**Gustavus 2019 Fall Research Symposium**

**September 13, 2019**

**Abstracts**

**Session 1: Nobel Hall of Science, Room 1412 1:30-2:30pm**

1:30 pm **Environmental Fate of Dicamba**

Eli McMahon

Advisor: Amanda Nienow

Abstract: Dicamba, a post emergent herbicide, can end up in many places after application. Three environmentally relevant pathways include volatilization, adsorption to plants, and runoff into streams and rivers. I studied how quickly dicamba breaks down in presence of light and its photoproducts in these cases. For these purposes I used techniques such as HPLC and LC-MS, which helped determine that the presence of certain additives increase and decrease the rate of photolysis.

1:45 pm **Exploring Mobile Zone Mass Transfer Phenomena in Liquid Chromatography**

Devin Makey, Huiying Song, Gert Desmet, and Deirdre Cabooter

Advisors:Deirdre Cabooter and Dwight Stoll

Abstract: Liquid chromatography is used for the separation of a mixture by passing it in solution through a column in which the chemical constituents of the mixture move at different rates. Many modern applications of liquid chromatography require efficient separations with narrow peaks, however, peak broadening can cause separations to be less efficient. That being said, a complete understanding of the individual contributions to mass transfer is crucial in designing more efficient liquid chromatography columns. This presentation will discuss our recent efforts to better understand the mobile zone contribution to mass transfer resistance (the cm-term in efficiency vs. flow rate relationships), or more specifically the Sherwood number (Shm in the general plate height equation). In the past, the Sherwood number has typically been calculated using the Wilson-Geankoplis or Kataoka models, however these models are not valid under typical chromatographic conditions. We will discuss two different approaches that we have used to obtain more insight into the mobile zone mass transfer phenomena. Both sets of experiments resulted in data that were subsequently used to evaluate alternative models for predicting the mobile zone contribution to the efficiency of packed particle HPLC columns.

2:00 pm **Synthesizing Peptides for Identifying Histone Mark Recognition in P. falciparum**

Alex Liebl

Advisor: Dr. Scott Bur

Abstract: Designing peptides to identify Plasmodium falciparum histone tails acetylation marks for Plasmodium falciparum GCN5 bromodomain recognition. Screening for binding affinities of various peptide with different marks using Protein-Observed-Fluorine (PrOF) NMR enables identification of histone tails marks that bind well to the PfGCN5 bromodomain.

2:15 pm **Fragment Based Ligand Design and Small Molecule Synthesis to Determine Binding Affinities for the PfGCN5 Bromodomain**

Emily Saari

Advisor: Scott Bur

Abstract: The molecular structures of indanone and 1,2,3,4-tetrahydroquinoline were observed to be possible small molecule targets through ProF NMR screening and virtual screening. These structures were shown to have tight binding and selectivity towards the PfGCN5 bromodomain, found in the malaria causing organism, P. falciparum. The binding affinities of these structures can be calculated through ProF NMR and derivatives can be pursed to increase binding affinities and selectivity.

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**Poster Session: Anderson Theatre/Nobel Lobby 2:30-3:15 pm**

**In Situ Determination of pH Changes inside HPLC Columns**

Alex Florea, Gabriel Leme, Tyler Brau, Tom Lauer, and Dwight Stoll

Advisor: Dwight Stoll

Abstract: In most modes of liquid chromatography a significant fraction of the mobile phase is an aqueous solution. When the analytes of interest to a particular separation are ionogenic, the pH of the aqueous component of the mobile phase can have a significant effect on retention and separation. This is an especially important issue on two-dimensional liquid chromatography where it is common to use mobile phases buffered at significantly different pH levels in the two dimensions of the system.
 In this work the pH levels at the inlet and outlet of HPLC columns of varying lengths were studied. Generally, a plug of pH 3 buffer was injected into a pH 7 mobile phase, where the volume of the injected plug was varied from 10 to 360 µL, and a mixture of colorimetric indicator dyes was used to determine the local pH, either at the column inlet or outlet. Other variables studied include the use of Active Solvent Modulation (ASM) and the compositions of the buffers used in the injected plug vs. the mobile phase. A methodology was developed to predict the pH levels at the column inlet and outlet. While the accuracy of this approach is good for several conditions, in other cases it is not, and work is ongoing to understand the observed discrepancies between predictions and experimental results.

