MONTANA STATE UNIVERSITY

SPRING 2024

30

YEAR CELEBRATION OF

UNDERGRADUATE RESEARCH

Montana State University's Undergraduate Scholars and McNair Scholars Progams invite graduate and undergraduate students from all disciplines to present their research and creative projects to the MSU community.

THURSDAY, APRIL 25 SUB Ballrooms

Morning: 10 a.m.–Noon | Break/Transition: Noon–1 p.m. | Afternoon: 1–3 p.m.

MONTANA STATE UNIVERSITY

Mountains & Minds

MONTANA STATE UNIVERSITY STUDENT RESEARCH CELEBRATION SPRING 2024

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MAP OF POSTER LOCATIONS
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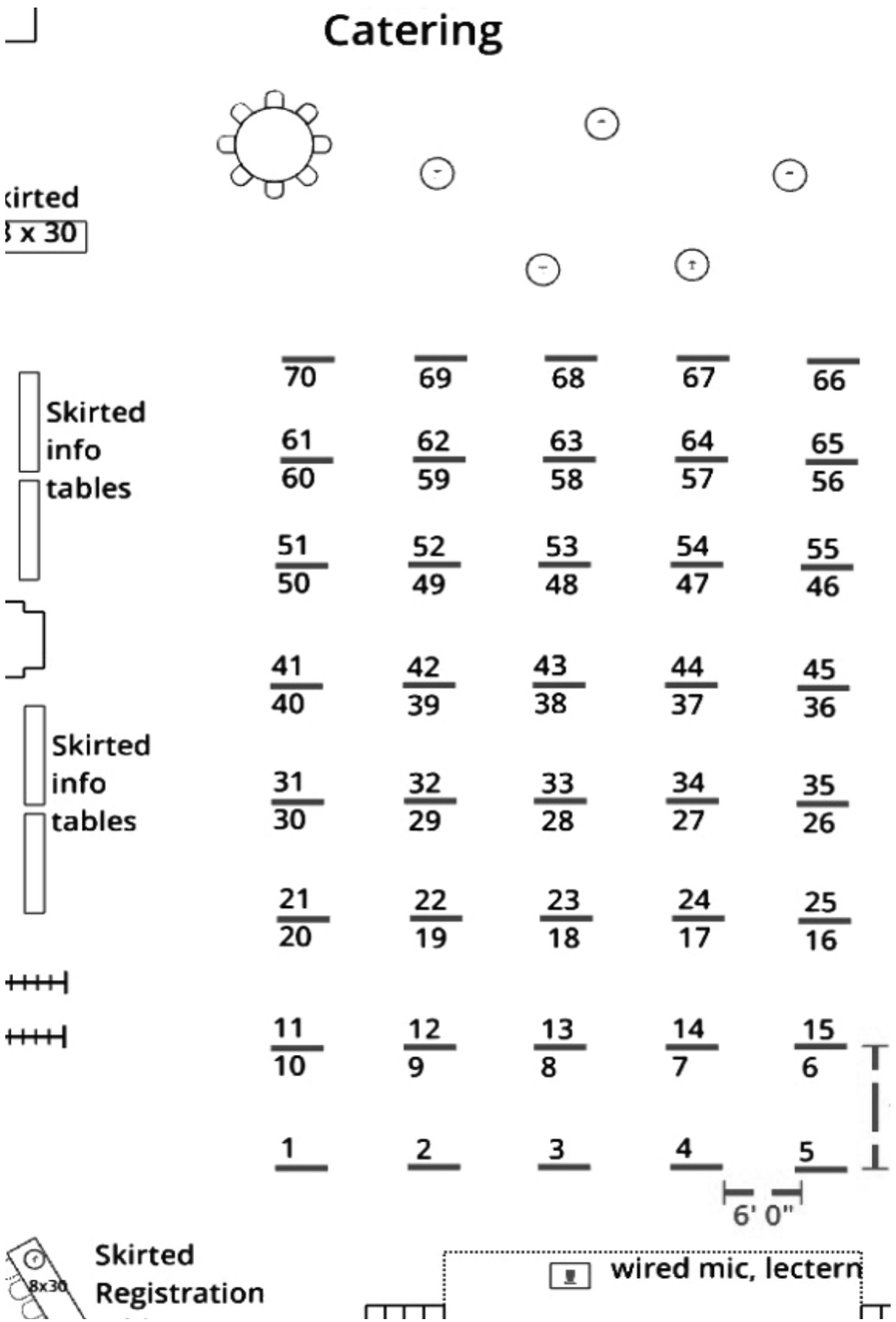

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ABSTRACTS

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AGRICULTURAL SCIENCE

#1 Afternoon

Investigating the mechanisms of a temperature-dependent survival effect in Pseudomonas Protegens (Pf-5)

Cassidy L. Citron, Microbiology & Cell Biology - Mentors: Qing Yan, Plant Sciences & Plant Pathology

Our survival depends on plants and their survival depends on the microbes they associate with. Understanding the dynamics that operate these relationships is essential to developing sustainable agriculture using beneficial microbes. In the face of a changing climate and a rapidly degrading ecosystem, understanding the dynamics that govern plant-microbe relationships is more important than ever. This presentation is a culmination of the research I have been conducting in Dr. Qing Yan's lab since January, 2023. The focus of the project is an observed prolongation of post-desiccation survival in plant-commensal bacteria Pseudomonas protegens (Pf-5). This survival effect becomes apparent only when the bacteria experiences temperature fluctuation, from higher to lower temperatures and is a novel phenotype, to our knowledge. In a natural environment, plants and their associated microbes undergo frequent temperature changes. However, the impacts of temperature fluctuations on the behaviors of the plant-associated microbes is largely uncharacterized. This research shows that bacteria which undergo a temperature change, from 28°C to a lower temperature prior to desiccation, have increased survival capability post-desiccation compared to control bacteria incubated at 28°C consistently. We also found that survival of mutants with a deletion in the gacA gene is similar to controls. Interestingly, when the gacA mutant is co-cultured with the wild-type strain, the survival capability of the wild-type strain is inhibited compared to wild-type in single inoculation, while the survival of the gacA mutant remains the same. We also investigated the effects of temperature cycles (28°C to 12°C and back) and the results of this ongoing experiment will be reviewed in my presentation. Elucidating the mechanisms of this novel phenotype may shine light on the plant growth-promoting effects of plant beneficial bacteria and these observations warrant further inquiry.

Acknowledgements: USP - Undergraduate Scholars Program

#2 Afternoon

Honey bee heat shock stress response to deformed wing virus and sacbrood virus infections

Bridget Flora Doyle, Ecology - Mentors: Michelle Flenniken, Co-Author/s: Naomi Kaku, Plant Sciences and Plant Pathology

Honey bees (Apis melifera) are important plant pollinators in both wild and agricultural landscapes. Globally, annual pollination services are valued at ~175 billion dollars. Unfortunately, honey bee colony losses have averaged 38% per year in the United States since 2008. These losses are associated with multiple factors, including agrochemical exposure, limited floral resources, management practices, and pathogens. The majority of honey bee-infecting pathogens are viruses including deformed wing virus (DWV) and sacbrood virus (SBV). To combat virus infections, honey bees have evolved several antiviral defense mechanisms including conserved immune pathways (e.g., Toll, Imd, JAK/STAT) and dsRNA-triggered responses including RNA interference and a non-sequence specific dsRNA-mediated response. In addition, the heat shock stress response was shown to reduce replication of a model virus, but the role of this response in limiting naturally occurring virus infections has yet to be determined. To investigate this, we examined the expression of two key heat shock response genes (i.e., heat shock protein 90 and

protein lethal(2) essential for life-like) in DWV and SBV-infected bees and determined that their expression positively correlated with virus abundance.

Acknowledgements: USP - Undergraduate Scholars ProgramINBRE - IDeA Network for Biomedical Research Excellence

#3 Afternoon

Identifying Areas of the Barley Genome to Increase Grain Quality and Drought Tolerance

Jaye Griffin, Ecology
Mentors: Jamie Sherman, Plant Sciences & Plant PathologyJessica Williams, Plant Sciences & Plant Pathology

This project's objective is to identify the effective areas of the barley genome that affect length. By utilizing the root roll-up technique, the phenotypic differences between the control samples and the Stay-Green grain should be easily identified. This Stay-Green grain consisted of two previously tested breeding lines from North Dakota State University, where the desired phenotype was identified. The control was from Montana State University's quantitative control line. The quantitative trait loci (QTL) of the root length of barley have not been extensively researched. As no QTL has been done for the barley genome, this research will change barley growing. This QTL is a region of the barley genome associated with the length phenotype that varies from sample to sample. The co-locations of seminal root trait QTLs with grain fill duration and grain quality should be found. This was done by setting up, growing, and analyzing both the Stay-Green and control barley in root roll-ups. Root tracing and T testing was also completed to identify the samples' quantitative differences. Furthering the viability of the Stay-Green samples, a longer root length is required to increase its drought tolerance and was found through testing. In addition to root length, other differences between the Stay-Green and the control samples were observable in the root rolls such as sprout length and an increased number of roots. Climate change drastically changes the growing season of barley annually and by finding an effective Stay-Green phenotype, the growing season of barley and crop yield will be stabilized.

Acknowledgements: Montana State Barley Breeding Program

#4 Afternoon

Microbial Inoculants For Wheat

Aidan R. Manthey, Plant Sciences & Plant Pathology - Mentors: Suchismita Mondal, Plant Sciences & Plant Pathology

The aim of this project is to evaluate the impact of microbial inoculants on the growth, development and yield of spring and winter wheat variety (Triticum aestivum L). Multiple measures of quality will be employed to understand the possible effects. These will include water use efficiency, seed emergence percentage, sap analysis, seed weight, crude protein content, overall yield, and tiller number. The study will be conducted in a greenhouse setting with three treatments and a control. The methods used will be a manure tea, LWJMS (Lothair Wheat Jadam Microbial Solution), and a vermicompost tea. Microbial inoculants have been known to assist in nutrient assimilation. This could potentially reduce the dependence on chemical fertilizer for crop production, which could improve farm profitability. The strain placed on complex ecological systems by agriculture due to leaching, soil degradation, and a multitude of other factors could be decreased as a result. The key to sustainability in agriculture is efficiency.

Acknowledgements: USP - Undergraduate Scholars Program

#5 Afternoon

Investigation Into the Potential for Cultivation of Edible Insects for Food and Feed in the State of Hawai'i

Max W. F. McGrath, Ecology
Mentors: Florence Dunkel, Plant Sciences & Plant Pathology - Co-Author/s: Sun-Hwa Kim, Coastal Carolina University, College of Business Administration

Edible insects are eaten by a large portion of the world, primarily in the Americas, Africa, and Asia, as a major source of protein and other dietary benefits such as fiber, calcium and vitamin B12. The authors were interested in the potential to farm edible insects as a source for human food, feed for livestock, and to source fertilizer (frass) in the state of Hawai'i. the authors decided to conduct interviews on the island of Maui to gauge public receptiveness with funding from the MSU Undergraduate Scholar Program. The survey instrument created consisted of questions determined using the holistic process followed by three probing questions. Interviewees were sourced at public areas. Interviews were conducted summer 2023 until the author had to leave the state to return to MSU. With the data base obtained (n=34), we computed a 2-tailed Pearson correlation coefficient. This correlation indicated a highly significant positive relationship (n=34) between interest in insects as feed and interested in insects for frass/compost [r (22)=.722; p=<.001]. However, the non-significance of several correlations could be attributed to the moderate sample sizes (22-30). We share this exploration of survey methodologies to encourage similar studies to be conducted locally in other diverse geographic areas. Errors in the process resulted in data that is hard to interpret. We suggest that uniform use of the probing questions, a larger data base, and a more diverse data pool/locality of data collection within Maui will be helpful in the future to test if there is a correlation between growing one's own food and interest in insects as food.

Acknowledgements: USP - Undergraduate Scholars Program

ARTS & MUSIC

#1 Morning

Nonprofit Architecture
Andrew Lodmell, Architecture
Mentors: Tyler Survant, Architecture

This research project aims to explore the range of business models in the nonprofit sector of architecture. This project will analyze the effectiveness, efficiency, sustainability, scalability and overall social output. This study will determine how they operate and generate revenue while delivering services to their beneficiaries. Examining a variety of models, from different scales, social missions and areas of influence, this project will determine challenges, best practices and opportunities within the sector. The methodology involves a comprehensive quantitative review of publicly available financial information, case-studies of successful non profit architecture organizations, and interviews with key stakeholders in the sector. Through this data collection, patterns, insights and strategies that drive nonprofit organizations, meaning this study will create a resource for people interested in the sector to gain valuable information. Further, the findings of this project will shed light on organizational strategies, funding sources and community engagement. Creating a greater understanding of the different models within the nonprofit architecture sector, will inform people in academia and in the profession in order to enhance the impact and viability of future and current nonprofit organizations.

Acknowledgements: USP - Undergraduate Scholars Program

BIOCHEMISTRY

#6 Afternoon

Molecular Differences Between Water and Land Fowl Cell Lines When Exposed to Avian Influenza
Sophia Kouko Adams, Chemistry & Biochemistry
Mentors: Emma Loveday, Microbiology & Immunology Co-Author/s: Grace Ducharme, Chemicals and Biological Engineering

Wild aquatic birds, such as ducks, geese, and shorebirds, actively serve as the primary natural reservoirs for influenza A viruses (IAV). Most infections in these waterfowl are asymptomatic, manifesting as mild intestinal issues due to indirect oral-fecal environmental exposure. Although IAV typically does not cause disease in migratory waterbirds, it can lead to severe mortality and morbidity when transmitted to humans and other animals, including swine and domestic poultry. Notably, ducks and poultry share highly conserved respiratory and digestive tracts, differing only in morphology during development. Currently, researchers lack cell culture-based tools to study how the intestinal and respiratory tracts of ducks and chickens influence IAV infection dynamics. A better understanding of these processes at a molecular level could help researchers comprehend how IAV jumps between different species, a process that may occur only after acquiring compensatory mutations. I propose that the differences observed in the susceptibility of land and waterfowl to influenza A viruses stem from adaptations occurring at the cellular level within specific host cells and unique viral components. My hypothesis suggests that exploration of these adaptations requires utilizing novel tools to study the molecular dynamics of IAV infection in ducks and chickens. To investigate this hypothesis, I established and characterized primary avian cell cultures, which included duck and quail lines, CCL-141 and QT-6, respectively. This line of inquiry emphasizes the significance of analyzing the host-virus dynamics that contribute to the varying susceptibility and resilience observed across avian populations, which has the potential to impact disease in humans.

Acknowledgements: USP - Undergraduate Scholars Program & Empower Program

#2 Morning

Computationally Deriving Factors in Serine Protease Catalysis
Kaylin Bruckhart, Chemistry & Biochemistry
Mentors: Patrik Callis, Chemistry & Biochemistry

Enzymes have been widely studied by biochemists for their natural catalytic abilities that facilitate reactions that are essential for life but occur too slowly on their own. One of the most studied enzymes are the serine protease enzymes which are capable of splitting one protein chain into two. This enzyme has a well-documented catalytic cycle, but it requires that a proton transfer occur between a very weak acid to a weak base creating a strong base. This research is devoted to computationally determining what in the surrounding environment of the active site facilitates this proton transfer using ab initio techniques. We determined that in a specific range of electric field, the proton will readily transfer, creating a strong base. We are currently determining if the electric field present in the enzyme is strong enough to facilitate the proton transfer. Moving forward, we will attempt to computationally recreate the first few steps of the catalysis in an environment comparable to that of the enzyme.

