PANEL SESSION 1
2:30-3:30pm, Friday, October 2
https://meet.google.com/hhq-ncva-cqn

Panel Chair: **Emma Rossow '23**

Madison Tooker '23 – "Isolation and Characterization of PfGCN5 Protein"

The bromodomain of the Plasmodium falciparum GCN5 protein (PfGCN5) was expressed and isolated from BL21 E. coli cells transformed with PfGCN5 wild-type, codon-optimized, or W1379F codon-optimized mutant plasmids and metabolically labelled with 5-fluorotryptophan. Proteins expressed in E.Coli were isolated and purified by nickel affinity and buffer exchange chromatography. Gel electrophoresis and mass spectrometry confirmed the identity of the desired PfGCN5 proteins. Protein-Observed Fluorine (PrOF) NMR was utilized to verify proper fluorine labelling of the protein. Comparison of the signals in the PrOF NMR spectra of PfGCN5 W1379F mutant with the wild-type protein was used to assign the signals to specific tryptophan residues in the protein.

Christen Gibson '23 – "Fragment Based Ligand Design"

Several tetrahydroquinone-based structures were identified in a computer screen to bind to the bromodomain of the Plasmodium falciparum GCN5 protein (PfGCN5), a protein important in the regulation of gene expression. A general synthesis for these kinds of molecules was developed that allows for easy substitution in two positions. Using the newly developed general synthesis, N-Acyl-7-(4-chlorobenzamido)-tetrahydroquinoline was prepared in good yield and tested against the PfGCN5 bromodomain using Prof NMR.

Jenna Kotz '21 – "Understanding the Epigenetics of Malaria: Solid-Phase Peptide Synthesis"

Epigenetics is the regulation of transcription and subsequent translation of genes. One major contribution to this regulation is modifications to histone tails to "open" or "close" regions of DNA for transcription. PfGCN5 is one protein in malaria that reads these modifications, and it has been shown that knockout of this protein kills the organism. This project's goal is to determine which of these modifications PfGCN5 reads by using solid-phase peptide synthesis to make analogs of these histone tails to test binding with the protein, which will indicate which marker is read.

Tessa Dethlefs '21 – "Differential Plasticity and Sex-Specific Resource Allocation in Response to Nitrogen Availability in a Dioecious Forb, *Silene latifolia*"

Dioecious plant species, those with male and reproductive structures on separate individuals, are uncommon. The innate reproductive roles of males and females incur different costs on the sexes which lead to trade-offs in resource allocation. Anthropogenic nitrogen (N) deposition imposes large ecological consequences, and soil N availability has the potential drive differential plasticity, in which dioecious individuals allocate resources in a sex-specific manner relative to soil nutrient conditions. We asked if male and female *Silene latifolia*, a dioecious forb, alter biomass allocation to vegetative and reproductive structures differently in response to N availability, thus displaying differential plasticity. *S. latifolia* seeds were planted in early-June 2020 (n=1355) and transplanted post-germination in mid-July (n=315). Plants were randomly assigned to N fertilization treatments: unfertilized control, medium N (5 g/m2) or high N (10 g/m2). Growth and number of reproductive structures (i.e., flowers) were measured throughout the study period. There was a general increase in plant height and leaf number with N fertilization. Mean flowers produced per day differed significantly between males and females in each treatment ($p<0.05$), and males produced approximately twice as many flowers as females under both medium and high N treatments. However, while males produced more flowers, they were on average 42% shorter and had 17% fewer leaves under high N; this trend suggests that males were preferentially investing in reproduction as opposed to aboveground vegetative growth compared to females under increased N treatments.

POSTER SESSION A

2:30-3:30pm, Friday, October 2

Click on student name to join Google Meet session and talk with the poster presenter(s) anytime during the hour.

Jessica Schwartz '23 – "The Photodegradation of Dicamba in a Gaseous State"

Dicamba is a post-emergent herbicide that is commonly applied to genetically modified corn and soybean fields. However, it is known to volatilize while being sprayed and drift to neighboring fields where it can damage non-genetically modified crops. Understanding degradation pathways, especially while the herbicide is in the air, is important to understanding how to best control and mitigate drift. The goal of this project is to determine the rate of photochemical degradation of dicamba while in the gaseous phase, then to use spectra to determine the structure of photoproducts. This will be done by exposing known concentrations of dicamba to relevant frequencies of light and analyzing the resultant gas over time. To date, research has focused on developing a method to sample dicamba using solid phase micro-extraction (SPME) fibers, and how to detect and quantify these analytes through the use of gas chromatography and mass spectrometry (GC/MS). (https://meet.google.com/ssw-geqb-cnm)