**The Flow of Dissolved Organic Carbon and Lead in the Marcell Experimental Forest**

Collin Carlson

Advisor: Dr. Jeff Jeremiason

Abstract: Peatlands in northern Europe and North America have long been studied to understand the cycling and retention of dissolved organic carbon and lead in these systems. One long-term study site is the S2 ombrotrophic bog in the Marcell Experimental Forest (MEF), a research facility located in northern Minnesota. Ombrotrophic peatlands depend on the atmosphere for water and nutrients and can provide long-term records of atmospherically derived pollutants such lead. The ombrotrophic peatland in the Marcell Experimental Forest (MEF) has large amounts of dissolved organic carbon (DOC), and is a model ecosystem for northern peatland bogs which contain ten percent of the world’s DOC. With this long-term study conducted at this site, it has been found that lead and DOC are highly correlated when flowing out of the system. One aspect of this study is to understand some of the factors that effect the trends of DOC and lead in this peatland system. To conduct a study on this system, we took peat cores from the S2 ombrotrophic bog and placed them into acrylic tubes. These tubes have sampling ports 5 cm deep and 10 cm deep and they were sampled weekly in a lab. After sampling, each tube was refilled to a preset water level that was consistent throughout the experiment. The goal of this study was to test if it is possible to replicate the trends of DOC and lead in a peatland system within a lab setting. Also, another goal of this research was to use historical data to study the historical levels of lead and DOC. With the results found, it shows that these columns can replicate an ombrotrophic peatland system within a lab because the data from these columns follows the same historical trends found in MEF.

**Poster Session (continued)**

**Comparison of Strategies for Separation of Glycans by Two-Dimensional Liquid Chromatography**

Gabriel Leme, Devin Makey, Matthew Fischer, Gregory Staples and Dwight Stoll

Advisor: Dwight Stoll

Abstract: The glycosylation of biopharmaceutical molecules such as monoclonal antibodies has a significant effect on the safety and efficacy of these therapeutic agents. As the trend in the biopharmaceutical industry moves toward the development of more complex (e.g., bi- and tri-specifics) and more highly glycosylated molecules, the analytical challenge associated with accurately characterizing the glycosylation profile of these molecules is exceeding the capabilities of conventional one-dimensional liquid chromatography (1D-LC) methods. This presentation will discuss results of our initial efforts to evaluate the potential for two-dimensional liquid chromatography (2D-LC) methods to improve the separations of glycans released from biomolecules, either in terms of resolution, or separation speed. Preliminary results indicate that coupling reversed-phase (RP) and hydrophilic interaction (HILIC) separations in an online 2D-LC format (RP x HILIC) has some attractive features, as does coupling two different HILIC separations having different selectivities (HILIC x HILIC). We will also discuss the impact of mobile phase conditions and stationary phase chemistry on chromatographic metrics such as peak patterning, detection sensitivity, and analysis time, and compare the quality of 2D-LC separations to state-of-the-art 1D-LC separations of released glycans.