Acknowledgements: USP - Undergraduate Scholars Program

#3 Morning

Expression, isolation, purification, and characterization of galectin-3 and domains
John F. Cambria, Chemistry & Biochemistry
Mentors: Mary Cloninger, Chemistry & Biochemistry

Galectins are β-galactoside binding lectins with at least one conserved carbohydrate recognition domain (CRD). Galectin-3, the only member of the chimera subfamily, is an approximately 30-kDa protein. Galectin-3 is comprised of 250 amino acids with the NTD spanning amino acids 1-111 and the CRD spanning amino acids 112-250. Due to its integral role in the functioning of immune cells, galectin-3 is highly expressed throughout human tissues specifically found in the cytoplasm, the nucleus, and the cell surface. Galectin-3 expression levels have been noted in various tumor cells and have often been associated with the promotion of tumor growth, survival, and immune escape due to the functional valency and the role of the NTD in the clustering of galectin-3. It is hypothesized that if the functional valency and the role of the NTD in the clustering of galectin-3 are resolved, then the role of galectin-3 in galectin-mediated cancer progression processes will be better understood. To more fully understand the functional valency, the role of the NTD in the clustering of galectin-3, and the multimeric regulation of galectin-3 a truncated portion of the NTD (residues 1-62) and a truncated portion of the full construct (63-250) must be expressed, isolated, purified, and characterized for future study. If the variant of galectin-3 chosen for purification does not display an obvious difference when cellular aggregation and glycodendrimer-mediated protein clustering studies are performed with 63-250 compared to 1-250, a new variant could be produced from the procedures developed in the experiment for future study.

Acknowledgements: USP - Undergraduate Scholars Program

#4 Morning

Elucidating Acetone Carboxylase Conformational Change Via Variable Temperature Hydrogen-Deuterium Exchange Mass Spectroscopy
Ethan J. Hasenoehrl, Chemistry & Biochemistry
Mentors: Brian Bothner, Chemistry & Biochemistry

Carboxylases are a category of enzymes that utilize acid/base chemistry to generate a carbonic species. Acetone Carboxylase (AC) derived from the bacterium Xanthobacter autotrophicus is a unique example of these carboxylases. AC hydrolysis ATP to AMP in a nearly simultaneous reaction without the use of biotin which is used in other carboxylases to protect the reactive intermediates. Because these intermediates are highly volatile, work by the Bothner group has hypothesized that a conformational change is likely taking place. The exact mechanism of this change is not known and thus requires further investigation. Hydrogen-Deuterium Exchange Mass Spectroscopy utilizes the property that deuterium can exchange with amide hydrogens of the protein backbone, thereby increasing the molecular weight. The rate of exchange is dependent on solvent accessibility, hydrogen bonding and ah amino acids' chemical environment. After a protein is added to a deuterated solution, the reaction is quenched, and the protein is digested with a protease. The peptides are then analyzed using Mass Spectroscopy to measure the deuterium incorporation. Measuring exchange at different temperatures allows the energetic landscape of the conformational change of AC to be mapped. This allows a high-fidelity view of AC conformational change associated with catalysis to be generated.

Acknowledgements: USP - Undergraduate Scholars Program

#5 Morning

Investigation of Characteristic Metabolite Patterns in Familial Dysautonomia Chat-Cre Mouse Model Biospecimens
Danielle Horan, Chemistry & Biochemistry
Mentors: Valérie Copié, Chemistry & BiochemistryStephanann Costello

Familial dysautonomia (FD) is a rare neurodegenerative disease that primarily affects individuals of Ashkenazi Jewish descent. The patients exhibit a variety of symptoms including pain and temperature sensation deficits, gait ataxia, gastrointestinal discoordination, and optic neuropathy. FD results from an autosomal recessive point mutation in intron 20 of the ELP1 gene. This gene encodes the ELP1 scaffold protein of the elongator complex, essential for the survival and development of neurons. The mutation ultimately leads to the degradation of ELP1 mRNA, causing reduced cellular synthesis of ELP1, with implications specific to different tissues. To investigate metabolic changes in this disease, which currently has no cure, several FD mouse models have been engineered. Specifically, the Chat-Cre mouse model, developed by Dr. Lynn George, represents a conditional knockout of the ELP1 gene which effectively eliminates the expression of the ELP1 protein in motor neurons (Chat-cre+; Elp1LoxP/LoxP). In this study, 1H NMR spectroscopy was utilized to characterize changes in liver metabolite patterns of the Chat-Cre mice. Six polar metabolites were found to display significantly altered levels in the livers of the FD mutant versus the control mice, two increased (3-hydroxybutyrate, cheno-deoxycholic acid) and four decreased (taurine, O-phosphocholine, glycerophosphocholine, trimethylamine). Taurine, produced by the liver or obtained from the diet, is of particular interest, being a constituent of bile acids that are essential for dietary nutrient absorption. In addition, a detailed analysis of impacted metabolite pathways has been performed and will be presented.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#6 Morning

Probing metabolic pathways mediating macrophage-Staphylococcus aureus interactions in a co-culture model mimicking a wound healing environment
Linnea Lake, Chemistry & Biochemistry
Mentors: Valérie Copié, Chemistry & Biochemistry

The goal of my project is to investigate how bacterial biofilms reprogram the metabolism of host immune cells to evade killing. In particular, we aim to identify small molecules that are secreted by the human pathogen, Staphylococcus aureus (S. aureus) bacterial biofilms, and their effect on the metabolic status of primary human macrophages. This research is particularly important to enhance our understanding of the role of metabolism in bacterial biofilm pathogenesis and how metabolic pathways mediate S. aureus- primary human macrophage interactions. The immediate goal of my research is to become proficient in the application of nuclear magnetic resonance (NMR) spectroscopy to investigate changes in the metabolomes (i.e. small molecule metabolite profile) of cells and how NMR metabolomics is employed to better understand the molecular networks that influence the interactions between host immune cells and bacteria. Herein, I will present my latest accomplishments in the Copié lab; I will explain the process of generating an S. aureus- human macrophage co-culture model that mimics macrophage-pathogen interactions in wound healing and how NMR metabolomics studies are conducted. Following the growth of S. aureus in this co-culture model and extraction of aqueous metabolites, 1H NMR experiments will be undertaken to identify and quantify metabolite patterns over time, shedding light on metabolic pathways involved in the interaction between biofilms and macrophages. In the long term, this study may offer insights into

metabolic networks that could be targeted for the treatment of chronic wound infections.

Acknowledgements: USP - Undergraduate Scholars Program & INBRE - IDeA Network for Biomedical Research Excellence

#7 Morning

Type III Based CRISPR Diagnostics

Gunnar Shanafelt, Chemical & Biological Engineering- Mentors: Blake Wiedenheft, Chemistry & Biochemistry

Current diagnostics suffer from either a lack of sensitivity and accuracy or lengthy testing times. We propose that a Type III CRISPR system will allow for a rapid, highly sensitive, and accurate diagnostic test. My project has been to clone and purify a new CRISPR system that has been hypothesized to have an effective polymerase rate at room temperature.

Acknowledgements: INBRE - IDeA Network for Biomedical Research Excellence & USP - Undergraduate Scholars Program

#8 Morning

Utilizing Nuclear Magnetic Resonance to Identify Polar Metabolites within Various Biological Samples

Logan R. Webster, Chemistry & Biochemistry
Mentors: Valérie Copié, Chemistry & Biochemistry

Nuclear Magnetic Resonance (NMR) spectroscopy is growing as an analytical technique within the field of metabolomics and could hold the key to unlocking future advancements within medical biochemistry. NMR spectroscopy is a technique that allows for the identification of known small molecules (i.e., metabolites of interest) within a sample containing several unknown metabolites by placing the sample within a powerful magnetic field and measuring the interactions of nuclear spins. Specific metabolites can be identified using this technique because different metabolites cause specific and unique shifts in the spectrum. Within Dr. Copié's lab group, they utilize MSU's 600MHz NMR spectrometer in every project to identify polar metabolites within a collected sample. The general process for using NMR metabolomics within any of the given projects is the same between each one. Therefore, once an individual is experienced within any project, it is easy for them to collaborate with another project within the group. This process includes, sample collection, metabolite extraction, NMR spectra collection using the software Topspin, processing and profiling using the software Chenomx, analyzing significant changes in metabolite concentrations, theorizing the biological significance, and finally additional hypothesis testing. NMR spectroscopy has a wide array of applications within the scientific community and is utilized extensively within Dr. Copié lab group.

Acknowledgements: USP - Undergraduate Scholars Program & INBRE - IDeA Network for Biomedical Research Excellence

SPRING 2024 MSU STUDENT RESEARCH CELEBRATION

BIOMEDICAL SCIENCE

#7 Afternoon

Ski Speed at Lactate Threshold as a Predictor of Race Performance in Elite US Para Nordic Sit-Skiers

Sage Blickensderfer, Health & Human Development - Mentors: James Becker, Health & Human Development - Co-Author/s: Madeline Inman, Health & Human Development, Dayne Jarrett, Health & Human Development

Unlike able-bodied skiers, Para Nordic sit-skiers rely exclusively on upper body musculature for forward propulsion. Due to a higher concentration of glycolytic fast-twitch fibers, the upper body musculature displays higher lactate production at lower relative work intensities. Therefore, it is unclear if speed at lactate threshold (LT) can be used as a performance predictor in sit-skiers. This study aimed to determine whether ski speed at LT predicts race performance in elite Para Nordic sit-skiers. It was hypothesized that sit-skiers who perform at higher speeds at 4mmol blood lactate would have faster 5k race times than those who perform at lower speeds. Six sit-skiers (3M, 3F) from the US Para Nordic Ski Team participated in this study. Participants completed a submaximal LT profile at a constant grade of 3.5%. Ear lobe blood lactates (bLa) were collected every four minutes after which speed was increased by 0.22 m/s. A third-order polynomial was fit to the speed-bLa curve and the speed corresponding to the LT determined. LT was identified as 4 mmol. Within one week of LT testing, athletes completed a 5k race. Linear regression was used to determine whether ski speed at LT predicted race times. The mean 5k race time was 1,213 seconds and the mean speed at 4 mmol bLa was 3.52 m/s for the 6 athletes. Speed at 4mmol of blood lactate was a strong predictor of race time in a 5k sit-ski race ($p = .005$, $r2 = .892$). Ski speed at LT is a strong predictor of race performance. This gives coaches a viable way to determine race readiness in sit-skiers without a lab. However, the inclusion of other laboratory determinants of performance (VO2 MAX/ Ski Economy) to improve performance prediction in sit-skiers requires further investigation.

Acknowledgements: US Para Nordic Ski Team

#9 Morning

Biathlon Shooting Post-Shot Stabilization Predicting Score

Owen Comes, Health & Human Development
Mentors: Jim Becker, Health & Human Development

Numerous studies have shown that the number of missed targets predicts race outcomes across all biathlon race formats. Therefore, there is a substantial body of literature examining factors which influence shooting scores. However, to date, all studies have evaluated what happens prior to a shot, typically in the last 0.5 seconds before the shot. No studies have examined how stabilization of the rifle and follow through influence shooting performance. Purpose: Therefore, this study examined whether shoulder forces and rifle stability following a shot predict the performance of subsequent shots in both prone and standing shooting. Fifteen experienced biathletes (11 male, 4 female) participated in this study. Methods: Participants included all members of the US National Biathlon team (WC) and Elite team members from the Crosscut Mountain Sports Center in Bozeman, MT (IBU). Participants shot four 5-shot magazines on scoring targets in both prone and standing positions. Movement of the rifle was measured with an IMU sensor placed beneath the front sight while a load pad was used to measure the forces between the shoulder and rifle butt. The following dependent variables were then calculated: mean (SFmean) and standard deviation (SFsd) of the shoulder force, mean rifle velocity (MV), and deviation of rifle aim point in the vertical

(DevY) and horizontal (DevX) directions. Results and Discussion: WC showed higher values in SFmean ($p < .001$), rifle_DevA ($p < .001$), rifle_DevV ($p < .001$), rifle_MV ($p < .001$), score ($p<.001$), and SF_sd ($p=0.013$) compared to IBU. However, prone SF_sd ($p = .028$) and SFmean ($p<.001$) showed higher values for IBU level compared to WC. A linear regression model containing rifle_MV, SFmean, and rifle_DevV was able to predict subsequent prone shot scores with increasing values of these variables leading to higher shot scores ($p < .001$, $R2 = 0.293$). Predicting standing shot scores varied slightly only using rifle_DevV and SFmean to predict high subsequent shot scores ($p<.001$, $R2 = .340$). These results show that more verticle rifle movement and shoulder force, as well as increased rifle velocity, will predict better subsequent scores.

#10 Morning

Low heart rate precision shooting predicts biathlete shooting performance in competition

Macie Hopkins, Health & Human Development
Mentors: Jim Becker, Health & Human Development

Biathlon is a paradoxical event where athletes must perform a skill-based precision task immediately following maximal effort aerobic exercise. However, during training athletes spend a significant amount of time using slow fire, low heart rate precision shooting. Whether performance on these low heart rate precision shooting tasks is indicate of shooting performance in race conditions is unclear. Therefore, this study explores whether performance on a low heart rate precision shooting test predicts race hit percentages in different levels of biathletes. Nine World Cup (WC) level and six IBU Cup (IBUC) level athletes participated in this study. Athletes performed a precision shooting test consisting of 20 shots prone and 20 shots standing onto paper targets. Shooting percentages in competitions from November 2023 through February 2024 were identified from publicly available databases or race results. Independent t-tests were used to compare precision shooting performance and race hit percentages between groups while linear regressions were used to determine whether precision shooting predicts race percentages. WC athletes had higher total precision scores (336.3 ± 8.72, $p < .001$) than IBUC athletes (276.4 ± 18.51). They also had higher hit percentages in races ($80.11\% \pm 5.82$ vs $62.81\% \pm 6.76$). Athletes with higher total precisions shooting scores had greater overall hit percentages in races ($p < .001$, $R2 = 0.76$). These results indicate that static shooting performance is indicative of how a biathlete will perform in competition and that on average, WC athletes score higher than IBUC athletes. From a coaching perspective, this highlights the importance of including low heart rate precision shooting in the annual training and that testing athlete capabilities in these areas can provide coaches insight into how an athlete may perform later in the year or whether athlete is progressing to a higher level or performance.

#8 Afternoon

Enhancing Language Comprehension in Neurodivergent Children of Rural Communities: A Multimodal Approach

MackenzieK. Hughes, Psychology
Mentors: Nadezhda Modyanova, Mechanical & Industrial Engineering Bernadette McCrory, Mechanical & Industrial Engineering

This research investigates the efficacy of incorporating gestures in enhancing language comprehension, particularly of determiners (e.g., “the”), in neurodivergent children from rural communities. Utilizing Electroencephalograms (EEGs) alongside eye-tracking technology, the study aims to provide deeper insights into the cognitive processes involved in language comprehension among children with Autism Spectrum Disorder (ASD) and Developmental Language Disorder (DLD). Existing studies highlight EEG abnormalities in neurodivergent children, underscoring the necessity of tailored interventions. However, past research often overlooks non-verbal and

partially verbal individuals, particularly in rural areas, exacerbating accessibility barriers. Addressing this gap, our study employs an inclusive approach, involving non-verbal rural participants, to offer a more comprehensive understanding of language comprehension in neurodivergent children. Through the integration of gestures and determiners, the study hypothesizes improved comprehension, especially among children with ASD and younger typically developing (TD) children. Eye tracking complements EEG data, enabling the observation of gaze patterns and correlations with cognitive and language skills. Notably, EEG data analysis aims to identify semantic processing differences and abnormal brain wave patterns, potentially serving as biomarkers for ASD and DLD.

This research builds upon previous findings, emphasizing the positive impact of multimodal interventions on language comprehension. Collaborative efforts with experienced researchers and utilization of innovative technologies enhance the study's robustness and potential for real-world application. Ultimately, this study aims to inform the development of effective interventions tailored to the unique needs of neurodivergent children in rural communities, thereby improving their quality of life and fostering inclusive practices in language development research and intervention. Data collection and analysis is ongoing, and future results will be reviewed.