Timothy W. Hirsch '22 – "Titrating Polylactic Acid from Household Sources in an Analytical Chemistry Lab"

Polylactic acid (PLA) is a plastic polymer that can be made using corn instead of fossil fuel and is used as an alternative to traditional consumer plastics. The polymer is formed with ester bonds between lactic acid monomers. In this project the plastic was depolymerized and the monomer titrated in order to gain information on the pKa of PLA and the % composition of PLA in a mixture of PLA and a substance without acid-base properties, such as sucrose. A digestion solution of 1:1 EtOH:H2O 1.4 M KOH effectively digested PLA from pure and mixed polymer samples. The digested polymer solution was acidified and then titrated with KOH. Using this procedure the PLA from a plastic object can be digested and titrated to determine wt % PLA and its pKa, which we have adapted for use in an undergraduate analytical chemistry course. (https://meet.google.com/zkj-cedn-yxg)

Collin Carlson '22 – "The Leaching of DOC and Pb in the Marcell Experimental Forest"

Peatland systems in Northern Europe and North America have long been studied to understand the cycling and retention of dissolved organic carbon (DOC) and lead. One long-term research site is the S2 ombrotrophic peatland bog at the Marcell Experimental Forest (MEF), a research facility located in Northern Minnesota. Ombrotrophic peatlands are hydrologically isolated from the surrounding landscape and are dependent on atmospheric deposition for nutrients. Within the long-term research conducted at MEF, it has been shown that lead and DOC concentrations are highly correlated within this system. The relationship between lead and DOC has remained consistent throughout the data present in historical archives. The goal of this study was to observe the concentrations of DOC and lead overtime within peat cores from S2 that had consistent water table levels. By modeling S2 in this manner we have found that, over a six-month period, concentration levels of lead and DOC in leachate samples diverged from one another. Our results show that the concentration of DOC stayed consistently high, while the concentration of lead dramatically decreased overtime. However, after these cores dried for three months, lead concentrations initially increased then continued to decline once again. It suggests that lead is mobile in these systems to a specific point and are potentially impacted by the local water table. These results allow for further understanding of how the fluctuations in the water table impact lead exports from the S2 ombrotrophic peatland at MEF. (https://meet.google.com/boh-vvie-nkh)

D. Melanie Kistnasamy '22 – "Seven Mile Creek Watershed: Monitoring Water Quality and Ravine Erosion for a Sustainable Agriculture"

Southern Minnesota has undergone considerable land use change during the past 200 years from being a land of wetlands, prairie and woods to mostly intensive row-crop agriculture. On top of the consequences of monoculture cropping, one of the downsides of drain tiling is the movement of topsoil (total suspended solids, TSS) and pollutants from farm fields like nitrate, phosphorus and E.coli bacteria. Because Minnesota and the Upper Midwest are expected to receive an increase in precipitation from large storm events in response to climate change, the region could be facing further increases erosion and the movement of sediment. Our project monitors these pollutants and visual indicators of erosion to examine the effectiveness of land-management; Best Management Practices (BMPs). Here, we report multiple years of TSS data from tributaries to Seven Mile Creek, and show time-lapse images that illuminate the processes by which erosion occurs. We found that most of a season's sediment is delivered during the largest storm events, and that ravine erosion can produce sediment that is then available for transport to the stream over the next few months and years. As we track those BMPs, we hope to improve our soil health, reduce erosion and improve water quality while enhancing landowner engagement. (https://meet.google.com/aoh-saph-ygw)

PANEL SESSION 2
3:30-4:30pm, Friday, October 2
https://meet.google.com/ror-jost-jxv

Panel Chair: **Kyra Bowar '21**

Ana Zaalishvili '22, Anna Teurman '22 – "Study of Cosmic Ray Muons in the Upper Atmosphere"

Muon count, altitude and angle were measured using a high-altitude balloon. Muon detectors were built, calibrated and assembled for flight in a payload attached to the balloon, which was filled with hydrogen and let go into the atmosphere. Preliminary results show that 15 to 30 km above the ground the count rate of muons become uniform across all angles measured. This supports the theory that when created, muons are travelling in all directions. However, only muons that travel vertically are able to reach the surface of the earth due to their short lifetime.

Ben Menke '22 – "The Effects of Voter Turnout in U.S. Elections"

Political scientists and politicians have long debated the relationship between voter turnout and electoral outcomes. The predominant theories, the conventional and two-effects model, both offer compelling explanations. Analyzing the outcomes of U.S. Presidential and Senate elections from 2000 to 2018, I find that increased voter turnout is associated with a higher vote share and winning percentage for Democratic candidates. These results are in agreement with the conventional model. Moreover, I use measurements of legislator ideology to find that turnout does not significantly influence congressional voting behavior within either party.