**A comparison of the sensitivity of two DAD flow cells in preparation for their use in HPLC analysis of glycopeptides**

Matthew Fischer

Advisor: Dwight Stoll

Abstract: Recent work on the development of a chromatography method for characterization of glycopeptides would benefit from a UV absorbance detector flow cell with high sensitivity. However, increasing sensitivity requires a longer flow cell path length that is accompanied by a larger internal volume, an attribute that will increase peak width and therefore decrease chromatographic resolution. An ultra-sensitive Agilent Max-Light flow cell was compared with a low dispersion flow cell using a HPLC system set up to minimize other contributions to peak volume. Data was collected for peak height, width, and signal-to-noise ratio under conditions chosen to systematically vary the widths of peaks exiting the chromatography column. It was found that although path length for the Max-Light flow cell is six times longer than the standard flow cell, and should theoretically offer six times greater sensitivity, the percent difference in peak height between the two cells plateaus at five-hundred percent, and the signal-to-noise ratio is at best three times greater with the Max-Light flow cell. These results will be invaluable in future experiments for managing our expectations about how much of a sensitivity gain we can expect given a particular set of chromatographic conditions.

**A Nanoscale Ultrasound Contrast Agent for Cancer- Specific Drug Delivery and Tissue Visualization**

Kira Holton

Advisors: Jefferson Chan and Lucas Akin

Abstract: Nanoscale ultrasound contrast agents were synthesized and characterized in vitro and in vivo. The nanoscale agents were shown to target tumors upon injection and were able to enter cancerous cells. Development of a drug delivery platform was pursued, with synthesis of a proof of concept and release probe.

**Midrange Wireless Power Transfer Using Strongly Coupled Magnetic Resonance**

Maya Lengvenis

Advisor: Jessie Petricka

Abstract: Power can be transferred wirelessly using strongly coupled magnetic resonance. This project attempted to recreate working models of midrange wireless power transfer using Printed Circuit Board based resonant circuits. The properties of the circuits were controlled by altering the geometry of the circuit present on a circuit board. This makes the resonant circuits a cost effective and reasonable addition to current technology.

**Poster Session (continued)**

**Development of An Enhanced, Inexpensive Multispectral Imaging System**

Samuel F. Maruska, Charles F. Niederriter

Advisor: Charles F. Niederriter

Abstract: Multspectral imaging systems have to ability to create images that are only of a certain light wavelength band. Most commercial systems have a blue, green, red, and near infrared, but not thermal infrared. They can be used for light emission characterizing as well as land surveying by image manipulation methods. The Normalized Difference Vegetation Index (NDVI) is a surveying method utilizing the normalized difference between near infrared light and red edge light. Our implementation utilizes a Raspberry Pi, four Raspberry Pi NoIR cameras, and a FlIR Lepton Thermal Camera to create an inexpensive alternative to commercial systems.

**DeepCHALLA Sediment Core: Atmospheric Mercury and Lead in Equatorial East Africa Over the Last 250,000 yrs**

Sarah Mersch

Advisor: Jeff Jeremiason

Abstract: Lake Challa, a crater lake located near Mt. Kilamanjaro in Tanzania, is a high-quality equatorial climate proxy with sediment records reaching through all of human history and multiple glacial cycles. This project looks at lead and mercury levels over glacial timescales, changes in atmospheric deposition, and compares the Lake Challa record with other global climate records.

**The Role of MESP1 in Early Skeletal Myogenic Differentiation**

Haley Moran

Advisor: Dr. Sunny Chan (U of MN)

Abstract: Muscular dystrophies are hereditary conditions characterized by the wasting or weakening of muscles. Potential therapies include the introduction of healthy myocytes or related progenitors to affected tissue. Consequently, skeletal myogenic differentiation processes are of interest to medical researchers. During skeletal muscle development, MESP1 expression varies by muscle groups, making it a point of intrigue since muscular dystrophies have different severities among different muscle groups. In this study, we explored the role of MESP1 in skeletal myogenic differentiation by using a MESP1/MESP2 (a homolog of MESP1) double-knockout (dKO) human embryonic stem cell line. Both wildtype and dKO cells expressed T (Brachyury) equally well, suggesting that mesoderm specification was not affected. However, dKO cells have reduced level of MSGN1, a transcription factor important for paraxial mesoderm patterning. Additionally, epithelial-mesenchymal transition (EMT) was diminished in dKO cells, as evidenced by a reduction in SNAI1 and TWIST1 expression. These results suggested that MESP1 may be critical for EMT which regulates paraxial mesoderm patterning, and thereby important for normal skeletal myogenic development.