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#11 Morning

Sepsis caused by acute arsenic poisoning

Andreina Rodoni, Microbiology & Cell Biology
Mentors: Seth Walk, Microbiology & ImmunologyTrenton Wolfe Microbiology & Immunology

Arsenic is a carcinogen and cytotoxin. Globally, it is estimated that 200 million people are exposed to unsafe levels. Interindividual susceptibility to arsenicosis is a hallmark observation in epidemiological studies but why some individuals develop symptoms and others do not is currently unknown. To date, interindividual effects have not been observed in animal models. Recently, the Walk lab developed a model in which mice are treated with an antibiotic then exposed to inorganic arsenic. Strikingly, a large interindividual susceptibility to arsenic was observed. Whereas about 60% of the mice became moribund, the remaining mice survived with no major symptoms of disease. To the best of our knowledge, this is the first whole-organism model to recapitulate this interindividual arsenic susceptibility, providing an opportunity to identify the underlying mechanisms of disease. In this study, we evaluated differences between the two model outcomes (sick vs. healthy). We found that sick mice had blood chemistry indicative of liver and kidney dysfunction and decreased white blood cell counts indicative of immune dysfunction. Additionally, the cecum of sick mice showed gross anatomical features suggestive of infection. In contrast, healthy mice exhibited normal blood chemistry and cecal anatomy. These observations suggest sick mice develop a sepsis-like disease state (Sepsis is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection). Our current work is aimed at identifying the source of septic infection, determining which immune cells are involved, and evaluating whether arsenic-induced sepsis in mice can be mitigated using treatments for human sepsis.

Acknowledgements: USP - Undergraduate Scholars Program

#9 Afternoon

Patterning method optimization for organized neural circuits in vitro

Mckennah Thompson, Chemical & Biological Engineering - Mentors: Anja Kunze, Electrical & Computer Engineering

Brain-on-chip technologies provide a unique platform to investigate neuronal networks removed from the native architecture of the brain through accelerated maturation and enhanced access for probing and recording at the cost of lost complex function. A fundamental feature of these complex functions is the emergence of local ensembles of functionally connected neurons, interacting to form global functional features. We hypothesize the introduction of locally structured cortical networks interconnected to form a global network enhances the cross-sample functional consistency observed in high-order neuronal architectures. To achieve this, we engineered a hydrogel embossed assay to introduce spatially guided local and global structures through topographically isolated channels. The assay consisted of a neuronal adhesion molecule (Poly-D-Lysine) exposed across the surface of the Petri dish, followed by embossing features in heated agarose (80 ºC) under compression with a poly-dimethyl-siloxane stamp and rapid cooling (8 ºC) to promote agarose gelling. We optimized the patterning method by introducing a magnetic stamping technology, which showed a greater yield than that of the previous hand-stamping method. Using the agarose features, we performed primary cortical neuron cell cultures, where minimal cell adhesion was observed by 4 DIV with no neuronal survival by 7 DIV. Using fluorescent microparticle embedded agarose, we show that embossed features maintain a thin layer of agarose, blocking the neuronal cell adhesion molecules, inhibiting adhesion and growth. This work suggests that a hybrid micro-contact printing – hydrogel embossing technique would provide significant growth enhancement for embossed neural cultures to investigate neural circuit dynamics in vitro.

Acknowledgements: USP & INBRE - IDeA Network for Biomedical Research Excellence

BUSINESS & MARKETING

#10 Afternoon

Is Nuclear Energy the Most Promising Energy Source for a Sustainable Future?

Grant D. Kahle, Agricultural Economics & Economics - Mentors: Paul Gannon, Chemical & Biological Engineering & Duane Catlett

Nuclear energy has proven itself as a safe, low carbon, and reliable source of electricity. Though in the past, public opinion has inhibited the growth and success of this electricity source; today, with the pressure of climate change forcing the world to make a lasting change in the way our society generates electricity, nuclear power is increasingly acknowledged as critical for a clean energy future. The first main goal of our research is to better understand Montana's public opinion and knowledge of nuclear power, and importantly, the reasoning for their views. We have conducted a survey that, in addition to demographic variables, asks respondents whether they are favorable or unfavorable toward nuclear energy, and if they feel knowledgeable or unknowledgeable about nuclear energy. We have surveyed Montana State University students from varying fields of study and are analyzing the data to make comparisons with current trends reported in national surveys. The second main goal of our research is to better understand why nuclear energy has such a high price tag associated with it. We are conducting basic techno-economic analyses of nuclear energy and collaborating with researchers and developers, and the local electric utility company, who is considering nuclear energy. Collaborators represent Northwestern Energy, Idaho National Laboratory, and other experts. These collaborators have shared abundant information and data regarding nuclear energy and various economic, technological, and regulatory factors to consider. With this information, a further goal is to identify where nuclear energy can decrease costs to make it more economically viable and competitive.

Acknowledgements: USP - Undergraduate Scholars Program

COMPUTER & INFORMATION SCIENCE

#11 Afternoon

POS Device Security Measures
Grant W. Eckerson, Computer Science
Mentors: Clemente Izurieta, Computer Science

The POS (point of sale) device is critical to the modern US economy. They are connected to the POS host's network to communicate with both their inventory systems inside the network and financial applications outside of the network. The information sent outside of the network contains highly critical personal information, such as a customer's name, address, DoB, and most importantly, their credit and/or debit card information. This sensitive personal information can be left vulnerable on the network and exploited through cyber attacks. In addition to cyber attacks made on the network, POS devices can be vulnerable to physical attacks when left unattended by their host. With how critical this information is, and how valuable it can be to those who exploit it, POS systems should be designed with sufficient security measures in place to prevent cyber and physical attackers from penetrating these devices. For this project, we conducted a thorough literature review to shed light on the various methods in place to safeguard our information. With information obtained from our literature review, we can start to identify where security measures can be improved to protect our sensitive personal information from POS device attacks.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#12 Morning

Cookie Monster: The Security and Risks of Online Cookies
Dustin Edgerton, Computer Science
Mentors: Clemente Izurieta, Computer Science
Yvette Hastings, Computer Science

Website access has become the dominant method for communication and business transactions in today's world. For user convenience and for the sake of selling advertisements, websites often require the implementation and collection of a user's personalized cookie data. This collection allows for features like auto filling forms while also allowing websites to sell data to advertising companies. These cookies are blocks of data stored on a user's web server which contain personal information, such as a user's passwords and credit card information. This sensitive data opens the window for cyber threats to those using the internet. The security of cookies often rely on the user's web server and the internet service provider. However, there are malicious ways that bad actors can steal a user's cookie information. If the web server is using Hypertext Transfer Protocol (HTTP), cookie data is not encrypted. Bad actors can use phishing attacks, such as fake websites or hyperlinks, to redirect a user from a secure HTTP (HTTPs) to an unsecure web server where they can launch their attack. Hackers can also launch a "man-in-the-middle" attack, which intercepts the connection between the user and the webserver. This allows attackers to steal the user's cookie data and breach their personal information. For this study, I researched the encryption methods that webserver's use to protect cookie data, as well as the different methods hackers use to get around the encryptions. Due to the nature and prevalence of cookies, cookie security is vital to assure the safety of all users who access the internet from all devices.

Acknowledgements: Cyser

#12 Afternoon

Fire ResQube
Nathan Johnson, Computer Science
Mentors: Clemente Izurieta, Computer Science
Co-Author/s: Dawson Jordan, Computer Science

Firefighters play a crucial role in community safety, consistently risking their lives and embodying qualities such as integrity, physical fitness, and teamwork. Despite these commendable attributes, a distinct need arises for a comprehensive tool to facilitate knowledge-sharing among firefighters across the United States. In response to these challenges, Fire ResQube emerges as an innovative mobile application designed with the React Native framework, aiming to connect, engage, and enhance the skills of the firefighting community. Notable features include user profiles, questions, discussions, search functionality, daily refreshers, and a secure login system. Our project emphasizes the meticulous development of the Weekly Workout Challenge. Leveraging a database and an interactive user interface, we enable users to upload personal statistics for weekly AI-generated workouts, access national leaderboards, and create custom groups for friendly competition and mutual accountability. By offering easily accessible workout history, we highlight individual improvements over time while simultaneously motivating users to maintain consistent workout streaks. Through the implementation of the Weekly Workout Challenge, our objective is to cultivate an engaging user experience that promotes fitness, camaraderie, and healthy competition among firefighters. This mission aligns seamlessly with Fire ResQube's broader goals of enhancing public safety, fostering skill development, and promoting community engagement.

Acknowledgements: MSU Computer Science Interdisciplinary Capstone course: CSCI 483 Interdisciplinary Project

#13 Afternoon

RedTrade
Jack E. Kleist, Computer Science- Mentors: Clemente Izurieta, Computer Science Co-Author/s: Brady Underwood, Computer Science

RedTrade is a stock simulation application targeted at individuals who are interested in learning more about the intricacies of financial trading. Its core features are interactive data visualization of stocks, clear explanations of financial terms, and a tool to allow users to invest and hold "play money" on the market. Redtrade will use AlphaVantages's capabilities to pull stock ticker information. By design, there will be a strong security component that helps ensure the integrity of personal information. RedTrade will use common software technologies (i.e., React Native for front end and Supabase for backend components), and will adopt native security infrastructure to create base line security, as well as the standard AES256 Encryption for session data. The software component Snyk will be used to validate the source code for common weaknesses and other vulnerabilities during the design phase.

#14 Afternoon

PyNaCl "Salt" Encryption and Authentication for Networking to 3D Printer

Justin Daniel Lamers Hartberg, Mechanical & Industrial Engineering - Mentors: Clemente Izurieta, Computer ScienceYvette Hastings Computer Science

In remote networking with 3D printers, ensuring secure and encrypted connections is crucial for maintaining confidentiality and integrity. Encrypting data and authenticating user credentials improves the safety of the 3D printing setup. This process ensures information originates from the correct source and hasn't been modified by unauthorized parties. We test encryption and decryption capabilities using the PyNaCl library to look at the information passed between a computer system and a 3D printer. This process involves a standard private/public key exchange. Additionally, a key exchange and a digital signature will be used to further ensure the authenticity of the sender and prevent man-in-the-middle attacks. The use of the PyNaCl library to encrypt the information being sent between a computer and a 3D printer has several implications for cybersecurity. Implementing security measures ensures the confidentiality, integrity, authenticity, and non-repudiation of data exchanged between the computer and the printer. Moreover, these measures enhance the security, privacy, trust, reliability, and availability of the 3D printing system. The inclusion of a robust security library restricts unauthorized access, use, modification, and disclosure of data transmitted between the computer and the printer. This proactive approach mitigates the risk of malicious commands being sent to the printer, safeguarding it and its environment from potential harm in both digital and physical domains.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#13 Morning

"Sampling Bounds for Topological Descriptors"

Maksym Makarchuk, Computer Science
Mentors: Brittany Fasy, Computer Science
Co-Author/s: Samuel Micka, David Millman and Luke Padula

Increasingly, topological descriptors like the Euler characteristic curve and persistence diagrams are utilized to represent complex data. Recent studies suggest that a meticulously selected set of these descriptors can encode geometric and topological information about shapes in d-dimensional space. In practical applications, epsilon-nets are employed to sample data, presenting two extremes: oversampling, where epsilon is small enough to ensure a comprehensive representation but may lead to computational inefficiencies, and undersampling, where epsilon lacks a grounded rationale, offering faster computations but risking an incomplete shape description without theoretical guarantees. This research investigates phenomena of oversampling and undersampling, delving into their prevalence across synthetic and real-world datasets. It experimentally verifies excessive oversampling in theory-guided approaches and examines the implications of undersampling, shedding light on the behavior and consequences of both extremes. We establish lower bounds on the number of descriptors required for exact encodings and explore the trade-offs associated with undersampling, contributing insights into the potential information loss and the resulting impact on the overall shape representation.

Acknowledgements: USP - Undergraduate Scholars Program

#14 Morning

Evaluating Charliecloud's Build Cache Performance in More Realistic Contexts

Layton R McCafferty, Computer Science
Mentors: Clemente Izurieta, Computer Science
Co-Author/s: Reid Priedhorsky, Lucas Caudill

Container technologies use Linux Kernel Isolation mechanisms to promote software package flexibility, application portability, and customization of user software stacks. Containerization is crucial to High Performance Computing (HPC). Charliecloud provides these benefits to HPC by providing a lightweight, fully unprivileged container runtime using a novel, git-based approach for its storage. Reid Priedhorsky et al. (2023) compared the git-based approach to a conventional layered architecture for containers. The study emphasized cache temperature, in other words, how much of the image has already been built and cached: none (cold), all (hot), or about half of it (warm). They found that the Charliecloud build cache performed better under certain conditions than others. For example, when using cold and warm cache instances, Charliecloud was faster. However, it was consistently slower with a hot cache. In terms of storage space, Charliecloud is usually larger; however, in warm instances Charliecloud is the same size or smaller than Docker. Note: these findings are based on images from the Charliecloud test suite including large and small synthetic images. The research developed by this team sought a more realistic way to evaluate the build cache. We present an approach to collect data traces from users that are representative of the workflows they use to produce their unique cache instance. We then can replicate those traces to reproduce the workflow using different container implementations, such as Docker, Charliecloud, Podman, and Singularity under different testing conditions such as large-file thresholds and filesystems. The final goal is to test cache performance, which is ultimately determined by image build time and storage size (as targeted by this study). This is important because Charliecloud is the only containerization software that implements caching via git, rather than layers. If Charliecloud is found to be more performant than other container implementations, container softwares may want to move to a git-based architecture rather than a layered one.

Acknowledgements: USP, McNair Scholars Program, Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#15 Morning

Snort Intrusion Detection and Prevention System for Network Traffic Analysis between Docker Containers

Brian S. Schumitz, Computer Science
Mentors: Clemente Izurieta, Computer Science
Co-Author/s: Megan Steinmasel, Computer Science

Ensuring the quality and security of software systems is crucial in our ever-expanding digital world. To that end, the Software Engineering and Cybersecurity Lab (SECL) at Montana State University developed PIQUE: a Platform for Investigative software Quality Understanding and Evaluation. PIQUE is a language-agnostic system that can be adjusted for language-specific static-analysis operations. One PIQUE model focuses on measuring the quality of cloud microservice ecosystems. Cloud ecosystems use tools like Docker, an open-source development tool, to deploy, run, update, and manage containerized services to create efficient and scalable web applications. Our research is focused on measuring the quality of networking services, which are critical in cloud infrastructure. Computer networks are constant targets of cyber-attacks, and many incident response tools exist to defend against malicious network traffic. One of these tools is called Snort. Snort is an open-source intrusion detection and prevention system that can detect and log benign and malicious network traffic using rules. Snort rules delineate patterns to look out for in network traffic. Then, when

those patterns are detected, rules will tell Snort how to react. Snort rules are powerful and have extensive customizability. By taking advantage of Snort's flexible and powerful rule options, we can construct testing methods to measure and quantify the network quality of cloud ecosystems. Our research goal is to automate the process of running network quality tests between containerized services that use Docker.

Acknowledgements: Federal funding (NSF, NIH, NASA, DOE, etc.)

#16 Morning

Hyper-Local Social Media: Herd-It
Nicholas F. Sulzbacher, Computer Science
Mentors: Clemente Izurieta, Computer Science
Co-Author/s: Gabe Ewsuk

The proposed application, Herd-It, outlines the development of a social media platform with a unique approach to content organization. This platform will feature dedicated hubs for various topics, fostering community engagement and discussions. A key feature is the platform's emphasis on location-driven content, allowing users to tailor their experiences by expanding or narrowing their searches based on geographical preferences. Additionally, users will have the option to post anonymously, but a premium offering will introduce a credibility threshold and implement karma systems to enhance content quality. While the project acknowledges the importance of user interface design, it aims to maintain simplicity in its initial stages.

Acknowledgements: USP - Undergraduate Scholars Program

#17 Morning

Side Channel Attacks on Compilers and Defensive Countermeasures
Robert J. Van Spyk, Computer Science
Mentors: Clemente Izurieta, Computer Science

Side-channel attacks exploit indirect information from computer systems, requiring cyber attackers to infer data from seemingly innocuous sources. This sensitive information can be leaked through various forms, such as, power usage, timing, heat, and memory caches. Despite their subtlety, these attacks pose a significant threat to computer systems, especially to software used in critical infrastructure. This project investigates the vulnerability of computer compilers to side-channel attacks by answering how compilers inadvertently leak sensitive information and what countermeasures can be employed. To analyze plausible sources of information leakage, data was collected on power usage, timing characteristics, and memory caching patterns associated with common compiler actions. The focus identified potential avenues for information leakage and developed effective countermeasures to mitigate such risks. Additionally, we conducted a thorough literature review on side-channeling attacks, focusing on their manifestation in compilers. The results of this study encompass a detailed analysis of data collected through monitoring various compiler actions. The findings provide insights into the potential vulnerabilities of compilers and the extent to which they may inadvertently disclose sensitive information. This research underscores the critical importance of addressing side-channel attacks on compilers by illustrating what information can be inferred from the collected data. The implications of these findings extend beyond the immediate scope, emphasizing the need for robust defensive countermeasures in software development. This study enhances the security posture of computer systems and software applications, ensuring their resilience against subtle yet potent threats.