Sara Cronk '22 – "Developing Theatre & Dance Audiences at Small Liberal Arts Colleges: A Case Study at Gustavus Adolphus College"

"It really doesn't matter how good your show is, without an audience, it's all for nothing" - Douglas Mayo The purpose of this study is to better understand the audience and potential audience who attend productions sponsored by the Department of Theatre & Dance at Gustavus Adolphus College. Specifically, the project studied attendance patterns, how well different marketing strategies have worked, and what the department can do to increase attendance. Using both analysis of existing ticket sales data and a survey distributed to ticket purchasers and the general Gustavus body, it was determined, amongst other things, that while Gustavus students and alumni are attending in relatively high numbers, attendance from the St. Peter community has the most potential for growth. The study also analyzed audience preferences in terms of genres and art forms, as well as marketing strategies including engagement with social media and news outlets. Our study concludes with recommendations to assist the department in building and growing its audience base, while increasing visibility in the community and beyond.

Filip Bělík '22, Ha Le '22 – "One-Dimensional Port-and-Sweep Solitaire Armies"

Peg solitaire is a puzzle game in which a player attempts to hop pegs, removing hopped pegs from the board, to reduce an initial board down to one peg. It is a puzzle with extensive mathematical research and literature revealing connections to modular 3 invariants, the Fibonacci numbers, the golden ratio, and more. Port-and-Sweep Solitaire (PaSS) was created in 2010 and differs from peg solitaire in the number of pegs or counters that can be on a single space and the type of moves available to the player. The one-dimensional army problem involves working with configurations of pegs and using valid solitaire moves in the proper order to advance the army of pegs as far to the left of its starting position as possible. While the standard peg solitaire result is quite uninteresting, a maximum advance of one space, the problem in PaSS is more complex. With the use of a non-increasing board value function, contradiction through deduction, and linear algebra, we present a definite upper-bound on the advances of PaSS armies, minimal configurations of armies that progress as far as has been shown possible, and a solution to the PaSS army problem given assumptions that match all current army advances.

PANEL SESSION 3
3:30-4:30pm, Friday, October 2
https://meet.google.com/cfw-zuyn-cku

Panel Chair: **Stella Hadjiyanis '21**

Maya Lengvenis '22 – "Computationally Approaching Fragment-based Ligand Design"

Plasmodium Falciparum, the parasite that causes Malaria is increasingly becoming resistant to traditional drugs. PfGCN5, a protein used in epigenetic regulation is identified as a new drug target. A fragment-based approach is used to identify small organic molecule fragments that bind tightly to PfGCN5 and can be connected to form a single large molecule. A ZINC library of over 2.4 million potential drug fragments was screened for binding affinity with PfGCN5 in the hydrophobic pocket and the WPF shelf using Autodock Vina. The tightly binding fragments were screened for binding with human analogues of PfGCN5 with the goal of isolating the fragments that bind selectively.

Katya McDonald '22 – "Fungal Species and Fluconazole Resistance"

Fungal pathogens have immense medical importance, as they infect 4.9 million people globally a year. One type of fungal infection, Candidiasis, is caused by multiple different yet related species. Additionally, new species capable of causing this infection have emerged in the last ten years, showing the intensity of this problem. Species that are related to pathogenic species but are non-pathogenic themselves can represent a model system to examine how drug resistance develops in organisms without prior exposure. This includes several Brettanomyces species. This summer, we began by sequencing 23 different strains to determine their identity. Next, we selected 20 strains, which included seven different fungal species, to be screened for fluconazole resistance. This involved multiple replicates of minimum inhibitory concentration (MIC) assays. We found three isolates to be resistant, six to be have some degree of resistance, and one isolate to be sensitive to fluconazole. Other isolates were unable to be classified during our time. For three strains that were thought to be resistant, we sequenced ERG11, the specific gene that is the fluconazole drug target to see if mutations had occurred. We found that while two strains had no changes, one strain had two amino acid changes. For strains with some resistance, we investigated cross-resistance, and screened six strains for voriconazole and itraconazole. In the future, we would like to continue screening for cross-resistance in resistant strains and screening for fluconazole in unclassified strains, evolve nonresistant strains, and further sequence ERG11 in more strains.

Alexandru Florea '22 - "Comparison of Separation Factors Obtained Using Different Injection Approaches for High Performance Liquid Chromatography"

Conventional high performance liquid chromatography (HPLC) methods utilize a rotary valve to inject samples. While this is useful for the majority of HPLC experiments, trying to achieve millions of retention measurements in a relatively short period of time is not practical with this valve-based approach. This is because frequent switching of the rotary valve causes rapid deterioration of the rotor and stator in the valve, leading to frequent and high replacement costs. In this work we have developed a novel syringe-based injection method that takes advantage of a syringe pump to inject samples instead of the conventional rotary valve. This novel method significantly prolongs the life of autosampler components and eliminates the need to frequently replace valves. Using short (5mm) columns, analysis times can be reduced to less than 1 minute and thousands of retention data can be gathered in the span of a few hours. Preliminary work by our group has shown that differences in separation factors between syringe-based and valve-based injections are not practically significant, and this new approach looks promising as an alternative to valve-based injections.

POSTER SESSION B

3:30-4:30pm, Friday, October 2

Click on student name to join Google Meet session and talk with the poster presenter(s) anytime during the hour.

Morgan Mellum '23—"Ecology and Climate Sensitivity of Ancient Polar Forest Ecosystems, Antarctica"

The Permian (300-251 Ma) to Triassic (251-200 Ma) transition marks the most severe mass extinction in the history of life on Earth and was caused by an icehouse to greenhouse climate transition. A significant change in high-altitude forested ecosystems occurred during the timeframe of the Permian–Triassic, however, the function and stability of these forests remain poorly understood. We applied the dendrochronology technique of cross-dating to measured ring widths of fossil trees from the Permian through the Triassic in Antarctica, at two locations separated by 9º latitude, to evaluate the effects of climate and ecology through time and space in this study area. Ring width variation, reflecting enhanced versus suppressed growth, occurs at different frequencies through Permian and Triassic time intervals. An unexpected result is that the distributions of ring width variations are similar between the latest Permian samples and all of the Triassic samples regardless of sample location. Older Permian samples, however, display variation across the two study locations, reflecting the only clear spatial trend in ring width variation. This data supports the working hypothesis that climate gradients decreased in the study area from the Permian to the Triassic, and that a rapid climate shift occurred following the latest Permian sample set studied here. (https://meet.google.com/etv-hinr-haj)

Caden Gunnarson '23 – "Effect of Flow Splitting on Peak Dispersion in HPLC"

High performance liquid chromatography (HPLC) continues to improve the separating power available to chromatographers. These capabilities are expanded through extension of the technique to two dimensions (2D-LC), or by coupling liquid chromatography with spectrometric detection (LC-MS). However, these approaches sometimes have the drawback that unreasonably high mobile phase flow rates are required. These problems are often mitigated by use of a flow splitter, which diverts the majority of the mobile phase into waste while optimizing the flow into the rest of the instrument (i.e., second dimension of 2D-LC, a mass spectrometer, or both). However, the use of a flow splitter comes with its own effects, one of which is the potential for increase in peak dispersion, which lowers peak resolution and capacity. Here, a theory accounting for the extra-column dispersion caused by a simple tee flow splitter is introduced and tested using both UV-visible absorbance and laser-induced fluorescence (LIF) detectors with various flow split ratios and post-split configurations. Theoretical predictions and experimental results match pretty well over a variety of conditions. Experimental results show that the diameter and length of post-split tubing has the greatest impact, in very extreme cases increasing the variance by over 500% from that observed when using small diameter tubing. Ultimately, post-split tubing dimensions should be carefully considered when using a flow splitter in order to minimize extra-column dispersion. (https://meet.google.com/tyu-tsxb-dmh)

Haley Jostes '23, Erin Beer '23 – "Mercury Analysis and Method Development"

Mercury is naturally occurring, but human activity has greatly enhanced environmental levels of this element which bioaccumulates and is a neurotoxin; thus having accurate measurements is imperative to public health and indicative of the well-being of an ecosystem. Current analysis methods are time-consuming and expensive as they require two different procedures to determine the values of total and methylmercury (an organic form of mercury). The currently accepted procedures involve using cold vapor atomic fluorescence spectroscopy (CVAFS) to measure total mercury content, and an additional step to measure methylmercury in an inductively coupled mass spectrometer (ICP-MS) via the isotope dilution method, this often also involves distillation. Due to the costs of current practices, the development of a new method using high-performance liquid chromatography (HPLC) coupled with ICP-MS was started. HPLC allows for the separation of compounds using a mobile and stationary phase each of which has multiple manipulatable variables. The purpose of this project was divided into two components, sample and automation. The sample goals were to advance from mercury spiked water to biological standards and ultimately to field samples. The automation goal was to progress from a manual fraction method to an automatic system. Throughout the course of the project, spiked water was successfully separated and initial runs with biological standards were completed. Should these goals eventually be met, one would be able to run a single method to obtain values for both total and methylmercury, making analysis of samples less time consuming and much more cost-effective. (https://meet.google.com/ftn-kzji-swr)