**Poster Session (continued)**

**Comprehensive 2D-LC method development for metabolomics studies: application to zebra fish embryos exposed to endocrine disruptors**

Miriam Carolina Pérez-Cova, and Gabriel Leme

Advisor: Dwight Stoll

Abstract: The complexity of biological extracts in metabolomic and lipidomic studies makes multidimensional analytical platforms highly desirable for obtaining a higher resolution separation, when compared to mono-dimensional approaches. Among them, LC × LC–MS seems especially promising for untargeted analysis, where there are no a priori assumptions of expected changes in the metabolomic pathways. These differences in metabolite concentrations can be detected by comparison of an exposed versus a non-exposed organism (the so-called control sample).
 Advanced chemometric strategies are tools that are very useful for dealing with the highly complex datasets produced by LC × LC, as they allow data processing and the detection of those metabolites and lipids changing between samples. After their identification, Kyoto Encyclopedia of Genes and Genomes (KEGG) platform will be used to identify the metabolomic pathways affected.
 This whole analytical strategy will be applied to a real case study: zebra fish embryos exposed to two endocrine disruptors. Nowadays, the interest in how endocrine disruptors can affect aquatic organisms has increased, as their presence in the environment presents hazards to the health of humans and wildlife. Thus, in this study, the effects observed in the lipidome/metabolome of bisphenol A (an exogenous endocrine disruptor in zebra fish embryos), are compared to the ones produced by a natural hormone, estradiol.
 The aim of this work is to evaluate RP × HILIC–HRMS and HILIC × RP –HRMS methods, to analyze in an untargeted way, the changes in the metabolome and lipidome of zebra fish embryos when exposed to bisphenol A and estradiol. Active solvent modulation (ASM) will be used to improve the compatibility between the two separations.

**Herbicide Resistance in Palmer Amaranth**

Ryan Sklar, Amir Attarian, Zahoor Ganie

Advisor: Colleen Jacks

Abstract: Herbicide resistance has become a major threat to the industry of crop science and crop protection. Many species of crop-weeds have developed resistance to commercial herbicides, however, none have been more adaptable than Palmer amaranth (Amaranthus palmeri). This project was conducted to help expose the threat of herbicide resistance in weeds, and help educate the importance of integrated crop-protection methods. A Nebraska population with known resistance (NP), and FMC's current screening population (CP) were grown, sprayed, and rated to observe differences in sensitivity to commercial herbicides that employ 4-Hydroxyphenylpyruvate dioxygenase (HPPD-) and Photosystem II (PS II-) inhibitor modes of action. Two post-emergence (POST) trials were conducted, where a primary trial treated both populations with the commercial herbicides of mesotrione, tembotrione, isoxaflutole, and atrazine. A second POST trial compared the responses of both populations to four novel compounds in FMC’s discovery pipeline, where on average, the NP showed less sensitivity to all four compounds when compared to the CP. After concluding both trials, results described the NP showing at least 1.19 times more resistance than the CP when treated with tembotrione, 1.59 times more with isoxaflutole, 1.65 times more with mesotrione, and 8.33 times more resistant when treated with atrazine. This experiment concludes that there was a large difference in the level of resistance between the two populations of Palmer amaranth, along with a difference in sensitivity to all novel compounds.