Acknowledgements: CySer

EARTH & ENVIRONMENTAL SCIENCE

#15 Afternoon

Is ExxonMobil Legally Liable of our Planets Demise?
Claire Cassellia, Land Resources & Environmental Sciences - Mentor: Paul LaChapelle, Political Sciece

ExxonMobil is one of the largest oil companies in the world, yet its plan to combat climate change remains weak and covers up the company's impacts and intentions. After the company became influential, many employees warned executive members of ExxonMobil on how its practices are poorly impacting our environment. Even with these warnings continuing for years, memos and company documents revealed ExxonMobil's plan to cover up and mislead the public about climate change. Funding fake science was a main tactic: paying unqualified scientists to make claims untrue claims about how climate change was a hoax. Today, their climate plan notes that they support science which is fact, climate change not being one of them. When looking at their current plan to help improve the climate crisis, they state "These statements are not guarantees" and "are subject to numerous risks and uncertainties." all while saying they are committed to helping the crisis. With evidence piling up, several states and cities have begun to sue ExxonMobil for their alleged disregard and misleading tendencies on climate change in their company practices. As the court cases unfold, everything from the company's past and present will be considered, including those in executive positions within the company.

#16 Afternoon

Constraining Regional Tectonics Using the Geochemistry of Mesozoic Strata in West-Central California
Ian Collivre, Earth Sciences
Mentors: Devon Orme, Earth Sciences

Ian Colliver, Devon A. Orme, Natalee Weis, Carly Ross, Emma Sweet Preserved Jurassic and Cretaceous lithotectonic units in western California present a complicated scientific debate regarding the timing and style of Mesozoic subduction. During the Mesozoic, mélange and ophiolitic bodies accreted to western North America while the Great Valley forearc (GVF) basin and Sierra Nevada-Klamath magmatic arcs developed inboard. This study investigates the trace element geochemistry of the Jurassic Coast Range Ophiolite (CRO) and Jurassic and Cretaceous sandstones and mudstones of the GVF basin, the Great Valley Group (GVG). We compare these values to data from mid ocean ridge basalts, island arc basalts, and continental volcanic sequences to reconstruct their provenance. Because of the proximal setting of the basin and affinity of rare earth elements (REE's) for transport in terrigenous sediments, we expect the chemical signature of clay sized particles to faithfully reflect original provenance. Chondrite normalized REE data show negative europium anomalies across units, indicating plagioclase deficiency. Positive excursions of Barium, Rubidium, and Strontium indicate the presence of minerals such as muscovite and monazite. Thorium/Scandium vs. Zirconium/Scandium plots show a stronger enrichment of thorium within GVG samples indicating a proximal felsic active margin volcanic source.
Thorium/Uranium vs Thorium concentration diagrams from zircon support this interpretation. A Lanthanum, Thorium, and Scandium concentration ternary plot shows scandium depletion with time, consistent with an increase in compositional maturity. These results indicate that the CRO is consistent with formation in either a MORB or continental arc

setting, and GVG sediments evolved through time due to sedimentary recycling and increasing magmatic differentiation.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#17 Afternoon

Protecting Wild Salmon

Italia L. Fraize,
Mentors: Carol Chang,
Co-Author/s: Rylee Isaac

Salmon and trout hatcheries have created an abundance of non-wild fish throughout most streams, rivers, and the ocean around America. However, without fish hatcheries, wild salmon and trout would stand a better chance at survival. The problem is that "75% of the salmon harvested in the Puget Sound come from hatcheries; 90% of the steelhead harvested in Washington come from hatcheries; it's estimated that up to 70% of the salmon harvested off the coast of California are from hatcheries; and one of the biggest problems is that 90% of the salmon and steelhead swimming in the Columbia River began their life in a hatchery," said the Director of the Hatchery and Wild Coexist Campaign, Dave Schamp. The main reason we have fish hatcheries is due to over-development in areas like California, Oregon, and Washington. Some examples of over-development include logging, along with the need for dams and agricultural fields. All of this blocked natural fish migration routes as well as destroyed many of the smaller feeder streams that trout and salmon used to spawn in. This issue is what forced fish and wildlife departments to install fish hatcheries as a means to maintain fish populations and fisheries. Nowadays many people live where salmon and steelheads once did, and their habitat has changed forever. Today's modern laws have stated that we need to "protect fish habitats" but there is little to no follow-through on that. Urbanization has always found a way around these laws. Our forefathers decided that fish weren't as important as people, yet we still depend on them so much. Restoring wild salmon and trout isn't an easy process, it requires a lot of time and money The negative part of it is that without hatcheries we won't have enough fish to harvest and keep the jobs and livelihoods of many Americans. That is why we are striving to minimize hatcheries' output of non-wild salmon that disrupt wild salmon from spawning, as well as breeding with wild salmon and trout, weakening the wild fish gene pool. We believe in the importance of the genetic integrity of the wild salmon population. Hatcheries have harmed wild salmonoid populations as well as reduced genetic diversity due to inbreeding with hatchery fish. If we can lower the output of hatchery fish and grow the numbers of wild fish. We can live happier, healthier lives for ourselves, and our wild salmon and trout.

Acknowledgements: USP - Undergraduate Scholars Program

#18 Afternoon

How climate change will impact military operations across the globe

Macy J. Schowalter, Land Resources & Environmental Sciences
Mentors: Paul Lachapelle, Political Sciece

The United States Department of Defense has classified the issue of climate change as a matter of national security, further stating that "the planet's changing climate has a significant effect on Defense Department missions, plans, and installations" (U.S. Department of Defense (Tackling the climate crisis)). The consequences and impacts of rising temperatures and natural disasters magnified by climate change impedes mission readiness and changes the way the U.S. military plans and executes its missions. This research will dive into how the U.S. military will plan, fight, and win our nations wars in the face of climate change. The policies and ideas surrounding how the U.S. military will reduce its global climate impact will not be the focus of my research, however, it may be brought up as supportive material.

#18 Morning

Assessing the Fluorescence Characteristics of Optical Brighteners in Rocky Mountain Streams

Jordy N. Renee Solliday, Land Resources & Environmental Sciences - Mentors: Geoff Poole, Land Resources & Environmental Sciences

Optical brightening agents (OBAs) are common fluorescent chemical additives to detergents and other household products and are indicative of untreated wastewater sources when present in streams. Differentiating the fluorescence of OBAs from other compounds such as naturally occurring organics requires knowledge of the specific excitation and emission wavelengths useful for detecting OBAs. We employed a two-phase experimental approach to assess the fluorescence characteristics of OBAs. First, we created a 5 by 5 grid of standard samples with 5 concentrations (0 ppm to 50 ppm) of artificial stream water (ASW) and 5 concentrations of OBAs. This allowed for the identification of optimal excitation-emission pairings where ASW fluorescence was least sensitive and OBA fluorescence was most sensitive. Subsequently, we sampled four local streams, split each sample into 5 parts, and added 5 known concentrations of OBAs ranging from 0 ppm to 50 ppm. Millipore water samples with similar added OBA concentrations were used as a control. And an excitation emission matrix was produced for each sample. We examined the correlation between emission intensity and OBA concentration for each combination of excitation and emission wavelengths to determine the wavelengths that yielded the strongest responses to OBA concentration with the least emission intensity interference from background stream-water organics. Our comprehensive analysis identified appropriate excitation and emission wavelengths to optimize detection of OBAs in Rocky Mountain Streams.

Acknowledgements: USDA NIFA and Dr. Margaret Eggers

#19 Afternoon

Petrographic Analysis of Mesozoic Franciscan Subduction Complex Sandstones, central California

Emma Sweet, Earth Sciences
Mentors: Devon Orme, Earth Sciences
Co-Author/s: Devon A. Orme, Earth Science, Carly Ross, Earth Science, Natalee Weis, Earth Science

The Franciscan subduction complex of coastal California primarily developed during Jurassic through Cretaceous time during oceanic-continental subduction. The Franciscan developed oceanward of the Great Valley Forearc basin succession and its underlying basement, the Coast Range Ophiolite. Seven sandstone samples collected from different locations in central California, southwest of San Jose, were petrographically point counted to determine bulk rock composition and provenance. Three of the samples were majority quartz (85%) and plotted as subarkoses on a sandstone ternary diagram. By contrast, two samples were richer in plagioclase felspar and plotted as an arkose and a feldspathic litharenite. Accessory minerals included muscovite and several unknown lithics, including fine-grained volcanic fragments. The cement in these samples was primarily iron oxide, with one sample containing calcite cement. Grain size varied drastically between samples making point counting following the Gazzi-Dickinson method challenging. Two of the analyzed were metamorphosed, with either parallel bands of plagioclase intertwined with iron oxide, or foliation fabrics defined by biotite, serpentinite, and opaque iron oxides. Bookshelf sliding deformation is also present in one sample indicating metamorphism was transitioning to a ductile-state to accommodate deformation of the matrix. This analysis highlights the wide variety of sandstones, including varying degrees of metamorphism, that comprise the Franciscan subduction complex in central California.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

ECOLOGY

#20 Afternoon

DETECTING THE BIOMAGNIFICATION OF PERFLUOROOCTANOIC ACID (PFOA) IN STREAM ECOSYSTEMS WITH CLOSE PROXIMITY TO SKI TRAILS

LydiaJ. L. Bushey, Land Resources & Environmental Sciences - Mentors: Lindsey Albertson, Ecology, Anna French, Ecology
Co-Author/s: Samuel Fritz, Ecology

Perfluorooctanoic acid (PFOA) is an emerging contaminant that can bioaccumulate in freshwater ecosystems. One source of PFOA is fluorinated Nordic ski wax compounds suspended in spring snowmelt from trail systems adjacent to streams. Little is known about the potential for ski wax runoff to affect PFOA biomagnification in aquatic food webs, despite 40 out of 50 U.S. states having documented, often well-used, ski trails. Our study considers how bioaccumulation of PFOA occurs, the spatial and temporal extents of current and future studies, and the methodology employed. We develop a framework for understanding whether PFOA concentrations in predatory macroinvertebrates can be detected using liquid chromatography mass spectrometry (LC-MS) for samples from streams influenced by ski wax runoff (within 1 km of trails) and control streams (10 km from any trails). Stream water, benthic biofilm, and nonpredatory and predatory macroinvertebrates are used to quantify biomagnification along the food chain from both wax-influenced and uninfluenced streams at the end of the ski season. We use alpine streams in southwestern Montana, a region that is snow-covered for 7 months annually and supportive of a growing community of recreational and professional skiers, as a model location for applying this framework. Our research may have important implications for understanding the lasting impacts of PFOA chemicals on ecosystems, especially in historically rural areas where populations are rising. Future research should consider distance of water bodies from trails, ski season duration, and skiing pressure to further inform guidelines about the impacts of recreational activities on streams.

Acknowledgements: USP - Undergraduate Scholars Program

#21 Afternoon

Fungal Associations in Montana's Native Orchids

Ansel Fiddaman, Plant Sciences & Plant Pathology - Mentors: William Dyer, Plant Sciences & Plant PathologyBarbara Keith, Plant Sciences & Plant Pathology

Montana is home to approximately 31 native orchid species, many of which are rare or threatened in the state. Most orchids rely on mycorrhizal relationships for part or all of their life cycle in the wild, particularly during seed germination and the protocorm stage. These relationships are often species-specific, with many orchids relying on only a few species of fungi. Understanding the relationships of orchids and fungi is crucial for orchid conservation, particularly for species which have not been successfully propagated using asymbiotic methods. In this ongoing study, fungi were isolated from the roots of several wild orchid species, cultured on agar plates and identified through genetic barcoding of the ITS region. Preliminary results show associations with several fungi in Basidiomycota and Ascomycota including Leptodophora orchidicola and several fungi in the genus Tetracladium. The results of this research may be of particular importance in orchid conservation, especially in propagation and reintroduction projects. Information on orchid mycorrhiza may see application in agricultural fields as well, as some orchid mycorrhizal fungi can also be found as pathogens in common crops.

Acknowledgements: USP

ENGINEERING & TECHNOLOGY

#19 Morning

Incorporating Gels in Microbially Induced Calcite Precipitation to Decrease Time in Shale Core Sealing

Levi Bala, Civil Engineering
Mentors: Adrienne Phillips, Civil EngineeringCatherine Kirkland, Civil Engineering

Microbially induced calcite precipitation (MICP) is a process through which Sporosarcina Pasteurii hydrolyze urea during growth, then, in the presence of calcium, produce calcite. This mineral production has been used to seal fractures in shale rock columns with a goal to apply it in unconventional oil and gas wells to reduce methane emission. In the summer of 2023, I conducted research at the Center for Biofilm Engineering at Montana State University to seal cores using MICP. One downside of this sealing method is it requires many injections to effectively seal a fracture. The goal of this project is to improve the sealing time of MICP of rock fractures by incorporating gels in the growth medias of S. Pasteurii. The incorporation of gels will increase the viscosity of the medias, ideally containing the mineral reaction within the fracture to reduce the need for multiple injections. Two gels, guar gum and sodium alginate, were tested for bacterial growth inhibition in a preliminary growth study; guar gum was determined to be the ideal additive. Guar was then implemented in a preliminary crushed shale sealing experiment to examine effective mineral production. Using the results of this experiment, a flow-through injection core sealing experiment will be performed, following protocol from a previous core sealing experiment. The results of this flow through experiment will then be compared to results from my previous research to determine effectiveness of gel addition.

Acknowledgements: USP - Undergraduate Scholars Program, Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#22 Afternoon

Kinetics of Denitrification by Pseudomonas stutzeri and Dechloromonas denitrificans

Madison Basile, Center for Biofilm Engineering
Mentors: Ellen Lauchnor, Civil Engineering

Treatment wetlands are systems designed to mimic natural wetlands, using vegetation, soil, and microbes to remove contaminants from wastewater. In treatment wetlands, microbes and plants treat wastewater, removing pollutants through natural biological and chemical processes. Microbes reduce influent ammonia in the wastewater to nitrate (NO3-) which can ultimately be turned into dinitrogen gas via denitrification. However, during the removal of nitrogen from wastewater, these systems often emit nitrous oxide into the environment. Nitrous oxide is a greenhouse gas that can remain in the atmosphere for up to 120 years and has a global warming potential 300 times that of carbon dioxide. Reducing the emissions of nitrous oxide is of interest to those developing and using treatment wetlands. Treatment wetland nitrous oxide emissions are a result of an imbalance in reaction rates during denitrification. The goal of this study is to determine kinetic values for denitrification of NO3- for Pseudomonas stutzeri and Dechloromonas denitrificans at 10°C and 22°C in order to evaluate whether these bacterial species have the potential to reduce the amount of nitrous oxide emitted from treatment wetlands. Michaelis-Menten kinetics were used to determine the two Michaelis-Menten parameters, maximum uptake rate (Vmax) and half saturation constant (Km). For D. denitrificans at 10°C, the Vmax was 2.77 ppm NO3- /min and the Km was 1.55 ppm NO3- . For D. denitrificans at 22°C, the Vmax was 11.64 ppm NO3- /min and the Km was 1.81 ppm NO3-

Acknowledgements: USP

#23 Afternoon

Power System Analysis of Wind Energy Power Output Variations

Jackson Blum, Physics
Mentors: Ying Zhang, Electrical & Computer Engineering

Wind power is an important technology for energy generation, but it does not produce consistent power day-to-day and throughout the year. In this work, fluctuations in energy output cause brown and black outs. Applying the common analytical techniques of power system analysis with MATPOWER and the statistical technique of the Weibull distribution on wind energy data from the Eastern United States, the analysis helped build a better understanding of how to prevent these issues in the future.

#20 Morning

Improving Cloud Thermodynamic Phase Measurements by Adding Spectral Information

Kyndra Buglione, Electrical & Computer Engineering - Mentors: Joseph Shaw, Electrical & Computer Engineering - Co-Author/s: Erica Venkatesulu

Distinguishing cloud thermodynamic phase (CTP), whether a cloud is composed of liquid water droplets, ice crystals, or a mixture of the two, is an important parameter used in weather forecasting, climate models, and aircraft icing predictions. The ORSL is beginning to test CTP retrievals with a small, low-cost system using a division-of-focal-plane (DoFP) polarization imager (~$2.5k) that could enable widespread retrievals because of its low cost and simplicity. These CTP retrievals with the low-cost polarization imager are based on prior work that showed the polarization state of scattered light could be used to discriminate between liquid and ice clouds. Further, that prior work suggested that adding spectral dependence to the retrieval algorithm may improve accuracy, because of a spectral dependence to the polarization state of light scattered from liquid and ice clouds. Thus, in this research, we prepared three DoFP polarization imager cameras with different spectral filters (450nm, 650nm, and 800nm) to simultaneously measure CTP alongside a lidar to test the spectral dependence of polarization in liquid and ice clouds. We performed radiometric and polarimetric calibrations and we characterized the spectral response and spatial relationship on all three cameras to obtain accurate measurements when collecting data. An initial step in calculating polarization of light scattered from clouds is to create a cloud mask, which identifies the location of a cloud in an image. We developed an algorithm based on the difference between clouds and the sky in both red-blue ratio and in degree of linear polarization. The three-camera system will be used in the future to collect more data and explore the relationship of ice and liquid cloud phase polarization in each spectral band.

Acknowledgements: USP - Undergraduate Scholars Program

#24 Afternoon

Thermophilic Degradation of Plastic Wastes

Calla Castro, Microbiology & Cell Biology
Mentors: Dana Skorupa, Center for Biofilm Engineering, Brent Peyton, Center for Biofilm Engineering - Co-Author/s: Alex Myxter, College of Agriculture

The biodegradation of plastic wastes at elevated temperatures represents a novel catalysis route that would allow plastic depolymerization and subsequent biotic polymer production to occur at elevated temperatures, creating a cost-effective and efficient alternative to plastic waste management. Work here sought to isolate and optimize the growth of thermophilic microorganisms capable of biodegrading prominent plastic wastes. Before cultivation, some of the plastic materials were oxidized with heat and pressure to transform them into soluble waxes, shortening the carbon chains and allowing the carbon to be more accessible

for biodegradation. Microbial samples were then collected from high-temperature (35-92°C) hot springs in the Heart Lake Geyser Basin region of Yellowstone National Park. The sites were chosen in an attempt to localize thermophilic plastic-degrading microorganisms. Following the establishment of enrichment cultures, several thermophilic species were isolated on solid media. Once isolated, the cultures were scaled up and returned to liquid media for long-term cultivation. Optical density was used to monitor and assess growth, with Sybr-gold nucleic-acid staining and downstream fluorescent microscopy techniques employed to observe morphology and conduct direct cell counts. Work here successfully established isolated thermophiles capable of growing on polystyrene film, oxidized nylon, or oxidized low-density polyethylene as their sole carbon and energy source for growth. The growth rate of several promising isolates is currently being assessed, with future experiments using Liquid Chromatography-Mass-Spectroscopy (LC-MS) analysis to identify and quantify degradation reaction products, determining the overall biocatalysis efficiency.

Acknowledgements: USP - Undergraduate Scholars Program & Battelle Memorial Institute

#25 Afternoon

Lab-on-a-Chip Platform for Precise Extracellular Vesicle Isolation in Disease Biomarker Exploration

Sidhee Sarit Das, Chemical & Biological Engineering - Mentors: Anja Kunze, Electrical & Computer Engineering

Extracellular vesicles, or EVs, are membrane-bound vesicles generated by cells and they serve as messengers that transfer molecular signals between cells. Due to the cargo they carry, such as proteins and nucleic acids, EVs have the potential to be used as biomarkers to diagnose cellular diseases, including neurodegenerative diseases like Alzheimer's Disease. Understanding the role of size-based subpopulations of EVs (exosomes, microvesicles, and apoptotic cell bodies) can advance our understanding of their roles as disease biomarkers. Therefore, the purpose of our project is to separate EVs based on their sizes so that we can explore their unique roles in disease progression, and pathogenesis. Traditional methods for isolating EVs lack size specificity, however, there are some emerging methodologies and tools, such as size exclusion chromatography, to overcome this challenge. As one of the emerging tools, our project aims to use inertial microfluidics, employing the inertial effects of fluid flow in curved microchannels to sort and manipulate different sizes of microparticles. In a curved microchannel, a combination of Dean forces and wall-induced lift forces result in the separation of particles based on size. The effectiveness of this separation is influenced by various parameters, including channel height, width, curvature, fluid properties, velocity, and flow regime. To optimize our design, we used COMSOL Multiphysics to simulate the velocity profiles and Dean vortices in microfluidic devices of serpentine, Archimedean spiral, and logarithmic spiral designs with diverse parameters. The velocity profiles and Dean vortices, in conjunction with varying design choices and fluid parameters, provided insights into the efficiency of particle sorting. Our separation platform will help us establish the foundation for a highly specific size-based EV sorting and later will serve as a tool to further investigate their biogenesis and role in neurodegenerative diseases.

Acknowledgements: USP - Undergraduate Scholars Program & VPRED

#26 Afternoon

Aging alters the subchondral bone response 7 days after non-invasive traumatic joint injury in C57BL/6JN mice

Lexia A. Dauenhauer, Chemical & Biological Engineering- Mentors: Chelsea Heveran, Mechanical & Industrial Engineering, Brady Hislop - Mechanical & Industrial Engineering

Post-traumatic osteoarthritis (PTOA) commonly develops following anterior cruciate ligament (ACL) injuries, affecting around 50% of individuals within 10-20 years. Recent studies have highlighted early changes in subchondral bone structure after ACL injury in adolescent or young adult mice, which could contribute to the development of PTOA. However, ACL injuries do not only occur early in life. Middle-aged and older patients also experience ACL injuries and PTOA, but whether the aged subchondral bone also responds rapidly to injury is unknown. This study utilized a non-invasive, single overload mouse injury model to assess subchondral bone microarchitecture, turnover, and material properties in both young adult (5 month) and early old age (22 month) female C57BL/6JN mice at 7 days after injury. Mice underwent either joint injury (i.e., produces ACL tears) or sham injury procedures on both the loaded and contralateral limbs, allowing evaluation of the impacts of injury versus loading. The subchondral bone response to ACL injury is distinct for young adult and aged mice. While 5 month mice show subchondral bone loss and increased bone resorption post-injury, 22 month mice did not show loss of bone structure and had lower bone resorption. Subchondral bone plate modulus increased with age, but not with injury. Both ages of mice showed several bone measures were altered in the contralateral limb, demonstrating the systemic skeletal response to joint injury. These data motivate further investigation to discern how osteochondral tissues differently respond to injury in aging, such that diagnostics and treatments can be refined for these demographics.

Acknowledgements: USP & INBRE - IDeA Network for Biomedical Research Excellence

#21 Morning

Development of on-chip, in-drop qPCR

Grace E. Ducharme, Chemical & Biological Engineering - Mentors: Emma Loveday, Chemical & Biological Engineering
Co-Author/s: Camden Long, Biological Engineering, Stephanie McCalla, Biological Engineering

This project aimed to simplify and execute on-chip, in-drop quantitative polymerase chain reaction (qPCR). The experimental method of qPCR enables researchers to amplify nucleic acids to measure gene expression over time. Current qPCR methods lack the capability to execute this technique within microfluidic drops, limiting our ability to evaluate heterogeneity in gene expression at the single-cell level. Combining previous research from the Loveday and McCalla labs, our goal was to design a microfluidic device enabling qPCR for single-cell gene expression analysis. The main challenge of this project was addressing the instability of aqueous microfluidic drops during temperature fluctuations necessary for qPCR. To combat this problem, devices were constructed with a 3D printed resin as opposed to the traditional microfluidic device polymer, PDMS, which tends to destabilize at high temperatures. This project involved utilizing computer-aided design (CAD) platforms to design various device geometries, subsequent fabrication of the devices, and evaluation of their overall performance. The successful development of these devices will enable quantification of nucleic acids from single cells, facilitating the monitoring of heterogeneous cell lines. Through interdisciplinary collaboration and utilizing previous research in drop-based microfluidics and single-cell qPCR, the objective of this project was to develop a system capable of performing on-chip single-cell qPCR reactions.

Acknowledgements: USP - Undergraduate Scholars Program

#27 Afternoon

Nanofabrication Techniques for Advanced Wire Grid Polarizers

James Graham, Electrical & Computer Engineering- Mentors: Wataru Nakagawa, - Electrical & Computer EngineeringDavid Dickensheets Electrical & Computer Engineering

Polarization, a fundamental property of light, plays a crucial role in various optical and photonic devices and applications. Wire grid polarizers (WGPs), composed of nanoscale parallel metallic wires, are a widely used device to create or measure optical polarization. One way of implementing these devices is by structuring a silicon substrate into the desired wire pattern through etching, followed by deposition of metal onto that structured surface. To enhance performance and broader applications for WGPs, smaller, more precise features within WGPs are needed. Building upon existing research, the project investigates creation of nanoscale structures in silicon to serve as templates for wire grid formation. The project seeks to push the boundaries of silicon etching and metal evaporation techniques to enhance the fabrication process of WGPs. This research involves systematically optimizing reactive ion etching processes for silicon to achieve sub-micron size features. Significant progress has been made in silicon etching, with developed processes achieving target depths of 100-200nm and demonstrating a precision of ±10nm. Simultaneously, optimized techniques are developed for precise metal layer deposition, emphasizing control over shape, thickness, and location. Additionally, through literature exploration, the project aims to identify materials for broader wavelength applications, crucial for enhancing the performance of wire grid polarizers. The advanced fabrication techniques developed in this project aim to significantly expand the application possibilities of WGPs, ushering in a new era of optical device fabrication with improved performance. These findings contribute substantially to the field of optics and photonics, presenting novel tools for manipulating light polarization.

Acknowledgements: USP - Undergraduate Scholars Program

#22 Morning

Investigating Substrate Material Influence on Hexavalent Chromium Condensation in High-Temperature Systems

Amberly Jessalyn Guerrero, Chemical & Biological Engineering - Mentors: Paul Gannon, Chemical & Biological Engineering
Co-Author/s: Travis Van Leeuwen, Material Science, Ryan Dowdy, Chemical and Biological Engineering

In high-temperature systems, stainless steel forms a chromium (III) oxide layer that is susceptible to vaporization and leads to the emergence of hazardous hexavalent chromium species. The subsequent condensation of these species onto insulation materials in industrial settings, such as power plants and manufacturing facilities, raises significant health and safety concerns. Specifically, hexavalent chromium is a known carcinogen with various adverse health implications where industrial personnel may encounter exposure. This study undertakes a comprehensive examination of the complex dynamics surrounding hexavalent chromium deposition on insulation. By investigating the influence of varying water vapor levels and alkaline substrates on chromium deposition, the research aims to mitigate exposure risks in industrial environments.

Meticulously designed experiments, including tube furnace setups, were employed to emulate real-world applications of high-temperature systems. These conditions included a specific focus on the evaporation of chromium (III) oxide layers at temperatures exceeding 500°C with the manipulation of distinct alkaline substrates as insulation material. Furthermore, through data analysis, including EPA-standardized tests, the interaction between hexavalent chromium

condensation on specific fiber insulation substrates was delineated. Advanced analysis techniques, such as diphenyl carbazide testing and scanning electron microscopy, were utilized to elucidate chromium deposition under diverse conditions.

These findings significantly enhance understanding of hexavalent chromium behavior in high-temperature environments, offering practical insights crucial for workplace safety and environmental protection. By shedding light on the complex dynamics of chromium condensation, this research provides critical knowledge to address potential health risks and ensure the integrity of industrial processes.

Acknowledgements: USP - Undergraduate Scholars Program

#28 Afternoon

Building Snow Sensors to Provide Data for Polarized Lidar Testing

Henry Hamp, Electrical & Computer Engineering
Mentors: Joseph Shaw, Electrical & Computer Engineering

The Optical Remote Sensor Laboratory (ORSL) is currently developing a polarizing light detection and ranging (lidar) system for object and material detection and identification. While general lidar systems capture the shape and distance profiles of given targets, the goal of this imager is to add polarization to capture information about the materials the targets are made of as well. Outdoor imagers like this one are bound to interact with inclement weather, including snow in many regions. For this reason, the aim of my project will be to characterize snowfall and provide baseline data to be used to determine the polarization effect of falling snow. The ORSL's weather station currently provides some data pertaining to snowfall, but it is necessary to know how the rate and water content of snowfall affect the polarizing lidar's performance. To gather data on these metrics, the weather station's rain gauge will be repaired, and a snow depth sensor will be added to the weather station. Furthermore, the data gathered by both of these instruments will be published on the ORSL's website, providing information that can be used by other research laboratories and the public of Bozeman.

Acknowledgements: USP - Undergraduate Scholars Program

#23 Morning

PCIe Hardware Design for Image Storage

Dirk Kaiser, Electrical & Computer Engineering
Mentors: Ross Snider, Electrical & Computer Engineering

As part of the NSF EPSCoR SMART FIRES grant, new smart hyperspectral imaging drones are being developed for use in fire science applications. These hyperspectral imaging drones use specialized optics to create images that hold data for a spectrum larger than visible light and process the collected data to infer how certain areas will burn. With the creation of these instruments, the need for high-speed and high-density storage devices has arisen. Peripherial Component Interconnect Express (PCIe) is the chosen standard for high-speed serial communication capable of storing the image tensors used in hyperspectral imaging due to the high bandwidth of the interface and the ever-growing storage capacity of PCIe devices. The fourth generation standard for PCIe being used in this application specifies a communication speed of 16 Giga-Transfers per second. This transfer rate brings additional concerns when creating hardware. With speeds this fast, signal integrity, propagation time, and electro-magnetic interference are now an important consideration when designing printed circuit boards for PCIe devices. For these reasons, a deep dive into PCIe hardware design was conducted with the specific case of hyperspectral image tensor storage in mind. As a result of this, specific development hardware was created for use of the FPGA System-on-Module (SoM) that will be the key processor used in the hyperspectral imaging drones for processing and inference.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#24 Morning

Removal of Fly Ash from Non-Proprietary Ultra High Performance Concrete and Exploring Thixotropy

Tony Losi, Civil Engineering
Mentors: Kirsten Matteson, Civil Engineering

In conjunction with the Montana Department of Transportation, Montana State University has been developing non-proprietary thixotropic Ultra High Performance Concrete (MT-UHPC) for the use on bridge projects in Montana. All previous mix designs have included fly ash which is increasingly hard to acquire in Montana. The goal of this project is to remove fly ash from the MT-UHPC mix. The first task of the project was to remove the fly ash from our non-thixotropic mix then the second task was to make the resulting mix thixotropic. A parametric study was used to find the optimum replacement for the fly ash in the mix. After 2 mixes it was determined that replacing half of the fly ash with cement powder produced the best results. The attempt to make the mix thixotropic failed because the admixture used was expired. The UHPC mix generated from task 1 will be used on smaller scale projects and more research should be done to create a thixotropic version of MT-UHPC without fly ash.

Acknowledgements: USP - Undergraduate Scholars Program

#25 Morning

Refining Hempcrete Mix Design for the Microbial Environment

Emma Jocelyn Morgan, Civil Engineering
Mentors: Kirsten Matteson, Civil Engineering, Chelsea Heveran, Mechanical & Industrial Engineering, Co-Author/s: Leah Davidson, Mechanical & Industrial Engineering

The high quantity of carbon emissions produced by the construction industry has instigated efforts to create materials with higher levels of embodied carbon. Hempcrete, concrete mixed with hemp hurd, is a sustainable insulation material that sequesters CO2 over time. Research at MSU has been investigating how to strengthen hempcrete for residential construction by inducing bacterial biomineralization within the material. This project aimed to optimize hempcrete's mix design by lowering pH levels, creating conditions conducive for microbial-induced calcium carbonate precipitation. Given that traditional concrete's high pH inhibits the microbial viability and metabolic activity required for biomineralization, achieving a low pH mix was deemed essential for advancing the greater hempcrete research at MSU. Through the variation of cement, lime, silica fume, and metakoalin in concrete mixes without hemp hurd, a decreased pH mix was successfully produced. Testing demonstrated that cement and lime collectively elevate pH, while metakaolin has a limited independent impact but influences pH at higher silica fume replacements. Silica fume was shown to primarily drive the observed pH reduction, and has therefore been eliminated from further mix designs. This initiative has gone forward to observe the strength of these low pH mixes without hemp hurd and will take its next steps to implement hemp into the concrete mixes. The project involves collaboration with faculty members, including Dr. Kirsten Matteson and Dr. Chelsea Heveran, alongside graduate student Leah Davidson, who is preparing the microbial life that will be implemented into future mixes to elevate hempcrete design strength.

Acknowledgements: USP - Undergraduate Scholars Program

#29 Afternoon

3D Printed Biodegradable Magnetic Microrobots for Targeted Drug Delivery

Karen Gabriela Nunez Michel, Mechanical & Industrial Engineering
Mentors: Yang Cao, Mechanical & Industrial Engineering

The purpose of this project is to discuss fabrication techniques for biodegradable nanorobots directed via magnetic field system for targeted drug delivery purposes. Traditional drug delivery methods like oral ingestion or intravascular injection are not efficient and/or lead to significant side effects. Methods

Microfabricating and designing the nanorobots: Gelatin-based nanosprings with embedded iron oxide nanoparticles were created to maintain necessary magnetic properties. This study is attempting to adopt Park et al. (2019) spiral/corkscrew shape to leverage the magnetic properties of the nanoparticles for controlled behavior. Various experiments were conducted using a fabrication technique developed for 3D microstructures involving extrusion, ensuring flexibility in material composition (Yoshida & Onoe, 2017). The extrusion process utilized a syringe pump, with adjustments made to material consistency and thickness to achieve the appropriate consistency and flow to generate the corkscrew shape.

Results: Trials employing different extrusion rates revealed that at a rate of 0.22 ml/min, produced the most optimal spiral shape in the behavior of the nanospring during extrusion. A microtube was affixed to the needle tip, with the microtube's tip cut at a 45-degree angle to attain the desired spiral shape.

Although several solutions were designed and tested, the crosslinker solution that proved most effective in meeting the study goals was comprised of calcium chloride dissolved in distilled water.

Conclusion: These nano-robots have the potential to transform drug delivery systems within the human body in an interdisciplinary project, holding promise for future advancements in additive manufacturing method applications.

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Acknowledgements: USP - Undergraduate Scholars Program

#26 Morning

GuideBot: Vision Companion

Emmett Osborne, Computer Science
Mentors: Clemente Izurieta, Computer Science
Co-Author/s: Cole Smith, Computer Science, Austen Harrell, Computer Science

Guide dogs have long been invaluable aids for the blind and visually impaired, ensuring safe navigation through various environments. Despite their benefits, guide dogs also necessitate continuous care, including feeding and attention, and can sometimes be distracting in certain settings. Addressing these challenges, we propose an innovative alternative: an automated robotic guidance vehicle tailored for visually impaired students at Montana State University designed to operate outdoors. This robotic solution emulates the functions of a guide dog, employing advanced features such as location tracking, obstacle detection, and an intuitive mobile user interface. The integrated

software manages robot movement, processes LiDAR data for real-time obstacle detection, interprets geolocation inputs, and facilitates user interaction through a dedicated app.

Acknowledgements: Self Funded with support from Clemente Izurieta.

#27 Morning

High Altitude Data Extraction System (H.A.D.E.S.)

Abigail Davies Ross, Mechanical & Industrial Engineering-Mentors: Randy Larimer, Electrical & Computer EngineeringMike Walach, Department of Agricultural and Technology Education-Co-Author/s: Isaac O'Rourke, Mechanical and Industrial Engineering, Zach Guentherman, Electrical and Computer Engineering

The Montana Space Grant Consortium (MSGC) Balloon Outreach, Research, Exploration, and Landscape Imaging System (BOREALIS) Program is focused on the design, manufacturing, and testing of high altitude balloons, including both zero pressure balloons as well as vented latex balloons. In addition to current research focused on developing hardware and software equipped to float a balloon at 90,000 feet for the duration of a solar eclipse to detect gravity waves in the upper atmosphere, the investigation of a steerable parachute mechanism has been identified as a reasonable method to direct the balloon payload to a designated waypoint. In order to reduce costs associated with transportation and risks with recovery, an autonomous payload retrieval method is ideal. Given the diverse terrain of Montana, the High Altitude Data Extraction System (H.A.D.E.S.) seeks to optimize the ease and reliability of payload recovery by autonomously directing the parachute to a more favorable landing location. From the water in Maine, cities in Michigan, and rural areas of Montana, this steerable parachute system will be a valuable addition to the balloon payload to avoid harsh landing conditions, which will protect the components of the payload and increase safety for individuals. Based on previous research conducted by BOREALIS interns for the NASA Floating Dragon Challenge and consideration of traditional paragliding and paramotoring aerodynamics, a steerable parachute was recognized as the ideal avenue for safely directing the payload to the designated waypoint. Background research relating to the NASA Gemini Project and preliminary experimentation of various parachute designs presented the twin-keel rogallo airfoil as the optimal design for achieving a high enough glide ratio to effectively reduce the vertical velocity while maintaining its steerability. In addition to the twin-keel rogallo airfoil, this project includes a 3D-printed control body that has the ability to be adapted to various balloon types and a custom printed circuit board that has the capability of operating the dual servo motors to control the direction and velocity of the parachute system.

Acknowledgements: MSGC - Montana Space Grant Consortium

#28 Morning

Understanding Clearance of Toxins from Brain Tissue

Sarah Shenk, Chemical & Biological Engineering
Mentors: Lori Ray, Chemical & Biological Engineering

The glymphatic system is composed of vessels enveloping the brain, driving the removal of discarded proteins and waste that can aggregate and become toxic. The glymphatic function is believed to increase during the deepest stage of sleep. Our current research is focused on developing mathematical models rooted in fundamental transport phenomena in physiological systems. The models aim to support a team of researchers in developing a noninvasive intervention to stimulate and extend the deepest stage of sleep to improve the glymphatic function. Given that previous research suggests a link between impaired neural waste disposal and neurodegenerative

diseases such as Alzheimer's and Parkinson's, our work shows potential for delaying the onset of neurodegeneration. By analyzing dynamic contrast-enhanced MRI (DCE MRI) data, our models display the transport of cerebrospinal fluid throughout the brain, highlighting the concentration trends in the ventricles, basal cistern, subarachnoid space, and periarterial space. Through our findings, we aim to contribute to the development of interventions to mitigate neurodegenerative diseases.

Acknowledgements: USP - Undergraduate Scholars Program

#29 Morning

Structural Property Testing of Small-Scale Rotor Blades

Shelby R. Slenes, Mechanical & Industrial Engineering-Mentors: Carl Russell, Co-Author/s: Katherine Klokkevold, Materials Science & Engineering

The Multirotor Test Bed (MTB), built in 2019, was a test that would allow for an easily reconfigurable test stand or multirotor aircraft configurations. The blades that were used for the second round of testing on this fixture were tested to find material values. The material values tested were Lag and Flap Sectional Stiffness, Chordwise Bending, Mass Properties, Center of Gravity Location, Torsional Stiffness, and Elastic Axis Location. Measuring these values would allow for the EI and GJ to be used in analysis of the data gathered from the original MTB2 tests. The values measured showed that the MTB2 blade is anisotropic, which was suspected. There is a possibility that there is variability in the blades which will be investigated in further tests.

Acknowledgements: MSGC - Montana Space Grant Consortium

#30 Morning

Ice Melt Dynamics Inspired by Naturally Occuring Ice

Nolan Rene Verret, Mechanical & Industrial Engineering - Mentors: Sarah Morris, Mechanical & Industrial Engineering

Ice formations occur naturally in a variety of ways, whether that be large icebergs in the ocean or small circular ice formations in lakes. In both cases, the ice is suspended in water and due to a natural phenomenon these ice formations can spin. This spinning phenomenon and the effect it has on the melting characteristics of the ice are not fully understood. This phenomenon has the potential to affect the melt rate of the icebergs, having the potential to affect the rise in ocean levels or affect a variety of natural systems in place. To further develop an understanding, experimental methods and data collection techniques were developed. A small scale tank was constructed to house the experiments, allowing the ice samples to be suspended in water. A laser plane is mounted to illuminate a cross sectional area of the ice, allowing for a camera to take photos over a set interval time or record videos. These photos and videos facilitate the observation of area decay or the flow visualization of the melting ice. The photo and video functions were run using a program built in LabVIEW. The area decay are measured using a program developed in the lab using MatLab. The tank was constructed successfully and lays the groundwork for future experiments in the lab. These techniques were also successful in developing experimental methods to further understand the dynamics of suspended ice melt.

Acknowledgements: USP - Undergraduate Scholars Program

#30 Afternoon

Neuroplasticity in ACLR Patients: A Multimodal Approach to Understanding Post-Rehabilitation Neural Adaptations and Implications for Return-to-Sport Decision Making

Kaylan Wait, Chemical & Biological Engineering Mentors: Scott Monfort, Mechanical & Industrial Engineering - Co-Author/s: Allie Lynch, Mechanical Engineering

Anterior cruciate ligament (ACL) reinjury rates of nearly 20% may indicate gaps in current RTS testing. ACLR patients' neural activation pathways may undergo significant change proceeding surgery contributing to the illusion of bilateral symmetry. Functional near-infrared spectroscopy (fNIRS) provides non-invasive and portable imaging that can be used during more functional movements such as a single-leg squat. Combining biomechanical analysis of performance with brain imaging may allow for novel insight into resultant neuroplasticity from ACLR surgery. PURPOSE: To determine how neural activation patterns may change after ACLR surgery, potentially revealing different adaptations that allow for the appearance of maintained physical function. METHODS: 11 healthy younger adults (20.25 +- 1.42 years, 1.77 +- 8.36 meters, 77.8 +- 13.8 kg, 5 males / 6 females) performed repeated single-leg squats to 45 degrees while conducting a cognitive task. The cognitive test was a modified Antisaccade test of attention control requiring participants to look away from cue and identify target letter as O or Q through hand-held buttons. The Motor + Cognitive task was repeated 5 times for 54 seconds with 2 minutes of rest between each block. fNIRS data were collected for the prefrontal, dorsolateral prefrontal cortex, precuneus, and motor regions. Data were analyzed using NIRS toolbox to compare differences in hemodynamic responses between ACLR and healthy control groups. Data collection is ongoing, particularly for ACLR participants, and the current data focuses on healthy controls. RESULTS: For the cognitive-motor dual task, there was a significant increase in oxygenated hemoglobin (HbO) levels in Brodmann area 5 (p=0.014, β=1.78, T = 2.56). In addition, there was trending significance in the increase of HbO in the precuneus region (p = 0.058, β=1.56, T = 1.92). Increased HbO levels indicate an increase in activation of corresponding area relative to baseline. CONCLUSION: In the healthy participants' data collected thus far, there is a significant increase in neural activation of Brodmann area 5, as well as a trending HbO increase in the precuneus region. As more data is collected, the activation of neural regions in the ACLR cohort will be compared against the activation pattern of healthy controls. The comparisons aim to identify ACLR-specific activation patterns that may arise following surgery. SupportedbyMSUVPREDGEResearchExpansionFundsandUSP

Acknowledgements: USP - Undergraduate Scholars Program, Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#31 Morning

The Measuring of Water Quantity in Snow via the NMR Dart

Marcella Jean Yatso, Civil Engineering Mentors: Catherine Kirkland, Civil Engineering Co-Author/s: Quirine Krol, Civil Engineering, Joseph Seymour, Chemical and Biological Engineering, Joe Eldering, Mechanical and Industrial Engineering

As of right now, there isn't a method to quantify how much liquid water is in a snowpack. This data is crucial to understanding snow melting rate and its corresponding mountain hydrology in times of climate change. The purpose of this experiment was to quantify liquid water quantity in snow by using a low-field (480 kHz) borehole NMR (nuclear magnetic resonance) probe called the Dart. The NMR Dart can detect liquid water content in a sample, but not frozen water (snow or ice). Moreover, the Dart can distinguish between thin water films on ice crystals and water filling pores in the snowpack.

A container was designed and constructed to sample snow in the sensitive region of the Dart, a six-inch diameter cylindrical shell. In the NACOE SubZero Research Lab, snow samples at temperatures ranging from -5° C to 1 °C were measured to quantify the liquid water. Based on the percentage of water content given by the NMR Dart, an estimate can be made on the liquid water content in the whole sample. These measurements are the first steps into developing a method in using the NMR dart to monitor the snowmelt of snowpacks over time.

Acknowledgements: USP - Undergraduate Scholars Program

HEALTH

#31 Afternoon

METABOLIC RESPONSES TO A HIGH-FAT DIET: COMPARING LOW VS HIGH VO2 MAX INDIVIDUALS

Caleb Neal Brownell, Health & Human Development- Mentors: Katy Kropatsch, Health & Human Development - Co-Author/s: Mary Miles, Health and Human Development, Katy Kropatsch, Health and Human Development, Prabina Bhattarai, Health and Human Development

Maximal oxygen consumption (VO2 max) is crucial for assessing fitness. Higher VO2 max allows for prolonged fat utilization at higher intensities, indicating metabolic efficiency. A high-fat diet (HFD) could elevate fat oxidation (FO) rates. Effects on trained versus untrained individuals, including impacts on cholesterol (CHOL), triglycerides (TG), and glucose (GLU), are unclear. The purpose was to determine the effects of a 28-day HFD (olive oil) intervention on FO, CHOL, TG, and GLU on healthy individuals with a high (HG, >50 ml/kg/min) or low(LG, <50 ml/kg/min) VO2 max following a fasted 30 minute steady state exercise test. Participants, aged 18-54, were divided into two groups (LG, HG) based on their calculated VO2 max after a submaximal exercise test and underwent pre- (PRE) and post-dietary (POST) intervention 30 min exercise tests, where FO was measured via indirect calorimetry and blood samples were analyzed for CHOL, TG, and GLU. The intervention included daily doses of 30g or 60g of olive oil for 28 days. FO summarized as area under the curve (AUC) for each time point. ANOVA and t-tests were used for statistical analysis. PRE indicated higher FO in the HG (n=12, 9.57 kcals/ 22 mins +/- SD) versus LG (n=12, 6.08 +/- SD kcals/22 mins, p=0.02). POST, HG (2.13 +/- SD kcals/22 mins) decreased in FO, while LG(0.71 +/- kcals/22 mins, p=0.047) increased. A HFD could improve FO and metabolic efficiency in those with lower VO2 max.

Acknowledgements: Cotton Seed Incorporated

#32 Afternoon

Influence of Ski Mountaineering Binding Design on Ground Reaction Forces During Skinning.

Emma Keating, Health & Human Development Mentors: James Becker, Health & Human Development - Co-Author/s: Isaac Burgess

Introduction: During uphill travel of ski mountaineering, bindings are crucial in determining the angle between the boot and ski. Previous research has shown that increasing rear binding riser height increases forces under the forefoot. However, it remains unclear the affect different binding designs have on forces under the foot. Purpose: Compare plantar foot force between pin(P) and freeride(FR) bindings while skinning uphill. Methods: 8 male ski mountaineers skinned on a treadmill for two minutes at 0.89 m/s at grade 15% using skis with R or FR bindings. Plantar pressure was recorded using XSensor Insole System (Technology Corporation, Calgary, AB, Canada) recording at 120 Hz. Plantar pressure maps were segmented into whole foot, rearfoot, and forefoot regions. The following variables were calculated for ten strides: impulse, first peak, and second peak of whole foot force, impulse and peak of rearfoot and forefoot forces. Paired t-tests with an alpha of $p<0.05$ (SPSS, IBM Corp. Armonk, NY) were used to compare mean values for each participant between bindings. Results: Whole foot impulses (P:338.6±95.5N*s, FR:353.0±57.6N*s, p=.684), first force peaks (P:439.5±72.1N, FR:454.6±38.3N, p=.521), and second force peaks (P:762.9±89.6N, FR:773.9±72.6N, p=.392) were all not different between bindings. Similarly, rearfoot impulses (P:103.6±26.1N*s, FR:114.9±23.7N*s, p=.309), peak forces (P:309.3±57.6N, FR:345.5±17.9N, p=.259), forefoot impulses (P:230.5±69.3N*s, FR:233.0±31.5N*s, p=.920) and peak forces (P:703.0±123.9N, FR:713.0±110.3N, p=.343)

were all not different between bindings. Conclusion: Binding design alone does not appear to affect boot orientation relative to the ski enough to influence plantar foot forces during uphill skinning while ski mountaineering.

#33 Afternoon

Maternal Oral Health and Differential Impacts upon Childhood Health

Margaret Louise Ludwig, Microbiology & Cell Biology - Mentors: Sally Moyce

Previous research has determined a definitive relationship between maternal oral health and hygiene and pediatric health. This has especially been investigated in the context of pediatric oral health; it has been found that maternal oral health can serve as a direct predictor of whether a child will develop early childhood caries due to colonization of maternal cariogenic bacteria. It has also been shown that maternal oral health can predict whether children will struggle with caries in adulthood. This finding demands the question of how directly maternal oral health predicts pediatric outcomes. How much of an influence does maternal oral health have upon pediatric health and wellbeing, and how influential are social determinants of health upon these outcomes? This project consisted of a comprehensive literature review examining the impact of a mother's oral health on the overall health of her children. Studies were chosen for review on the basis of their focus upon mothers in the United States, and upon their discussion of social determinants of health which could impact maternal oral health. The findings of this literature review revealed that social determinants of health such as medical inequality, social status, discrimination, income, and education level have the potential to impact maternal oral health and therefore pediatric health. The implications of these findings are broad and could catalyze improvements within healthcare, education, and policy in Montana and across the United States.

Acknowledgements: USP

#32 Morning

Consuming Cottonseed Oil for One Month Improves Total Cholesterol and Low-Density Lipoproteins in Healthy Adults

Collin Mcguyer, Health & Human Development Mentors: Mary Miles, Health & Human Development - Co-Author/s: Katy Kropatsch, Food systems, Nutrition, and Kinesiology, Prabina Bhattarai, Food systems, Nutrition, and Kinesiology Alexandria Lotstein, Food systems, Nutrition, and Kinesiology, Morgan Chamberlain, Food systems, Nutrition, and Kinesiology

Hyperlipidemia (HLD) is a risk factor for cardiovascular disease. Consuming cottonseed oil (CSO) has been shown to improve total cholesterol (TC) and low-density lipoprotein (LDL) levels. The daily recommendation for dietary oil consumption is 30 g. To our knowledge, it is unknown if this amount of CSO can improve lipid levels and how different doses of CSO impact lipid levels. PURPOSE: To explore how high-density lipoprotein (HDL), triglyceride (TG), TC, and LDL levels are affected by consuming 30 or 60 g of CSO compared to olive oil (OO) after 28 days. METHODS: Participants (n = 48, ages: 18-55 years, BMI: 18-27 kg/m2) were randomly assigned to consume smoothies containing CSO or OO each day for 28 days. Serum lipid values were measured with a lipid panel from a fasting blood draw pre- and post-intervention. Statistical analysis was conducted using delta change between pre- and post-intervention with a paired t-test in Excel (16.66.1). Summary of RESULTS: Total cholesterol levels significantly decreased when consuming 60 g of CSO compared to OO (Δ = -11.33 ± 13.36 mg/dL vs +4.55 ± 13.83 mg/dL, CSO vs OO, p = .01). LDL levels also significantly decreased when consuming 60 g of CSO compared to OO (Δ = -14.58 ± 9.42 mg/dL vs -0.25 ± 8.94 mg/dL, CSO vs OO, p = .05). CONCLUSION: Consuming CSO may be useful in preventing HLD at a higher dose than what is recommended.

Acknowledgements: Cotton Incorporated 22-070

#33 Morning

Importance of Cultural Competency in Higher Education Spanish Curriculum

Reyna Josephine Sundell, Health & Human Development- Mentors: Sally Moyce

In the state of Montana there is an increased need for culturally competent, educated, bilingual Spanish speakers, especially as the population is growing and the support infrastructure is not growing at the same magnitude (Moyce, 2023). While it is important to be able to speak the same language as the Hispanic population, cultural competency must also be learned. This skill breaks down cultural barriers and provides a human-centric focus, diminishing systematic racism and inequalities. This study uses a survey to numerically evaluate the cultural competency within the Spanish department at Montana State University. These numerical values were then analyzed and compared with students in aspiring health careers and those who are not. The primary purpose is to investigate the aspiring health career cultural education pipeline. This study pinpoints the gaps found in the student population

Acknowledgements: USP - Undergraduate Scholars Program

#34 Morning

Differences in Mechanical Efficiency Between Bindings at Various Grades

Garrett Westling, Health & Human Development Mentors: James Becker, Health & Human Development - Co-Author/s: James Becker, EHHD, Isaac Burgess, EHHD

Equipment used for ski mountaineering must be tailored for increasing uphill travel efficiency through decreasing mechanical work required to maintain high outputs of metabolic work without fatigue. While there is research surrounding the physiological response to mass added at the ankle during uphill skinning, few studies have evaluated the physiological response to specific equipment. PURPOSE: Compare mechanical efficiency (ME) between Pin (P) and Freeride (FR) bindings at various grades. METHODS: Eight males (age: 21, height: 1.8m, mass: 76kg) participated. A VO2 max protocol specifically designed for uphill walking was used to determine the interaction between heart rate and VO2. A linear relationship was used to determine the relative VO2 while skinning uphill on a ski treadmill at different grades and speeds using either P or FR bindings, from which metabolic work was calculated. Mechanical work was calculated as the product of mass, sine of the slope, and treadmill velocity. Finally, mechanical efficiency was determined as the ratio of mechanical work to metabolic work. Differences between bindings at various grades were evaluated using a 2x2 repeated measures ANOVA. RESULTS: There was no statistically significant binding*gradient interaction ($F_{1,4} = .348$, $p = .587$). Within both P and FR binding, as grade increased there was no difference in ME (P; $p = 0.553$, FR; $p = 0.087$). DISCUSSION: Binding type does not affect mechanical efficiency of uphill skinning at various grades in a laboratory setting. This could be explained by the minimal weight difference between binding types and the short duration of uphill skinning between grade changes. Influence of binding type on ME during uphill skinning in the field needs further investigation.

Acknowledgements: USP - Undergraduate Scholars Program

HUMANITIES

#35 Morning

Animals in Medieval Beast Fables and Bestiaries
Anna R. Emmans, English
Mentors: Gretchen Minton, English

The Middle Ages saw the rise of the Beast Fable and Bestiary, two unique forms of storytelling involving animals. A Beast Fable is a story set in a fictionalized world where animals act as avatars, playing out the effects of moral actions that they have no control over in order to communicate the results of said actions. These stories are action driven, not character driven, which works because animals have expected, natural traits that most people are (or were) already familiar with (Mann, 2009). The Bestiary is a collection of short descriptions and pictures about animals, through which we can learn about people's attitudes towards certain animals. Through literary examinations of texts like the Middle English The Vox and the Wolf, Chaucer's "The Nun's Priest's Tale," and the illuminated text, The Aberdeen Bestiaries, this research aims to examine the Western tradition that laid the foundation for the way that we think and talk about animals today. This research is pertinent to modern fields like animal agriculture and natural resources as we rethink how we interact with nature and all of its inhabitants.

#34 Afternoon

An Analysis of Organic Materials from an Ice Patch
Colin Michael King, Sociology and Anthropology
Mentors: Craig Lee, Sociology & Anthropology
Scott Dersam, Sociology & Anthropology

Ice patches are a unique source of information that can be used to infer past environments. With support from the Matthew Hansen Endowment for Wilderness Studies, and the Beartooth Environmental Alpine Archaeological Research Group, I was able to participate in two archaeological surveys of ice patches in the Greater Yellowstone Ecosystem in 2023. While both surveys were compromised by late lying snow, one resulted in the identification of non-rooted—and likely non-cultural—wood in association with two ice patches. Examination of Google Earth imagery indicates the presence of two small ice cores; a ca. 15 m long transverse core, as well as a less defined 10 m lateral core of ice in this location. The ice patch was identified by Lee's 2019 revised assessment of snow and ice for the Greater Yellowstone Coordinating Committee (GYCC) as "SB1_A." With additional support from Montana State University's Undergraduate Scholars Program, I was able to submit samples of the three collected specimens to Paleoscapes Archaeobotanical Services Team (PAST) for genus and composition analysis. PAST's analysis suggests that two of the samples (1A and 2A) are consistent with Picea (spruce). The composition of the samples appears to be similar, and macroscopic observations suggest they are likely fragments of branches. The third sample (3A) is a species of Abies (fir), with the generally smaller size of the tracheids suggesting it is from a branch. With the financial support noted above, a fragment of the spruce and fir were submitted for radiocarbon analysis, the result of which will be compared to extant reports on dated wood from other ice patches in the Rocky Mountains.

Acknowledgements: USP - Undergraduate Scholars Program & Mathew Hanson Wilderness Foundation

#35 Afternoon

The Use of Dark Humor in Holocaust Literature & Memorialization
Catherine Long, English
Mentors: Peter Schweppe, Modern Languages & Literatures

The aim of my research and corresponding essay is to explore why the Holocaust and Holocaust literature has fallen from the forefront of research and education in the United States, especially regarding how current and future generations can remember and memorialize the significance of this historical event. Due to the unusual nature of combining humor with a serious historical subject, there is very little research compiling various literary examples that employ this technique. The Holocaust is not funny, but I argue that its ability to be portrayed through humorous survivor literature is instrumental for continuing its remembrance. I explore this primarily through This Way for the Gas, Ladies and Gentlemen, a collection of short stories written by Tadeusz Borowski, a Polish political prisoner whose prolific writing was based on his experiences at Auschwitz. Through the use of the current framework often utilized in Holocaust research, I've analyzed Borowski's use of humor to better understand how it functions for his own psychological relief through unique, cathartic storytelling, as well as an increased literary understanding for readers. In adopting an interdisciplinary lens, this project aims to address the knowledge gap of younger generations when it comes to history of the Holocaust and its long-term impact for everyone. While humor is context specific, it proves successful in Borowski's writing because of its challenge of the mainstream lens of Holocaust education, one which my essay argues, is no longer effective for the changing perspective and needs of current generations.

Acknowledgements: USP - Undergraduate Scholars Program

#36 Afternoon

Summits & Skirts: Gender Dynamics in 19th-Century Mountaineering
Madison Maus, History & Philosophy
Mentors: Michael Reidy, History & Philosophy, Jacob Northcutt, History & Philosophy

My research looks at the intersection between gender and mountaineering, and reveals the inequalities, challenges, and unique experiences women face in high-altitude environments. Mountaineering has conventionally been perceived as a male-dominated activity, but my research explores the amount of women who participated in nineteenth century mountaineering. My study examines how lower-altitude mountains became feminized, and how the desire for exclusivity prolonged the gender imbalance in mountaineering. Gender dynamics influence the physical, psychological, and logistical challenges of mountaineering. My research analyzes the use of language, media, and science in the nineteenth century to divide men and women within mountaineering.

The history of mountaineering helps us better understand how complex and socially constructed our gender structure is. Maintaining exclusive access to summits and high environments was very important to British mountaineers like, John Tyndall, Edward Whymper, and George Mallory. These men may not have consciously contributed to the gender segregation in mountaineering but they used their social power as men to discourage 'unfit' people, including women, from becoming mountaineers. My research reveals notable achievements by female mountaineers despite attempts to limit women's access to mountain spaces. By looking at female mountaineers a broader understanding of nineteenth century British gender relations becomes clear.

Acknowledgements: USP - Undergraduate Scholars Program

#36 Morning

Chamois Hunting and Mountaineering in the 19th Century Alps
Aidan J. Quigley, History & Philosophy
Mentors: Michael Reidy, History & Philosophy

My research abstract delves into the historical relationship between chamois hunting and mountaineering during the 19th century. Drawing from archival records my paper discusses the interconnected cultures and histories of both pursuits. In my project I look at and discuss techniques and strategies used by chamois hunters and how their experience in rugged, alpine terrain proved critical to the development of the sport of mountaineering in the nineteenth century Alps.

My project explores the beliefs, and motivations of 19th century hunters and mountaineers, seeking to find common motivations and experiences between the two groups. It explores the impact of 19th century European mountain tourism as well as early conservation efforts in the Alps. My paper also addresses the ecological impacts of chamois hunting and mountaineering in the 19th century, focusing on the long term repercussions of actions associated with these activities. Overall my project examines the intertwined history of chamois hunting and mountaineering focusing on shared landscapes, motivations, challenges and techniques.

Acknowledgements: The College of Letters and Science - Department of History and Philosophy

#37 Morning

Animal Rights: A Deontological View
Sara F. Raffel,
Mentors: Carol Change, Michael Reidy
Co-Author/s: Micah Bush, Gabrielle La Fay, John Hoekstra

The ethical guidelines for the use of animals in cognitive and biomedical laboratory research must be reevaluated and rewritten under the same deontological principles that regulate human based research. Animal testing has been an integral part of biomedical and cognitive research. With a growing awareness of the complex sentience of animals, as well as their experience with pain and suffering, societies are increasingly struggling with deontological versus utilitarian ideas on how to extend legal and ethical considerations to nonhuman animals. Deontology is often associated with Imannuel Kant, who argued that the details of an action must be just to be considered morally correct, even if the benefits outweigh the costs. Utilitarian ethics was popularized by Jeremy Bentham, and it is the idea that the action is only right if it produces the best possible result. Those against animal testing argue that the benefit of animal testing to humans does not outweigh the harm done to animals, while those in favor argue that animals are inherently inferior to humans and should not be judged under the same ethical considerations as humans. There are no current comprehensive alternatives to animal testing, but the use of animals is declining as other methods are being offered in certain fields. We seek to contribute to the ongoing discourse on animal rights, fostering a greater understanding of the ethical imperatives that underpin the call for compassion, empathy, and justice towards all creatures.

#38 Morning

Antiquities in Gaza: Reexamining Wartime Cultural Heritage Protection
Theo W. Sage-Martinson, Liberal Studies Degree
Mentors: Teresa Greenwood, American Studies

The Gaza Strip is an area dense with antiquities and sites of cultural heritage. Israel's current military operations in Gaza have put those sites at grave risk, but the damage done to museums and archeological sites may not be fully realized for years. A full investigation by capable powers will be needed to establish if criminal wrongdoing has taken place in regard to international conventions on the protection of cultural heritage. Those investigations ultimately will not be able to undo the damage done to our collective cultural heritage; instead, a critical approach to international cultural heritage law is needed. The 1954 Hague Convention must remove clauses that weaken its application, and the non-state international community must establish standards that reduce the incentives for appropriation or damaging of culturally significant artifacts. This includes academic communities advocating for a post-war Gaza where Palestinians retain sovereignty and an end to the blockade of Gaza. Additionally, a renewed effort to return artifacts previously stolen from Gaza and the West Bank should be undertaken with the support of universities and museums worldwide.

#39 Morning

Romantic Mountains: Poets, Mountaineers, and 19th Century Britain
Kathryn A. Simpson, History & Philosophy
Mentors: Michael Reidy, History & Philosophy, Jacob Northcutt, History & Philosophy

The 19th century was an inspired time for the British, featuring the decline of the Enlightenment and the rise of the Romantics. During this age, Romantic poets wrote about love, nature, and the beauty of the world. This romanticism flowed from literature and art to other aspects of British life, particularly influencing how the British, as a people, interacted with nature. At the same time, the 19th-century also saw the massive rise in British interest in sports, including mountaineering, an interest that continues globally today. My research analyzes how Romantic poetry and British mountaineering overlapped--how one influenced the other--and how Romanticism and mountaineering demonstrated new aesthetic concerns by Britians in the 19th century. Using archival sources as well as secondary sources, my project shows the symbiotic relationship between aesthetics and sport in 19th century British society, which inspired both the glorification and possession of the natural world.

#37 Afternoon

Outlawed: An Indigenous Way of Life
Cyrus G. Spino-Harris, English
Mentors: Doug Downs, English

Throughout the early 19th century, concluding in 1859, the threat of cultural annihilation brought the Pacific Northwest tribes of the Umatilla, Cayuse, and Walla Walla into a Confederation; the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). While the joining of these tribes would prove disagreeable in most aspects—including the fact the treaty, signed June 9th, 1855, was not ratified until March 8th 1859, five years after the Walla Walla council met—Indians would not even gain their citizenship until 1924. While not wholly the responsibility of the government at the time to make the treaty readable in layman's terms for Indians, it was certainly made infinitely more difficult since it mirrors language used in documents such as the Bill of Rights, or the US Constitution; legal jargon. In addition to the Walla Walla treaty, other documents, acts, laws, and newspaper clippings would give rights as easily as they were taken away, or gauge the public about the "Indian problem". The Indian Citizenship Act of 1924, which deemed Indians eligible to be citizens of this country; The Indian Voting Rights Act of 1968, which gave Indians the right to vote; The Indian Religious Freedom Act of 1978, which decriminalized Indian religion across the US; and finally, newspapers, like The Oregonian, which since 1850 has provided residents with news and other such conservative and Republican interests. These documents, as well as many others to be mentioned later, are prime examples of the removal of agency for both Pacific Northwest tribes and beyond.

Acknowledgements: USP - Undergraduate Scholars Program

MATHEMATICS

#38 Afternoon

Identifying Physical Laws from Data
Derek W. Jollie, Mathematical Sciences
Mentors: Scott McCalla, Mathematical Sciences
Co-Author/s: John Sample, Physics, Brian D'Urso, Physics

For nonlinear physical systems, there are multitudes of sparsity-promoting machine learning algorithms which attempt to extract governing equations from measured data. This project aims to apply these techniques to understand several experimental systems. First, we have trajectories of projectiles flying through the air acquired from a high-speed camera. These trajectories are extracted using particle tracking software, and we are using sparse learning algorithms to find models for air-resistance. This is a particularly interesting system as it is well-understood theoretically, noisy, and in a low-data limit. Second, we have built a circuit that is similar to a forced Van der Pol Oscillator using a uni-junction transistor. This is a chaotic system. It is a good test for the learning algorithms as there are frequency modulations, noise, and the nonlinearities are not well understood. Real data is difficult to work with and these two systems are challenging in distinct ways from each other. The overarching goal is to overcome the difficulties in real data that have limited application of these learning algorithms. We eventually hope to use the results of this project as benchmark datasets for the NSF-funded AI Institute in Dynamic Systems Common Task Framework. Lastly, we have put these algorithms to the test by trying to find a potential function for a levitating particle for use in Dr. Brian D'Urso's laboratory (MSU Physics).

Acknowledgements: USP - Undergraduate Scholars Program & AI Institute in Dynamic Systems

#40 Morning

The Manifold Density Function: An Intrinsic Method for the Validation of Manifold Learning
Eli Quist, Mathematical Sciences
Mentors: Brittany Fasy, Computer Science
Co-Author/s: Benjamin Holmgren, Department of Computer Science, Duke University, Jordan Schupbach, Department of Mathematical Sciences, Montana State University Bastian Rieck Helmholtz Munich and Technical University Munich

We introduce the manifold density function, which is an intrinsic method to validate manifold learning techniques. Our approach adapts and extends Ripley's K-function, and categorizes in an unsupervised setting the extent to which an output of a manifold learning algorithm captures the structure of a latent manifold. Our manifold density function generalizes to broad classes of Riemannian manifolds. In particular, we extend the manifold density function to general two-manifolds using the Gauss-Bonnet theorem, and demonstrate that the manifold density function for hypersurfaces is well approximated using the first Laplacian eigenvalue. We prove desirable convergence and robustness properties.

Acknowledgements: USP - Undergraduate Scholars Program, Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

MICROBIOLOGY & CELL BIOLOGY

#39 Afternoon

Hydrogen and sulfur metabolism in the archaeal species Pyrosphaera yellowstonensis
Leah Baranek, Microbiology & Cell Biology
Mentors: Anthony Kohtz, Chemistry & Biochemistry Roland Hatzenpichler Chemistry & Biochemistry - Co-Author/s: Paige Schlegel, Chemistry & Biochemistry, Anthony Kohtz, Chemistry & Biochemistry and Zackary Jay, Chemistry & Biochemistry

Yellowstone National Park (YNP) contains many unique environments among its geothermal features, which support many poorly understood archaeal lineages. The lack of high-quality genomes and cultures of these organisms impedes our understanding of the ecology and biogeochemistry of geothermal environments. Even in well studied lineages, cultures only represent a fraction of the diversity in environmental surveys. In pursuit of novel archaeal cultures, we recently isolated Pyrosphaera yellowstonensis from a hot spring (78-80°C, pH 6.1) in YNP. This organism represents a new archaeal genus within the class Thermoprotei and is abundant (0.1-7.2%) across diverse hot springs. The closest relative to P. yellowstonensis, Zestosphaera tikiterensis, grows on proteinaceous substrates and requires thiosulfate for growth. P. yellowstonensis was originally enriched on thiosulfate containing media. Interestingly, no known thiosulfate reductase was identified in either genome, suggesting that the Zestosphaera and Pyrosphaera may use divergent enzymes. Their genomes also encode several novel hydrogenases, which could allow for the use of protons as an alternative electron acceptor to thiosulfate. This project aimed to determine if P. yellowstonensis also requires thiosulfate for growth or if the encoded hydrogenases are sufficient. We observed growth in media with or without thiosulfate and found that Pyrosphaera produced hydrogen. For hydrogen production, the Pyrosphaera genome contains multiple [NiFe] hydrogenases and a rare [NiFe]-[FeFe] hybrid hydrogenase that has only recently been described in anaerobic archaea. These results help refine the metabolic model of P. yellowstonensis and inform on its role in carbon and hydrogen cycling in YNP.

Acknowledgements: MSU Thermal Biology Institute

#41 Morning

Metabolic Profiling of Rhodanobacter sp. R12 and Acidovorax sp. 3H11 with Preferred Carbon/Nitrogen Sources: Implications for Optimized Denitrification in Synthetic Microbial Communities
Katerina N. Bruhl, Microbiology & Cell Biology
Mentors: Matthew Fields, Microbiology & Immunology - Co-Author/s: Heidi Smith, Microbiology and Cell Biology, Sara Altenburg, Microbiology and Cell Biology Molly Schreve, Microbiology and Cell Biology

Nitrate pollution is an ongoing and critical threat to human and wildlife populations due to its association with elevated disease rates and birth defects. This pollution primarily stems from agricultural expansion and military research activities. Oak Ridge, TN, a former hub for uranium enrichment during the Manhattan Project in the 1940s, harbors environmental legacies characterized by four polluted ponds containing various contaminants, including elevated nitrate levels. This contamination poses a significant risk to community water sources. To address this issue, we explored the metabolic potential of native microbes in the contaminated area with the aim of harnessing their capabilities for mobile contaminant removal, particularly nitrate. We investigated the growth behavior of environmental isolates Rhodanobacter sp. R12 and Acidovorax sp. 3H11 under anaerobic conditions when

provided with serine and glutamic acid, respectively, as sole carbon/nitrogen sources. Our results suggest that these metabolites may hold the key to optimizing denitrification processes for these isolates. This study focuses on the monocultures of Rhodanobacter sp. R12 and Acidovorax sp. 3H11, as well as their performance in a synthetic community (SynCom) culture where serine and glutamic acid were the exclusive carbon/nitrogen sources. Through the integration of exometabolomic and proteomic data alongside optical density measurements and nitrogen species consumption rates, we can elucidate the cellular mechanisms governing the preferred metabolism of these carbon/nitrogen sources. Furthermore, this research provides valuable insights into the intracellular dynamics of these isolates under specialized stress conditions, offering a potential pathway for optimizing denitrification processes in contaminated sites burdened with high nitrate levels. This work represents a critical step toward addressing the persistent threat of nitrate pollution, safeguarding both human health and environmental integrity in affected regions.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#40 Afternoon

Treating gastric epithelial monolayers with forskolin to induce mucus production

Alexis Burcham-Carter, Microbiology & Cell Biology - Mentors: Katrina Lyon, Microbiology & Immunology

Gastric epithelial monolayers are a model for the human mucosal layer of the stomach. The mucosal layer is a protective barrier between bacteria in the gut and the underlying epithelial cells. Recently, gastric epithelial monolayers have not been secreting enough mucus for collection. Mucus secretion is essential for studying the efficacy of these models. Gastric organoid derived monolayers are useful when studying motility of bacteria, specifically Helicobacter pylori. Thus, we need an efficient culture method to produce sufficient mucus from which to draw results. In this study, we will be using forskolin to increase cAMP levels which allows for mucus production from goblet cells. Yet, the differences between lab grown mucus and fresh tissue mucus are unknown. It has been shown that forskolin induces colonic organoid swelling. These findings suggest that gastric organoids can swell and produce more mucus. Patient to patient tissue sample variability allows for mucosal production to be compared and contrasted. Gastric epithelial monolayers will be cultured with forskolin to enhance the expression of mucus producing cells. The mucus will be collected from the growth of epithelial cells at the air-liquid interface (ALI) of the monolayers. Gastric mucus will be collected and quantified. Transepithelial electrical resistance (TEER) measurements will quantify the cohesion of tight junctions of the gastric monolayers. FITC-dextrin will measure the permeability of the epithelial layer. Rheology of the tissue derived lab grown mucus will be compared to fresh patient extracted mucus.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#41 Afternoon

Exploring the Mechanisms Involved in Transmembrane TNF Alpha Production and Corresponding Bacterial Clearance in Macrophages

Luke Reeve Conway, Microbiology & Cell Biology Mentors: Agnieszka Apple, Microbiology & Immunology - Co-Author/s: Abby Luu, Microbiology and Cell Biology

Cytokines are intracellular signaling molecules which are involved in regulation of the immune response. Upon recognition of a pathogen, cytokines are produced primarily by macrophages and T cells. Understanding interactions of these cytokines with leukocytes is critical to further understanding the overall functions of an immune response. Many cytokines can be classified into having pro or anti-inflammatory functions. Interleukin 6 (IL6) and Tumor Necrosis Factor alpha (TNFα) are largely involved in pro inflammatory processes, Interleukin 10 (IL10) is a primary anti-inflammatory cytokine. TNFα has been described as a “master regulator” of other cytokines; it exists in both a transmembrane (tmTNFα) and soluble (sTNFα) form. Previous work has found that when macrophages are stimulated with bacterial proteins prior to infection with Staphylococcus aureus, bacterial clearance efficiency of macrophages is greatly increased. This function was found to be dependent on tmTNFα production and signaling. Existing literature indicates that tmTNFα is involved in reverse signaling mechanisms which contribute to inflammation resistance of macrophages. In this project we show there may be an association between TNFα and IL10 during macrophage stimulation. Signal Transducer and Activator of Transcription 3 (STAT3) is a transcription factor involved in the pathway to produce IL10. We believe that phosphorylated STAT3 (pSTAT, activated form) protein will be upregulated alongside IL6, IL10, and TNFα in response to bacterial protein stimulation, as seen through western blot. These cytokine responses may contribute to the observed increased macrophage efficiency. Further elucidation of these mechanisms could increase understanding of macrophage function and signaling.

Acknowledgements: USP - Undergraduate Scholars Program, Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.), INBRE - IDeA Network for Biomedical Research Excellence

#42 Morning: *Vaginal Oxidative Metabolites Based on Menopausal Status & Race*

Bridget Dassenko, Microbiology & Cell Biology Mentors: Joanna-Lynn Borgogna

Menopause is linked to a decline in estrogen and often a loss of protective lactobacilli. Post-menopausal women are at increased risk for acquiring sexually transmitted infections (STIs). They may experience symptoms such as painful urination and intercourse due to changes in hormone levels and vaginal health. The vaginal microenvironment of post-menopausal women remains severely understudied; thus, we focused on the characterization of post-menopausal women relative to peri- and post-menopausal women. We hypothesized that as women progress through menopause, oxidative metabolite concentrations increase while antioxidant metabolite concentrations decrease. 476 participants, aged 35-60, attended semiannual visits over two years, resulting in 1,153 samples collected. Bayesian mixed-effects regression of log2-transformed metabolites (n=770) assessed metabolomic differences in samples from pre- (n=287), peri (n=335), and post-menopausal (n=531) participants, 25% of whom were racial/ethnic minorities. Chi-squared and Fisher’s exact tests were conducted on demographic characteristics. Metabolites were analyzed using Bayesian mixed-effects regression to account for the longitudinal design. The results were obtained using R Studio and Excel. Bar graphs showed no observable difference between race and menopausal status based on metabolite concentrations. However, Bayesian regression models indicated a significant decline in oxidative metabolites among post-menopausal women and non-Hispanic Black women. Post-menopausal women had the lowest concentrations of micronutrients (e.g., vitamin B) and the highest concentrations of many metabolites that comprise the epithelial cell wall. This response appeared to be attenuated in non-Hispanic Black women, as they had lower levels relative to non-Hispanic White women. Conversely, postmenopausal women had the highest levels of oxidative-stress-related metabolites (and lipids reflective of cellular damage). These metabolites were also highest in non-Hispanic Black women relative to White women. Further investigations include exposure assays with select metabolites and vaginal lactobacilli. *Acknowledgements: USP - Undergraduate Scholars Program*

#43 Morning

Needleless Connectors Experiment, Summer 2023

Abigail Greenberg, Microbiology & Cell Biology
Mentors: Kelly Kirker, Microbiology & Immunology, Garth James, Microbiology & Immunology

This experimental study focused on needleless catheter experiments aimed at addressing central-venous catheter-related bloodstream infections (CRBSIs), which significantly contribute to nosocomial infections. This research aimed to potentially identify an alternative solution for preventing these infections to reduce their morbidity and mortality rates. This experiment hypothesized that experimental solutions, when subjected to simulated use testing, would show greater efficacy in eliminating microorganisms compared to the saline solution control. Needleless connectors were colonized with methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, or Candida albicans. The colonized connectors were treated with clinically used, experimental, and saline solutions to evaluate their effectiveness. Surviving microorganisms were enumerated 1, 3, and 7 days of treatment. The results of the experiments were visualized using bar graphs that compared the average log CFU/connector data for each test solution. There was not an observed difference in the effectiveness of the clinically used solution versus the experimental solutions in eliminating microorganisms from the connectors, suggesting that the experimental solutions treat microorganism growth similarly to clinically used 70% isopropyl alcohol. The findings of this research suggest a potential alternative for preventative or active treatment of female catheter connector microorganism growth in clinical settings. Further statistical analysis could be done to determine if the experimental solutions are significantly different from the clinically used solution. Moreover, further experiments could be done with the experimental solutions in treating microorganism growth on other medical devices. These experiments offer alternative treatments of medical devices to combat CRBSIs.

Acknowledgements: Medical Biofilms Lab, CBE

#44 Morning

Assessing the Impact of Urea on Helicobacter pylori motility in Gastric Mucus

Lydia Hampton, Microbiology & Cell Biology
Mentors: Katrina Lyon, Microbiology & Immunology, Michelle Cherne Microbiology & Immunology

The goal of this research is to determine the optimal urea concentration for in vitro experiments investigating Helicobacter pylori (H. pylori) motility through gastric mucus. It has previously been shown that urease–a virulence factor of H. pylori–is necessary for successful colonization of the stomach. Urease is secreted by H. pylori to hydrolyze the ammonium in the stomach, which raises the pH surrounding the bacteria, allowing the H. pylori to travel through the gastric mucus and colonize the epithelium without being destroyed by the stomach acid. Thus, it is hypothesized that increased urea concentration in gastric mucus would enable increased motility of H. pylori. H. pylori moves through the gastric mucus layer by altering the pH of its surroundings to change their structure and ability to prevent intrusion of the epithelium. In this project, gastric mucus samples containing urea concentrations ranging from 10mg% to 60% will be loaded with one of three distinct strains of H. pylori, some fluorescent for easier tracking. I will then use fluorescent microscopy (Keyence All-in-One Fluorescence Microscope) or widefield microscopy (Leica Thunder) in combination with particle tracking software to measure the bacterial motility of each strain. More specifically, motility will be quantified in terms of bacterial trajectory length and speed. