently used antibiotics are common, even in the hospital setting. For this reason, there is a pressing need to develop new antibacterial compounds derived from molecules of different chemical classes. Molecular Topology (MT) is an innovative mathematical system that is dedicated to just that purpose. This program is able to correlate chemical structures to biological properties. Using this system, it is possible to predict the chemical structures of compounds that are not analogous to currently used, biologically active compounds, particularly those compounds which have a high probability of being effective antibiotics. The synthesis of a compound predicted by MT to have antibacterial activity, along with various derivatives of the target compound, is the goal of this research project. The synthesis of the target molecule was completed recently, and future work will be dedicated to testing the molecule for antibacterial activity.</p>
48	<p>Nicholas Lewellyn <i>Measuring Frequency Dependence of AC Magnetic Susceptibility</i> Advisor: Dan E. Dahlberg Department or Program Sponsoring Summer Research: School of Physics and Astronomy - REU Home Institution: St. Cloud State University Abstract: Measurement of AC magnetic susceptibility was done using anisotropic magnetoresistance (AMR). The AMR effect was used to relate the measured resistance of the sample to the magnetization. Specifically, we used a permalloy sample and looked at how the frequency of the AC field applied affected the susceptibility, both the real and imaginary parts. We found that the frequency dependence was not as we had expected. The imaginary susceptibility did not continue to increase with frequency.</p>

49	<p>Yuanda Li <i>Transport Properties and Scanning Electron Microscopy Study of Spin Logic Devices</i> Advisor: JiangPing Wang Department or Program Sponsoring Summer Research: MRSEC Home Institution: Georgia Tech Abstract: The use of spin in logic applications has many potential advantages over the use of charge based devices such as CMOS in terms of power consumption. Also, it is possible to change the magnetic configuration of nanomagnets via providing sufficient current, known as spin transfer torque. These nanomagnets produce high resistance states or low resistance states depending if the orientation of the nanomagnets are aligned either antiparallel or parallel to each other. This change in resistance can correspond to different logic bits and has applications such as allowing signals to be transferred to certain input and output magnets for logic functions. A lock-in amplifier will be used for electrical measurements and a program needs to be developed to utilize the lock-in amplifier. Electrical instruments will be used to analyze the resistance states of the sample. Scanning electron microscopy images will be taken to analyze the physical structure of the samples.</p>
50	<p>Jordan Ly <i>Photonic Crystal Gas Sensor</i> Advisor: Mo Li Department or Program Sponsoring Summer Research: Electrical and Computer Engineering REU Program Home Institution: Villanova University Abstract: Gas sensors are used in many fields such as medical, automotive, and environmental applications due to the importance of monitoring and controlling gases. The advantages of optical gas sensors, specifically photonic crystal (PhC) gas sensors, are their size and sensitivity. PhCs are drastically smaller compared to the alternatives. A smaller sensing area is essential to applications where the amount of analyte is limited. They are also highly sensitive to local changes in its environment due to their high Q factor to volume ratio. The proposed gas sensor consists of a PhC that is coated with a polymer that will absorb the analyte. Based on the change in refractive index in the polymer, the unknown gas can be determined.</p>
51	<p>Nancy Magee <i>Carbon Dioxide Interaction with N-N'-dimethylethylenediamine</i> Advisor: Laura Gagliardi Department or Program Sponsoring Summer Research: MRSEC Home Institution: Dillard University Abstract: The use of Metal Organic Frameworks (MOFs) is becoming increasingly popular in the scientific community. These crystalline, three-dimensional, porous materials are composed of metal ions and organic ligands, and have been used for a wide variety of applications ranging from catalysis to gas separation and storage. One application that has piqued interest, due to the rising concerns about atmospheric pollutants, is Carbon Capture and Sequestration (CCS). Previous research performed by the Gagliardi group (U of M) in collaboration with the Long group (UC Berkeley) performed a DFT mechanistic study that tackled the capture of carbon dioxide (CO₂) by N, N'-dimethylethylenediamine (mmen) anchored to the MOF Mg₂-(dobpdc), where dobpdc²⁻ is 4, 4'-dioxidobiphenyl-3, 3' -dicarboxylate) and explained the experimentally observed 1:1 (CO₂: amine) stoichiometry by an effective 2:2 stoichiometry yielding a bas-carbamic acid complex. CO₂ capture by amines in aqueous media occurs through a 1:2 stoichiometry reaction, and the product consists of carbamate and ammonium adduct. Inside of the MOF, the corresponding intermediate species exists as neutral carbamic acid hydrogen bound to an amine. This work investigates the nature of carbamate-ammonium complex species in the gas phase for mmen derivate species containing different substituents.</p>

52	<p>Kelsey Meinerz <i>Probing the Point Spread Function</i> Advisor: Dr. Joachim Mueller Department or Program Sponsoring Summer Research: Physics REU Home Institution: Marquette University Abstract: Near point source objects emit light which is subject to diffraction and the aberrations of optical equipment. Images of these objects appear to be extended and can be described completely by a Point Spread Function (PSF). In an ideal optical imaging system obeying the paraxial limit, unpolarized plane waves result in a PSF that is exactly the Airy pattern in the focal plane. The spatial extent of the PSF is on the order of the wavelength of light, which fundamentally limits the resolution of the optical microscope. In order to image biological objects on the order of 10-100nm, super-resolution techniques are being developed. These techniques require a quantitative understanding of the PSF, which is influenced by many factors in a real microscope. The first step towards this goal was to verify a program developed in the Mueller lab that computes the PSF of a microscope. Once the validity of the PSF program was established, it was utilized to simulate the PSF and compared with fluorescence microscopy techniques of biological samples, in order to explore different parameters. The thickness of the coverslip was found to heavily impact the PSF and the size of the detector is a crucial parameter when using 2-photon microscopy.</p>
53	<p>Kara Meyers <i>Crystallographic and Spectroscopic Characterization of Bis(N-methyl-N-phenylcarbamoyl)polysulfanes</i> Advisor: George Barany Department or Program Sponsoring Summer Research: Undergraduate Research Opportunities Program (UROP) Home Institution: University of Minnesota Twin Cities Abstract: Bis(N-methyl-N-phenylcarbamoyl)polysulfanes, with one to six linearly connected sulfurs, have been prepared, purified, and characterized by ¹H and ¹³C nuclear magnetic resonance, infrared spectroscopy, mass spectrometry, liquid chromatography, and most informatively, x-ray single crystallographic analysis. The detailed structural information compiled and interpreted in this project provides insights into the chemical and physical properties of this novel, surprisingly robust, and often useful family of homologous compounds.</p>
54	<p>Kayla Mitt <i>Optimization of the Procedure to Synthesize OSDA</i> Advisor: Dr. Tsapatsis Department or Program Sponsoring Summer Research: MRSEC Home Institution: Dillard University Abstract: Synthetic zeolites have a multitude of applications in today's world. However, a zeolite's efficiency depends upon several factors such as pore size, thickness and smoothness, all of which are impacted by the purity of the starting material. This starting material is a bi-quaternary ammonium salt, which is produced through a lengthy process. Because this process is lengthy, there are many opportunities for error to occur and result in an impure product or low product yield. Therefore, the aim is to optimize this process at every available opportunity. To optimize this procedure, the original procedure was done and the steps that seemed problematic were noted. Ways to improve these steps were then researched and tested. These improvements were in regards to the chronologic order of the steps, mode of addition of the reactants and calculation of molarity. Through these improvements, the new, optimized procedure resulted better results in regards to yield and purity.</p>

55	<p>Evan Moen <i>Dynamics of Water on a Magnetite Surface</i> Advisor: Dr. J.W. Halley Department or Program Sponsoring Summer Research: Physics Home Institution: University of North Dakota Abstract: We simulated magnetite using the molecular dynamics method which uses a Newtonian model of atomic level dynamics and allows for the dissociation of water. We ran simulations of pure magnetite with two sets of surface terminations in a vacuum and compared them to literature results to ensure the model's validity. We then simulated a monolayer of water on the magnetite in agreement with the results of previous simulations, some of which used more exact methods. We then took the results of that test and added a model of melted water on top of the magnetite/monolayer. At the current stage our results incorrectly indicate that the water is in an amorphous solid state. After this problem is resolved we plan to calculate the free energy cost of removing a proton from the surface in order to better understand recent experimental results of the generation of hydrogen by electrolysis using magnetite.</p>
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56	<p>Katya Moghadam and Chris DeVet <i>SYNTHESIS OF AMIDES USING A CATALYZED CONTINUOUS FLOW PROCESS</i> Advisor: Michael Wentzel Department or Program Sponsoring Summer Research: Sundquist Scholar Home Institution: Augsburg College Abstract: Amides are pervasive in nature and technology and their synthesis is one of the most extensively used organic transformations due to their widespread occurrence in modern pharmaceuticals and biologically active compounds. The result of research efforts focused on the development of a more efficient, economical, and environmentally friendly method of amide synthesis has led to a novel catalytic method for the conversion of nitriles and amines into amide products. A lab scale continuous flow reactor system fitted with a titanium dioxide packed catalyst column was successfully used to couple various amines with either acetonitrile or butyronitrile to form amide products. The effects of temperature and pressure were explored and conditions were optimized for our model system using benzylamine and acetonitrile. The conversion rates of investigated amines demonstrate improved efficiency and comparable yields to cited literature values.</p>
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57	<p>Frances Morris <i>Detection of DNA Point Mutations with MutS by CE-LIF</i> Advisor: Edgar Arriaga Department or Program Sponsoring Summer Research: Heisig/Gleysteen Chemistry Program Home Institution: University of Minnesota-Twin Cities Abstract: Single point mutations as well as insertion/deletion loops (IDLs) in DNA are isolated by protection with MutS, an E. coli mismatch repair pathway protein, followed by DNA digestion. A method of capillary electrophoresis paired with highly sensitive laser-induced fluorescence (CE-LIF) separates and detects the DNA-MutS complex and accurately measures point mutations or IDLs.</p>
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58	<p>Aminatou Mouhamed <i>Reactivity of Dicopper Complexes to oxidize C-H bonds</i> Advisor: William B. Tolman Department or Program Sponsoring Summer Research: MSROP Home Institution: University Of Minnesota Abstract: With the goal of understanding the structural, spectroscopic and reactivity properties of the pMMO enzyme, research was done to develop a new mimic of the pMMO enzyme active site using small molecule copper complexes. pMMO is an enzyme found in bacteria and is unique in the ability to oxidize methane to methanol. Although, little is known about the pMMO active site structure and mechanism, the Tolman lab is using mimics to try and replicate the reactivity in order to better understand the enzyme. Success of developing new oxidation catalysts to activate C-H bonds can have far reaching impact in alternative energy, fuel sources and lead us closer to a methanol economy. With all the reactions conducted in the glovebox under various conditions, the macrocycle, H4L-C2 ligand was synthesized and reacted with copper to yield a novel dicopper complex. The product was characterized by elementary analysis, UV-Vis, NMR, and mass spectrometry.</p>
59	<p>Kirsten Mueller <i>DNA Structure Affects Binding to Polycationic Delivery Agents</i> Advisor: Dr. Lisa E. Prevette Department or Program Sponsoring Summer Research: Undergraduate Research Home Institution: University of St. Thomas Abstract: Innovations in gene therapy have brought researchers closer to finding a cure for genetic disorders, cancer, and other genetically-based illnesses. For treatment, one must transfect DNA into the cell via delivery agents – PAMAM, PEI, and TAT. To study how the effect of DNA structure on its binding to this delivery agent, an ethidium bromide exclusion assay, electrophoretic mobility shift assay (EMSA), and isothermal titration calorimetry (ITC) were used to test for strength of binding. Thus far, it has been found that single- and double-stranded DNA bind similarly, both better than plasmid DNA. PAMAM and PEI also bind similarly to all types of DNA, both better than TAT. Poly(A), poly(T), and poly(C) DNA show no binding to any polymer. Each DNA-polymer complex will be tested on each assay to complete the project. This data can be used to determine which type of DNA can best transfect cells during gene therapy.</p>
60	<p>Janet Muzulu <i>"Greening up": A Multistep Synthetic Transformation</i> Advisor: James Wollack Department or Program Sponsoring Summer Research: Summer Scholars Home Institution: St Catherine University Abstract: Green Chemistry, a design that is meant to reduce the use and generation of hazardous substances, addresses problems we face in the world today like water contamination, global warming and ozone depletion. Teaching the importance of green chemistry is imperative to the future of chemistry and the environment. Because most useful organic chemical targets require more than one synthetic step, undergraduate organic chemistry students are encouraged to be exposed to labs that require multiple transformations. Students will understand how reactions work after observing them first-hand. Additionally, since the 'traditional' synthesis of most chemical substances utilizes solvents and reagents that are hazardous, students had to propose their own green alternatives by completing a 3-step synthesis, determining a greener route and using a metric system to compare the greenness of reactions. A reaction was considered green if there were relative decreases in factors that include cost, environmental toxicity, and waste produced.</p>

61	<p>Sarah N. Larson <i>C-H...F Contacts in the Crystal Structures of Some Isomeric bis-Benzylideneanilines</i> Advisor: William H. Ojala Department or Program Sponsoring Summer Research: UST Summer Research Home Institution: University of St. Thomas Abstract: We designate as "bridge-flipped isomers" those pairs of molecules differing only in the orientation of a bridge of atoms connecting two major molecular fragments. Examples exist among benzylideneanilines (Ar-CH=N-Ar' vs. Ar-N=CH-Ar') and among phenylhydrazones (Ar-CH=N-NH-Ar' vs. Ar-NH-N=CH-Ar') (Ar = aryl). Isostructural pairs of bridge-flipped isomers may prove co-crystallizable to form continuous series of solid solutions; non-isostructural pairs may be differentiated by intermolecular interactions relevant to crystal engineering. Through single-crystal X-ray diffraction we have been examining the crystal structures of fluorine-substituted bis-benzylideneaniline isomers of the structures Ar-CH=N-Ar-N=CH-Ar vs. Ar-N=CH-Ar-CH=N-Ar to determine what role C-H...F interactions may play in the solid-state packing arrangements. Although these interactions are known to be weak, they may contribute to any differences between crystal structures of bridge-flipped isomeric pairs. We observe C-H...F contacts in our structures (particularly to the bridge H atoms), but they do not appear to be decisive in establishing the molecular packing patterns.</p>
62	<p>Katherine Nygren <i>Optimizing Liquid-phase Exfoliation of MoS₂</i> Advisor: Professor Andre Mkhoyan Department or Program Sponsoring Summer Research: MRSEC Home Institution: St. Olaf College Abstract: Monolayers of Molybdenum Disulfide (MoS₂) have special electronic and mechanical properties that could be used in a large variety of applications. Most of these applications require a large volume of monolayer flakes which can be achieved through liquid-phase exfoliation. Prior to achieving such monolayers, the flakes produced in the liquid-exfoliation process must be optimized for size, specifically thickness. To optimize the flakes from the exfoliation process, we studied the effects of different solvents, sonication times, as well as centrifuge speeds. The optimized process is established by the size and thickness of the flakes from atomic force microscopy (AFM) and transmission electron microscopy (TEM) analysis. From AFM and TEM analysis we observed no correlation between lateral flake size and thickness, nor a correlation between initial concentration and flake thickness. There were noticeable thickness differences as a result of different solvents.</p>
63	<p>William A. Ogden <i>Synthesis of Rubrene Derivatives</i> Advisor: Christopher J. Douglas Department or Program Sponsoring Summer Research: Heisig/Gleysteen Chemistry Summer Research Program Home Institution: University of Minnesota Abstract: Small molecule based organic semiconducting materials have applications in organic field effect transistors and organic photovoltaic devices. In light of the recent energy crisis, the study of organic photovoltaic devices has become an important research topic. A central aspect in this field is studying the relationship between molecular structure, crystal structure and electronic properties. Rubrene, long known for its outstanding semiconducting properties, has been the focus of this work. New electron withdrawing functionality was incorporated into rubrene using an eight step sequence. Several modifications to the known synthesis were required to achieve the desired functionality. The new derivatives were analyzed using X-ray crystallography to determine the packing structure. The crystal structures obtained allowed the effect of the new functionality introduced to be understood.</p>

64	<p>Adedolapo Ojoawo and Choua Xiong <i>Structural Dynamics Studies of Phospholamban and Fatty Acid Binding Protein-4</i> Advisor: Dr. Kim N Ha Department or Program Sponsoring Summer Research: Chemistry Home Institution: St.Catherine University Abstract: Phospholamban (PLN) is a 52-residue cardiac membrane protein that is associated with regulating the activity of Sarcoplasmic Reticulum Ca²⁺-ATPase (SERCA). Imbalances in the regulation of SERCA activity by PLN phosphorylation can lead to heart failure. Mutagenesis studies have shown that changes in the structural dynamics of PLN can tune SERCA function. PLN mutations were designed and will be studied using activity assays to determine their level of inhibition on SERCA's activity. Finally, the functional studies will be correlated to relaxation measurements by NMR spectroscopy. Our second project is focused on human adipocyte fatty acid binding protein (FABP4). FABP4 is an intracellular adipocyte lipid binding protein involved in the transport of fatty acids between cell membranes and organelles. Here, NMR experiments will be carried on FABP4 to study its structural transitions between its unbound and bound states with its fatty acid and prostaglandins binding partners.</p>
65	<p>Zachary Pace Pace <i>Galaxy Zoo 2: Characterizing the Bimodal Color-Magnitude Distribution</i> Advisor: Lucy Fortson Department or Program Sponsoring Summer Research: Physics REU Home Institution: University at Buffalo, The State University of New York Abstract: In the past, large galaxy surveys have been characterized by their distribution in color-magnitude space, and these populations have been fit to luminosity functions (Schechter functions) by Baldry et al. We implement a similar procedure for morphologically-distinct populations, as identified by volunteers in the Galaxy Zoo 2 project. We implement vote-cleaning methods in order to isolate clean and superclean identifications, and we investigate characteristics of several populations, including elliptical galaxies, spiral galaxies, barred galaxies, and their sub-populations. Several morphological populations are found to have qualitatively different population distributions from the full sample, and we experiment with methods of fitting these individual populations with both unimodal and bimodal models.</p>
66	<p>Stefani Prigozhina <i>SYNTHESIS AND CHARACTERIZATION OF MONODISPERSE, NEAR-INFRARED LIGHT ABSORBING NANOPARTICLES FOR TARGETED DRUG DELIVERY FOR CANCER TREATMENT</i> Advisor: Joseph Zasadzinski Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Minnesota-- Twin Cities Abstract: Targeted drug delivery can improve the efficacy of cancer treatments by using spatial and temporal control to release drugs specifically at the tumor site. Our project focuses on the synthesis of nanoparticles that can be combined with drug carriers, proteins, and laser irradiation to treat cancer. We are interested in biocompatible nanoparticles that absorb near-infrared (NIR) light, which penetrates human tissue effectively. Also, we want monodisperse particles to maximize the laser energy that is transformed to heat. Silver, copper sulfide, gold/gold sulfide nanoparticles, and hollow gold nanoshells were synthesized for this study. They were characterized with TEM, DLS, UV-Vis spectroscopy, and the NanoSight. Their morphology, size distribution, and absorptions were compared. Our results show biocompatible, monodisperse—10, 25, 35, 45, 55, 65 nm—nanoparticles that have absorptions in the NIR region, ranging from 720 – 950 nm. In the future, these nanoparticles will be combined with drug carriers to study their interaction with picosecond NIR laser irradiation.</p>

67	<p>Jennifer Pullman <i>Determining the Switching Efficiency of a Spin Valve Structure</i> Advisor: Randall Victora Department or Program Sponsoring Summer Research: Electrical and Computer Engineering Home Institution: UC Berkeley Abstract: Improving magnetic memory structures involves increasing their switching efficiency without decreasing their thermal stability. Recently, a structure was developed consisting of dual reference layers and a three-layer composite free layer. The idea is that the switching of each free sub layer exerts torque on adjacent sub layers, assisting the switching of the adjacent layers' magnetizations. Because of this interaction, the switching efficiency of this structure is predicted to be two times greater than that of dual magnetic tunneling junction structures and three times greater than that of single spin valve structures. This project focused on determining the energy barriers of switching the magnetization of the composite layer for several different sets of anisotropy and exchange constants in order to accurately determine the switching efficiency. Preliminary results showed that this structure does produce greater switching efficiency.</p>
68	<p>Matthew Quan <i>The effects of alkali impurities on the electronic properties of Cu₂ZnSnS₄ thin films for photovoltaic devices</i> Advisor: Eray Aydil, Chris Leighton Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of California, Berkeley Abstract: The quaternary semiconductor Cu₂ZnSnS₄ (CZTS), consisting of abundant and non-toxic elements, is an ideal candidate for the absorbing layer in thin film solar cells due to its band gap and high absorption coefficient. However, synthesizing high quality phase-pure CZTS remains a challenge. To this end, we investigated the allowable elemental compositions for CZTS and developed a method to introduce Na and K to increase grain size. CZTS synthesis starts with cosputtering Cu-Zn-Sn precursors of varying compositions, followed by annealing in an evacuated sealed ampoule with a S vapor. Varying amounts of Na or K are introduced by coating the ampoule with NaOH or KOH. We found a wide window of precursor compositions that led to phase-pure CZTS and have noted a remarkable increase in grain size with Na or K inclusion. We will also present preliminary electronic measurements on the impurity-free and impurity-containing CZTS films.</p>
69	<p>Lucero Ramirez <i>Polymer Scaffold for Tissue Engineering</i> Advisor: Efi Kokkoli Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Texas- Pan American Abstract: Polymer scaffolds have emerged as a potent tool in various areas of tissue engineering. Recent advances have shown that they can be employed as versatile 3-dimensional matrixes for cultivating cells and in the formation of targeted tissue growth. Hydrogels, in particular shown immense promise as scaffold materials based on their structural similarity to the extracellular matrix of several tissues. In this project, we hope to synthesize block copolymers based on low molecular weight poly (lactide-co-glycolide) (PLGA) copolymers using ring opening polymerization and their subsequent characterization. Ultimately, it is envisioned that these unique block polymer hydrogels will greatly aid in the adhesion, differentiation and proliferation of cells with potential applications as tissue replacements.</p>

70 **Roberto Reyna**
Experimental Characterization of Collagen Pre-Stress using Collagen Hyaluronic Acid Co-gel
Advisor: Professor Victor Barocas
Department or Program Sponsoring Summer Research: MRSEC
Home Institution: The University of Texas-Pan American
Abstract: In tissue engineering, collagen gel tissue equivalents (TEs) have been used to study how structural properties affect the mechanical functions of soft tissues. One aspect not captured in past TEs is residual stress found naturally in tissues such as the blood vessels and ligaments. To achieve this in a TE a co-gel was fabricated consisting of Hyaluronic acid (HA) and Type I Collagen. Because of HA's high fixed charge density, it is able to swell in hypotonic solutions from the build up osmotic pressure arising from the Donnan Effect. This in turn stretches and stresses the collagen fiber networks, resulting in pre-stressed fibers that provide a useful experimental model system to examine residual stress in tissues. Therefore, the goal of this research is to fabricate Collagen-HA TEs, in order to determine their swelling properties and to measure the amount of pre-stress being introduced into the collagen networks.

71 **Ruben Reyna**
Optical Characterization and Synthesis of Silicon Nanoparticles through Nonthermal Argon-Silane Discharges
Advisor: Prof. Uwe Kortshagen
Department or Program Sponsoring Summer Research: MRSEC
Home Institution: University of Texas-Pan American
Abstract: Silicon nanocrystals have gained much attention in recent years due to their excellent semiconductive properties that prompt their use in light-emitting diodes (LEDs), photovoltaic (PV) cells, and other optoelectronic devices. Synthesis of these nanoparticles has been achieved through many techniques, but none offer advantages of plasma-phase processing, which is known to be environmentally benign. Therefore, optically studying the production of silicon nanocrystals through nonthermal plasma can contribute highly in understanding one of the ideal methods of synthesizing semiconductive powders. Using a monochromator and charge coupling device (CCD), time and spatially resolved optical emission spectra from these discharges can be recorded and used to determine electron temperature and various species densities. LASER light scattering will be captured using a CCD to determine the locations of nanoparticles in the plasmas during their development. This data will be compared to computational results to better comprehend spatiotemporal evolution of nanoparticle growth, position, and charging.

72 **Nicole Sauer**
Synthesis and Optimization of Silica Supports for Thin-Film Zeolite Membranes
Advisor: Michael Tsapatsis
Department or Program Sponsoring Summer Research: Catalysis Center for Energy Innovation
Home Institution: University of Minnesota
Abstract: MFI-zeolite membranes have shown great potential as an energy-efficient means of separating water from ethanol. Currently, however, the cost-efficiency ratio of the zeolite membranes does not yet make them attractive for use in industry. To increase the efficiency of these particular zeolites, silica support structures, rather than the usual alumina supports, are being investigated because they help stimulate b-oriented crystal morphology so as to obtain the highest flux. The difficulty of this method arises in the microporous nature of the silica nanospheres used to create the supports, which causes shrinking and cracking when the supports are heat treated. In this study, the parameters of the Stöber synthesis, including reactant concentrations, reactant addition rate and order of addition, pH, and characterization techniques, were studied and optimized to create monodisperse silica spheres with 300nm and 500nm diameters. The process used to make silica disks, including sintering and polishing conditions, was also studied to improve the mechanical stability of the support structures without compromising porosity or surface uniformity. A new standard operating procedure and supplementing instructional video were developed to include all newly defined parameters and protocols.

73	<p>Jairah Shaikh <i>Nanocomposite Cathodes for Rechargeable Lithium Ion Batteries</i> Advisor: Andreas Stein Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Texas Pan American Abstract: Lithium ion batteries provide a reliable source of electric power for transportation and portable devices. However, they maintain a low power density and are susceptible to significant loss of capacity over cycles. Through careful selection of cathode materials and design of nanoscale architecture, current challenges with conductivity and volume expansion can be overcome. Three-dimensionally ordered mesoporous and macroporous (3DOM/3DOM) carbon hosts were prepared separately and infiltrated by precursors, which were then successfully converted into the active material. Theoretically, the active material promises a large capacity, while the carbon and porosity of the hosts' structure deliver a matrix of conductivity and an improvement in mass transport of lithium ions, thus yielding higher power density. Additionally, the carbon's structure enhances cyclability by confining the volume of the active material within its pores. XRD and SEM confirm the synthesis of the active material within the carbon and the presence of porosity.</p>
74	<p>Claire Simpson <i>Toward the total synthesis of drimentine C: preparation of cyclo-L-tryptophan-L-proline</i> Advisor: Chris Douglas Department or Program Sponsoring Summer Research: N/A Home Institution: Breck School Abstract: _</p>
75	<p>Wesley Singelton <i>RAFT polymerization of ABC triblock: Poly(N-isopropylacrylamide) - poly(N,N-dimethylacrylamide-co-acrylic acid) - poly(N,N-diethylacrylamide)</i> Advisor: Dr Ronald Siegel Department or Program Sponsoring Summer Research: MRSEC Home Institution: Florida Agricultural and Mechanical University Abstract: Reversible hydrogels that respond to pH and temperature stimuli are of interest for their many possible functions such as substrates for drug delivery, cell immobilization, and tissue engineering. Poly(N-isopropylacrylamide) - poly(N,N-dimethylacrylamide-co-acrylic acid) - poly(N,N-diethylacrylamide), PNIPAm-P(DMA-co-AA)-PDEA, was synthesized by reversible addition-fragmentation chain transfer (RAFT) polymerization. The A and C blocks are composed of PNIPAm and PDEA, which are well known temperature responsive polymers. The B block is a copolymer of DMA and AA. In literature, dimethylacrylamide has shown the ability to readily copolymerize with a number of acrylamide derivatives, while poly(acrylic acid) is a well known pH sensitive polymer that has been used as a thickener in paints and a water absorbing agent in disposable diapers. Traditional hydrogels that have covalent bonded structures are permanently in their gel state, while PNIPAm-P(DMA-co-AA)-PDEAm is expected to undergo a reversible sol to gel transition. The ABC triblock terpolymer exhibits sensitivity to both temperature and pH, due to its respective compounds. In a high temperature environment, the polymer is expected to form a physical hydrogel and exhibit swelling and shrinking in different pH and temperature environments.</p>

76	<p>Hannah Skopec <i>Developing a Lanthanide Based Luminescent Probe to Monitor HIF Hydroxylases</i> Advisor: Valerie Pierre Department or Program Sponsoring Summer Research: Heisig/Gleysteen Home Institution: University of Minnesota Abstract: Lanthanide-based probes are a promising new tool for cellular imaging. The large Stokes shift between excitation and emission wavelengths in conjunction with narrow emission bands and non-overlapping spectra enable the possibility of using multiple probes for detection without interference. Additionally, lanthanide based probes have long luminescent lifetimes, so time resolved assays guarantee luminescent signal only from the probe. The aim of this project focuses on synthesizing and testing a specific probe to monitor HIF (Hypoxia Inducible Factor) hydroxylases. These enzymes are involved in sensing oxygen concentrations in cells. The long term objective is to understand how cells sense oxygen concentrations and how HIF hydroxylases are involved in the process.</p>
77	<p>Joseph Slaughter <i>Characterizing The Role of HiF1 alpha in Pancreatic Ductal Adenocarcinoma</i> Advisor: Dr. Anindya Bagchi Department or Program Sponsoring Summer Research: MSROP Home Institution: University of Minnesota Abstract:</p>
78	<p>Anne Sledd <i>Gas-Phase Surface Passivation of Silicon Nanocrystals for Light-Emitting Devices</i> Advisor: Prof Uwe Kortshagen Department or Program Sponsoring Summer Research: MRSEC Home Institution: Carleton College Abstract: Silicon nanocrystals (SiNCs) are widely researched because of their potential application in renewable energy devices. At the nanoscale, silicon exhibits quantum mechanical properties; its wavelength-tunable light emission makes it an attractive material for light-emitting devices. Photoluminescent properties of SiNCs depend strongly on surface chemistry due to their small sizes. Thus, for industrial applications, a simple and efficient method is needed to synthesize SiNCs and modify their surface chemistry. One promising approach is an all-gas-phase method where SiNCs are synthesized and passivated with organic ligands in a single low-pressure nonthermal plasma. Here we explore ways to improve SiNC photoluminescence efficiency by varying plasma parameters such as pressure, input power, gas flow rates, etc. Exposure to ultraviolet (UV) light has also been shown to aid in the attachment of organic ligands to SiNCs' surface. Preliminary results show up to 30% photoluminescence efficiency for UV exposed SiNCs synthesized at lower gas flow rates.</p>
79	<p>Ryan Smith <i>Conjugation Ratio and Polyethyleneglycol Molecular Weight Affect the Interaction of Polyethyleneimine with DNA</i> Advisor: Dr. Lisa Pevette Department or Program Sponsoring Summer Research: Chemistry Home Institution: St. Thomas Abstract: Polyethylenimine (PEI) is the most widely used gene delivery agent. Unfortunately, PEI-DNA polyplexes aggregate in the blood stream and can be toxic to cell membranes. To combat this, we synthesized a library of nine cationic copolymers by grafting three molecular weights (750, 2000, 5000 Da) of poly(ethylene glycol) (PEG) to PEI in three conjugation ratios (1:3, 1:12, 1:30; PEG:PEI N). Using Ethidium Bromide Exclusion Assays, Isothermal Titration Calorimetry, Dynamic Light Scattering, and Electrophoretic Mobility Shift Assays, we have determined that DNA binding is hindered only at conjugation ratio 1:3 with no effect of PEG molecular weight. Conjugation ratios of 1:12 and 1:30 show little to no decrease in binding affinity. At physiological ionic strength, PEGylation decreases aggregation of the polyplexes as a function of both PEG molecular weight and conjugation ratio. These results lead to the design of gene delivery agents that will be more effective in vivo.</p>

80	<p>Andrew Stephan <i>Infrared Photodetectors With 2D Materials</i> Advisor: Dr. Steven Koester Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Home Institution: Bethel University Abstract: As computer processor speed rises exponentially, the bandwidth required for inter-processor communication grows as well. Integrated optoelectronics may solve the interconnect bandwidth bottleneck. The unique properties of 2-D materials could help realize the next generation of high-speed optical communications. The three necessary components are infrared transmitters, modulators and detectors. In this work a new heterostructure photodetector has been designed and built using monolayer graphene and varying thicknesses of molybdenum disulfide. This device provides sensitivity in the infrared region optimal for optical communication (1550 nm) while maintaining low dark current. Monolayer graphene grown by chemical vapor deposition (CVD) has been patterned onto mechanically exfoliated molybdenum disulfide (MoS₂) and titanium-gold contacts made to both materials. Initial electrical characterization of the devices has been performed. The resulting resistance and linearity of the contacts agree with predictions. These preliminary results are encouraging and indicate the photodetector device will perform as expected.</p>
81	<p>Samuel Stoneburner <i>Computational Study of Binding Properties for Methane/Nitrogen Separation Using Metal-Organic Frameworks</i> Advisor: Prof. Laura Gagliardi Department or Program Sponsoring Summer Research: Chemistry Lando Home Institution: Hillsdale College Abstract: Natural gas refinement requires separation of nitrogen, carbon dioxide, and methane, and metal-organic frameworks (MOFs) are receiving a great deal of attention for this reason. M-MOF-74 (M₂(dobdc), dobdc⁴⁻= 2,5-dioxido-1,4-benzenedicarboxylate) is the object of particular focus due to the presence of coordinatively unsaturated metal sites. , Binding energies of methane and nitrogen with a cluster model of Fe-MOF-74 were calculated and compared with prior studies of comparable models of V-MOF-74 done at the Nanoporous Materials Genome Center at the University of Minnesota. Results had mixed agreement with past data from other methods.</p>
82	<p>Hunter Storaci <i>Error Localization</i> Advisor: John Sartori Department or Program Sponsoring Summer Research: ECE Home Institution: University of Wyoming Abstract: Software Canaries are a software-based technique for finding the minimum energy operating point of a processor. These routines execute on a processor testing for timing slack on the processor's critical (longest) timing paths ensuring that they meet necessary timing constraints. Available timing slack can be exploited to achieve a safe, aggressive operating point that is more energy efficient than the conventional worst case operating point. Since software canary tests are executed periodically during runtime, their overhead should be minimized. The goal of our error localization routines is to determine the parts of a processor that are most sensitive to dynamic voltage and frequency scaling (DVFS) and therefore fail first in the event of an unsafe operating condition. Knowing this, we can limit the scope of the software canary testing to these specific areas, reducing the overhead of canary testing and further improving the energy efficiency of the system.</p>

83	<p>Matthew Styles <i>Plasmon Optimization of Nanoscale Lithography and Synthesis of Silver Nanoparticles</i> Advisor: Dr. Christy L. Haynes Department or Program Sponsoring Summer Research: None Home Institution: University of Minnesota Abstract: Surface-enhanced Raman spectroscopy (SERS) is a powerful technique for sensitive, real-time chemical and biological sensing with the potential for numerous medical applications. The enhancement is due to the localized surface plasmon resonance (LSPR) of the substrate, which can be tuned by changing the size and shape of the substrate; specifically, this is done by varying the thickness of the gold or silver film deposited on the silica nanospheres of the SERS substrate to shift the wavelength of the plasmon. These SERS substrates will be functionalized and used to sense proteins, glucose, and other biological agents of interest. In addition to biological sensing on solid substrates, noble metal nanoparticles can be used to investigate interactions in solution suspensions. To this end, the size and shape of silver nanoparticles (AgNPs) can be tuned to study the ionization of Ag(0) to Ag⁺ in bacterial suspensions.</p>
84	<p>Anthony Tabet <i>Studying the Effect of π Stacking and Interface to Bulk Ratios in Poly (3-hexylthiophene)</i> Advisor: Aaron Massari Department or Program Sponsoring Summer Research: National Science Foundation, Division of Chemistry Home Institution: University of Minnesota Abstract: Organic solar cells have been the topic of research and interest in recent years. Light weight and flexible, these solar cells are the frontrunners in the race to make solar energy competitive with fossil fuels. Understanding the fundamental properties of organic semiconductor polymers like poly (3-hexylthiophene) used in solar cells is crucial to making significant advancements in this field. In this work, we studied the absorption of varying film thicknesses of P3HT because we were interested in the interface- specifically, how the interface differs from the bulk, and what role the ratio of interface-to-bulk plays. Furthermore, we found the morphology to understand the uniformity (or lack thereof) of the interface in thin films. UV-Visible Spectroscopy was used for finding film absorption while Fluorometry was used for finding film emission. Variable Angle Spectroscopic Ellipsometry was utilized to measure film thickness, and Atomic Force Microscopy was used to map out morphology.</p>
85	<p>Meghan Talbot <i>Investigating the Role of Triazole Based Ligands in a Nickel Catalyzed Dehydrogenation of Ammonia-Borane</i> Advisor: Dr. Marites Guino-o Department or Program Sponsoring Summer Research: Summer Research 2013 Home Institution: University of St. Thomas Abstract: Enders' carbene, as stated by Baker in 2007, is the ligand most effective in the nickel catalyzed dehydrogenation of ammonia-borane. Our goal is to understand the stereoelectronic properties of Enders' carbene that allows it to be an efficient catalyst. To accomplish this, we will synthesize different triazole-based ligands with unique stereoelectronic properties. The steric and electronic properties will be investigated using single crystal x-ray diffraction and Fourier transform infrared spectroscopy respectively. These synthesized ligands will be used in the nickel catalyzed dehydrogenation reaction with the amount of hydrogen gas evolved being measured. By comparing the stereoelectronic properties of the ligand with the amount of hydrogen gas evolved a correlation can be drawn. This correlation can then predict the effectiveness of a ligand based on its stereoelectronic properties in the dehydrogenation of ammonia-borane.</p>

86	<p>Ariel Taylor <i>Rapid Detection Methods</i> Advisor: Dr. Theodore Labuza Department or Program Sponsoring Summer Research: MSROP Home Institution: University of Minnesota Abstract: According to the FDA, allergens are the leading cause in food recalls, resulting in millions of dollars spent by companies, loss of trust by consumers, allergic reactions and hospitalizations. So how can we rapidly detect these trace amounts of allergens in our food supply before they are sold? The methodology used first will be Immune Magnetic Separation (IMS). Using the magnetic dynabeads to extract the protein and any other metallic substances. Once the solids are extracted we will then combine them with a liquid enhancer and use a portable Raman device also known as SERS (Surface Enhanced Raman Spectroscopy) to come up with a spectrum. Using this portable Raman device and the enhanced protein there is a favorable chance we are able to detect the soy protein even in a complex matrix such as milk. We would like to make this a repeatable process with quality results and a consistent Raman spectrum.</p>
87	<p>Jeremy Tuttle <i>Fabricating MoS₂ Field Effect Transistors</i> Advisor: Paul Crowell Department or Program Sponsoring Summer Research: MRSEC Home Institution: Century College Abstract: The nano-scale structures of ubiquitous, everyday materials has become an area of extreme interest since the success of Graphene. The electro-magnetic character of certain transition metals, and/or dichalcogenides have promising capabilities for the future of electronics, if only we can apply nano-sized components and test their physical properties. One of those dichalcogenides that will be studied here is molybdenum disulfide (MoS₂), in which the properties of MoS₂ in bulk differ from those of its monolayer. By using the scotch tape micro-cleavage technique used in the exfoliation of graphene, we will acquire single-layer, nano-sized flakes of MoS₂ and transfer them to a silicon substrate for electronic fabrication. Once these micro-devices are assembled, we will carry out regular physics experiments to determine their properties, in the hope that they will perform as the dynamic material we hope them to be.</p>
88	<p>Ritesh Uppuluri <i>Solution synthesis and optimization of kesterites onto flexible substrates using microwave heating</i> Advisor: Prof. Lee Penn Department or Program Sponsoring Summer Research: MRSEC Home Institution: University of Illinois at Springfield Abstract: In this project, we propose to grow kesterite thin films, such as copper zinc tin sulfide (CZTS), for photovoltaic applications. The thin films will be synthesized by selective heating of conductive substrates (ITO, Mo-coated glass, and Mo-coated Kapton) using a microwave-assisted synthesis at low temperatures. The synthesis will be optimized to find the right metal precursor, temperature, power, and solvent. The synthesized thin film materials will be characterized using X-ray diffraction (XRD), Raman spectroscopy, Scanning Electron Microscopy (SEM), and Energy-Dispersive X-ray Spectroscopy (EDS). X-ray diffraction is utilized to verify the crystal structure of the synthesized material and Raman spectroscopy is used to verify the phase of the structure based on its vibrational and rotational modes and also identify any contaminants present. Scanning Electron Microscopy will be useful in obtaining the image of the film, identifying its thickness and crystallite size. Finally, Energy-Dispersive X-ray spectroscopy will be used to provide elemental information in the crystallite structure.</p>

89	<p>Nick VanDeusen <i>Implementing Stochastic Computing to Model the Logistic Map and its Transition Probability Matrix</i> Advisor: Kia Bazargan Department or Program Sponsoring Summer Research: Electrical and Computer Engineering REU Program Home Institution: Western New England University Abstract: In mathematics, the complexity of chaotic behavior can be showcased with simple dynamical equations. We have opted for the logistic map, a degree-2 polynomial that is familiar to most who study dynamical systems. Our mission is to model the logistic map with a stochastic approach. That is, digital values encoded as random bit streams. The statistics of the bit stream lends itself a probability value. Using probabilistic signals instead of deterministic signals, simple digital circuitry can accurately model the complexities that dynamical systems exhibit but with far less hardware logic compared to traditional methods. For a stochastic implementation to work, input values fed to digital logic must exhibit little statistical correlation. However, in dynamical systems the same output values are fed back as inputs, which makes stochastic implementation of dynamical systems challenging. By experimenting with several output shuffling techniques, we were able to successfully reduce input correlation and hence model the logistic map. MATLAB and C++ were used to simulate the logic circuits and analyze the architecture's behavior with a transition probability matrix -- a mathematical tool to predict the long term behavior of a stochastic system.</p>
90	<p>Dylan Walsh <i>Development And Mechanistic Study Related To Quinoline-Directed Alkene Oxyacylation Reactions</i> Advisor: Christopher J. Douglas Department or Program Sponsoring Summer Research: Heisig/Gleysteen Chemistry Summer Research Program Home Institution: University of Minnesota Abstract: One of the biggest challenges of modern organic synthesis is the preparation of complex molecules with a high level of efficiency. To this end, attempts were made to develop a ketone carboacylation reaction with a quinoline directing group which would provide a novel method to react two ketone functionalities within a single molecule. The reaction proceeds through carbon-carbon bond activation by means of a transition metal. This work has resulted in a new understanding of the barriers to such reactivity. A newly proposed theory suggests that the formation of expected product is unfavorable due to the final functionalization step. As proof of concept, an alkene oxyacylation reaction was proposed to be favorable through the activation of the acyl carbon-oxygen bond of an ester. The alkene oxyacylation reaction has proven to be effective by producing yields as high as 90% over several substrates.</p>
91	<p>Ming-Lun (Jimmy) Wu <i>Micro-Fabrication of Chemical Field-Effect Transistor</i> Advisor: Dr. Stephen Campbell Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Program Home Institution: University of Florida Abstract: A transistor amplifies electrical signals applied to the gate electrode. Metal-oxide field-effect transistor (MOSFET) is the most commonly manufactured example. If one replaces the metal gate of a MOSFET with a selective membrane, it enables transistors to amplify electrical signals based on the ion concentration of a solution. Such devices are known as a chemical field-effect transistor (ChemFET). Integrating micro-fabrication techniques, photolithography and wet oxidation, with transistor knowledge, we can fabricate ChemFETs at the micro-scale. A research group at Minnesota envisions these micro-scale ChemFETs could measure sweat droplet as small as 1 millimeter in diameter. This will allow noninvasive tests of neural function and simple aspects of the endocrine system. Casting of Poly(2-hydroxyethyl methacrylate) and including ionophores, Valinocycin and ETH 2120, in the membrane enhance the selectivity and responses of ChemFETs. The goal is to fabricate micro-scale ChemFETs that measure the concentration of sodium, and potassium in a solution.</p>

92	<p>Ashlyn Young <i>Microfluidic Assessment of Neutrophil Chemotaxis in Asthma</i> Advisor: Dr. Christy Haynes Department or Program Sponsoring Summer Research: National Nanotechnology Infrastructure Network REU Program Home Institution: University of North Carolina at Chapel Hill Abstract: Neutrophils play a key role in the human immune system as the first cells to migrate to sites of inflammation. Several common respiratory diseases, such as chronic obstructive pulmonary disease (COPD) and asthma, are characterized by excessive chemotaxis and damaging apoptosis of neutrophils around infection. Theophylline, one potential therapeutic candidate, was employed to examine drug effects on neutrophil function. The chemotactic behaviors of neutrophils were monitored using a microfluidic platform after incubation with various concentrations of theophylline for different time periods. Theophylline works to limit the motility of neutrophils in small concentrations and long incubation times; however, there is no influence on the polarization of neutrophils. Meanwhile, theophylline indicated the tremendous decrease in neutrophil viability based on colorimetric assay in a time-dependent manner. These results display no significant difference in the chemotactic activity of neutrophils, though cell death and decreased mobility were observed when incubated for short time periods.</p>
93	<p>Olga Zamulko <i>Synthesis of a Novel Isoxazolinone</i> Advisor: Dr. J. T. Ippoliti Department or Program Sponsoring Summer Research: Chemistry Home Institution: University of St. Thomas Abstract: In recent years, antibacterial resistance has been steadily rising. As a result, synthesis of novel antibiotics that are safe and effective against multidrug resistant bacteria is imperative. One such drug, commercially known as Zyvox, was approved by the Food and Drug Administration in 2000. Zyvox is in a class of oxazolinones that are readily used in treatment of infections caused by Gram-positive bacteria. Since its development thirteen years ago, the synthesis of several derivatives of Zyvox has been attempted. Isoxazolinone is one derivative that has shown antibacterial activity. The purpose of this research is to synthesize a novel compound that is an isoxazolinone derivative in an attempt to increase antibacterial activity over known isoxazolinone molecules. The synthesis utilizes a seven-step route to produce the isoxazoline target molecule. This research hopes to introduce a more effective antibiotic to combat multidrug resistance bacteria.</p>
94	<p>David Zoltowski <i>Sparsity-promoting optimal control of spatially-invariant systems</i> Advisor: Mihailo Jovanović Department or Program Sponsoring Summer Research: Electrical and Computer Engineering REU Home Institution: Michigan State University Abstract: Sparse and block sparse feedback gains are designed for spatially-invariant systems. An existing method that minimizes the variance amplification is altered for spatially-invariant systems. First, sparsity patterns are found using the alternating direction of multipliers. The circulant state-space representation matrices can be diagonalized by Fourier matrices, which allows for the decomposition of the minimization problem into many smaller problems instead of one large problem. This is shown to be more efficient for larger systems. Next, optimal feedback gains are designed for the identified sparse structure also using the alternating direction of multipliers. The introduced methods are theoretically parallelizable. Examples are provided that verify the success of this approach.</p>

Poster Presentations for RET Participants
Listed Alphabetically by Presenting Author

95	<p>Cassandra Knutson <i>Development and Implementation of Forensic Chemistry Techniques in an Educational Setting to Increase Comprehension of the Scientific Method</i> Advisor: Christy Haynes Department or Program Sponsoring Summer Research: MRSEC RET Home Institution: White Bear Lake High School Abstract: Recently public interest in forensic science has increased greatly, due in part to television shows such as CSI and Bones, which feature scientists using analytical tools to solve crimes. The increased public interest in forensic science presents an opportunity for science educators to engage students by leveraging student interest in the applied nature of forensic chemistry while practically introducing students to the scientific method. In an outreach setting, mysteries were used as a way to engage middle school students in thinking about selecting forensics tests, making observations while conducting the tests, considering positive and negative controls, and using the results to reach conclusions. The outreach activities have proved to generally increase student understanding of the concepts related to the scientific method. These activities have been translated from outreach activities into accessible activities for middle and high school classrooms.</p>
96	<p>ANGELA Osuji <i>Cryo-Electron Microscopy:</i> Advisor: ALON MCCORMICK Department or Program Sponsoring Summer Research: MRSEC RET Home Institution: MINNEAPOLIS WASHBURN Abstract: As science and engineering emphasis shift from the study of bulk structures and properties of materials to their nano structures and properties, understanding the behavior of materials at the nanoscale is becoming increasingly significant in K-12 Science, Technology, Engineering and Mathematics (STEM) education. The learning of science and engineering practices (SEP) should reflect the practices of professional scientists and engineers. We studied nanoemulsions and characterized them using cryogenic transmission electron microscope and scanning electron microscope. Dilute emulsions are ubiquitous in our environments. These colloidal systems have found widespread use in our lives such as foods, consumer products, and industrial applications for detergency. Thus, it is important that we understand how to formulate the colloidal particles and precisely control their structures. Emulsions and their processing are fascinating as well as intriguing to students. Understanding the systems for optimum emulsification and characterization would provide rigorous learning experiences for k-12 students to develop their science and engineering practices.</p>