**Poster Session (continued)**

**Electrochemical Reduction of Nitro Groups: From Bioanalysis to Lightweight High-Energy Density Cathodic Materials for Lithium Batteries**

Presenter: Matthew Venzke Authors:Brady Samuelson, Matthew Venzke, Peyton Keller, Brock Goeden, Miththira Balasingam, Miles Koppang and Haoran Sun

Advisor: Dr. Miles Koppang (USD)

Abstract: Electrochemical Reduction of Nitro Groups: From Bioanalysis to Lightweight High-Energy Density Cathodic Materials for Lithium Batteries.
 Derivatization of amino acids and aliphatic amines with suitable reagents enhances the separation and detection using liquid chromatography. Sanger’s reagent (1-fluoro-2,4-dinitrobenzene, DNFB) makes amino acids and amines suitable for absorbance detection but little has been done using liquid chromatography with electrochemical detection (LC-EC). Electrochemical investigation of nitrobenzene (NB) demonstrated that NB is reduced to phenylhydroxylamine (PHA) by addition of four electrons and four protons. PHA can be reversibly oxidized into nitrosobenzene by removal of two electrons and two protons. LC-EC analysis of derivatized amino acids with Sanger’s Reagent was achieved via in-series dual electrode detection preceded by coulometric conversion. The coulometric cell converted the nitro groups to hydroxylamines and the dual electrode detection upstream and downstream electrodes oxidized the resultant hydroxylamines to nitroso groups and then back, respectively. The reduction of nitro-substituted aromatics has also been investigated as a route for new cathodic materials for lithium batteries. We are investigating a new type of Schiff Base polymeric material with a conductive backbone as cathodic materials for primary lithium batteries. The new conductive polymer with theoretical capacity of 4 times the energy density of LiCoO2 cathodes is based on nitro group reduction. We have also investigated quinone reduction in the presence of lithium cations for the development of new cathodic materials for secondary batteries. This project explores the field of light-weight organic cathodic materials and has the potential to greatly increase the energy density for lithium batteries.

**CaMad2 promoted multiple aspects of genome stability beyond its direct function in chromosome segregation**

Maicy Vossen

Advisor: Laura Burrack

Abstract: Mad2 is a central component of the spindle assembly checkpoint required for accurate chromosome segregation. Additionally, in some organisms, Mad2 has roles in preventing mutations and recombination through the DNA damage response. In the fungal pathogen Candida albicans, CaMad2 has previously been shown to be required for accurate chromosome segregation, survival in high levels of hydrogen peroxide, and virulence in a mouse model of infection. In this work, we showed that CaMad2 promotes genome stability through its well-characterized role in promoting accurate chromosome segregation as well as through reducing smaller scale chromosome changes due to recombination and DNA damage repair. Deletion of MAD2 decreased cell growth, increased marker loss rates, increased sensitivity to microtubule-destabilizing drugs, and increased sensitivity to DNA damage inducing treatments. CaMad2-GFP localized to dots, consistent with a role in kinetochore binding, as well as to the nuclear periphery, consistent with an additional role in DNA damage. Furthermore, deletion of MAD2 increases growth on fluconazole, and fluconazole treatment elevates whole chromosome loss rates in the mad2D/D strain suggesting that CaMad2 may be important for preventing fluconazole resistance via aneuploidy.

**Session 2a: Nobel Hall of Science, Room 1412 3:15-4:30pm**

3:15 pm **Optimal Expression and Fluorine Labeling of Plasmodium falciparum General Control Non-Repressed Protein 5**

Katie Orcutt and Jada Nelsen

Advisor: Scott Bur

Abstract: The optimized Plasmodium falciparum General Control Non-Repressed Protein 5 was expressed in BL21 E. coli cells and grown in a defined media containing a fluorinated tryptophan in PfGCN5. A mutant PfGCN5 protein with one tryptophan removed was expressed to correlate the two tryptophans to their respective peaks in PrOF NMR. Different conditions were explored to optimize cell growth and protein expression in the defined media. PfGCN5 will be used in future assays with synthesized small molecules to investigate the binding affinity in the PfGCN5 binding pocket.

3:30 pm **Development of an in vitro chromatin model for the investigation of PIWIL4 function**

Abby Trouth, Stephen Wu, Aaron Johnson

Advisor: Aaron Johnson

Abstract: Transposons are parasitic mobile elements within the genomes of nearly all organisms. Multicellular eukaryotes defend against these invaders through a variety of mechanisms, including small non-coding RNA-mediated silencing. PIWI proteins form complexes with piRNAs to recognize active transposons and recruit heterochromatin forming proteins to ultimately silence the transposon. Most PIWI-piRNA complexes are active in germ line cells, but PIWIL4 is expressed in somatic tissues as well, leading to the hypothesis that the PIWIL4-piRNA complex maintains silencing of transposons in somatic cells through the recruitment of chromatin-modifying proteins. An in vitro chromatin model was developed to investigate if the association of the PIWIL4-piRNA complex was sufficient for DNA and histone methylation, modifications indicative of heterochromatin formation. Chromatin was successfully reconstituted and conjugated to magnetic beads for use in this model. Additionally, the generation of the PIWIL4-piRNA complex was attempted, though the loading requires more troubleshooting before it can be included in the in vitro model.

3:45 pm **Exploring the function of MAD2 in Candida albicans through drug sensitivity**

Hanaa M. Alhosawi

Advisor: Laura S. Burrack

Abstract: There are many causes of genome instability; these include unrepaired DNA damage, DNA replication errors, and chromosomal missegregation. These processes give genomic variation among cells in a population. In most cases, mutations and aneuploidy are deadly to cells. However, in specific stressful situations, mutations and aneuploidy can serve as a selective. MAD2 is a gene that is critical to the function of the Mitotic Checkpoint Complex (MCC). MCC complex promotes accurate chromosome segregation, thus preventing aneuploidy. However, in some organisms, MAD2 also has other roles in the cell. To investigate and better understand the MAD2 gene in Candida albicans, we used different drugs and treatments as tools. Additionally, we looked at the localization of the Mad2 protein in the cells with and without drugs. Through this project, we found that MCC role is conserved in C. albicans, that Mad2 has additional functions beyond chromosome segregation to help cells respond to DNA damage, and that Mad2 localization is similar to other organisms.

4:00 pm **X-ray Crystallography of Proteins**

Alyssa Paulson

Advisor: Scott K. Bur

Abstract: We want to create a small molecule that binds tightly and selectively to the WPF shelf in the PfGCN5 bromodomain. X-ray crystallography is extremely useful for determining the molecular structure of proteins. Once the molecular formula has been determined it is easy to see how that molecule can bind and what parts of the molecule can be modified.

**Session 2a (continued) Nobel 1412**

4:30 pm **Electrochemical Reduction of Nitro Groups: From Bioanalysis to Lightweight High-Energy Density Cathodic Materials for Lithium Batteries**

Matthew Venzke, Miles Koppang

Advisor: Dr. Miles Koppang

Abstract: Derivatization of amino acids and aliphatic amines with suitable reagents enhances the separation and detection using liquid chromatography. Sanger’s reagent (1-fluoro-2,4-dinitrobenzene, DNFB) makes amino acids and amines suitable for absorbance detection but little has been done using liquid chromatography with electrochemical detection (LC-EC). Electrochemical investigation of nitrobenzene (NB) demonstrated that NB is reduced to phenylhydroxylamine (PHA) by addition of four electrons and four protons. PHA can be reversibly oxidized into nitrosobenzene by removal of two electrons and two protons. LC-EC analysis of derivatized amino acids with Sanger’s Reagent was achieved via in-series dual electrode detection preceded by coulometric conversion. The coulometric cell converted the nitro groups to hydroxylamines and the dual electrode detection upstream and downstream electrodes oxidized the resultant hydroxylamines to nitroso groups and then back, respectively. The reduction of nitro-substituted aromatics has also been investigated as a route for new cathodic materials for lithium batteries. We are investigating a new type of Schiff Base polymeric material with a conductive backbone as cathodic materials for primary lithium batteries. The new conductive polymer with theoretical capacity of 4 times the energy density of LiCoO2 cathodes is based on nitro group reduction. We have also investigated quinone reduction in the presence of lithium cations for the development of new cathodic materials for secondary batteries. This project explores the field of light-weight organic cathodic materials and has the potential to greatly increase the energy density for lithium batteries.

**Session 2b: Nobel Hall of Science, Room 1413 3:15-4:30pm**

3:15 pm **Monitoring Water Quality in the Seven Mile Creek Watershed**

Hannah Schroeder, Shauna Capron

Advisor: Laura Triplett, Julie Bartley

Abstract: Looking at different best management practices that have been put in place in the seven mile creek watershed, and looking at data to determine what affect they are having on the water quality.

3:30 pm **Evaluating Landslide Frequency in Minnesota**

Matt Allison

Advisor: Laura Triplett

Abstract: Most citizens of Minnesota do not consider themselves to be at risk from landslides, but hillslope failures are surprisingly common and have recently caused expensive damage to infrastructure and even loss of life. This study was to identify landslide locations and characteristics along the Minnesota River valley from Mankato to Chaska, as part of a larger state-wide project. We used digital elevation models and limited fieldwork to identify slides. We also categorized the landslides into groups depending on the characteristics of the slide. We identified thousands (or actual number!) of slides, most of them small-scale and located along ravines, stream valleys and roads in steep terrain. This information will help landowners, township and city planners and risk managers to better protect citizens and prioritize mitigation efforts.

3:45 pm **DeepCHALLA Sediment Core: Atmospheric Mercury and Lead in Equatorial East Africa Over the Last 250,000 yrs**

Sarah Mersch

Advisor: Jeff Jeremiason

Abstract: Lake Challa, a crater lake located near Mt. Kilamanjaro in Tanzania, is a high-quality equatorial climate proxy with sediment records reaching through all of human history and multiple glacial cycles. This project looks at lead and mercury levels over glacial timescales, changes in atmospheric deposition, and compares the Lake Challa record with other global climate records.

4:00 pm **Photodegradation of the Herbicide Bromoxynil**

Jenna Kotz

Advisor: Amanda Nienow

Abstract: Bromoxynil is a post-emergent herbicide widely used on weeds in many croplands. This study focuses on the photodegradation of bromoxynil in an aqueous state to determine photoproducts and mechanisms of degradation. Experiments were performed using UV lamps and a quartz column to irradiate samples. HPLC was utilized to determine rates of degradation under various conditions, and NMR will be used to identify photoproducts.

4:15 pm **Herbicide Resistance in Palmer Amaranth**

Ryan Sklar, Amir Attarian, Zahoor Ganie

Advisor: Colleen Jacks

Abstract: Herbicide resistance has become a major threat to the industry of crop science and crop protection. Many species of crop-weeds have developed resistance to commercial herbicides, however, none have been more adaptable than Palmer amaranth (Amaranthus palmeri). This project was conducted to help expose the threat of herbicide resistance in weeds, and help educate the importance of integrated crop-protection methods. A Nebraska population with known resistance (NP), and FMC's current screening population (CP) were grown, sprayed, and rated to observe differences in sensitivity to commercial herbicides that employ 4-Hydroxyphenylpyruvate dioxygenase (HPPD-) and Photosystem II (PS II-) inhibitor modes of action. Two post-emergence (POST) trials were conducted, where a primary trial treated both populations with the commercial herbicides of mesotrione, tembotrione, isoxaflutole, and atrazine. A second POST trial compared the responses of both populations to four novel compounds in FMC’s discovery pipeline, where on average, the NP showed less sensitivity to all four compounds when compared to the CP. After concluding both trials, results described the NP showing at least 1.19 times more resistance than the CP when treated with tembotrione, 1.59 times more with isoxaflutole, 1.65 times more with mesotrione, and 8.33 times more resistant when treated with atrazine. This experiment concludes that there was a large difference in the level of resistance between the two populations of Palmer amaranth, along with a difference in sensitivity to all novel compounds.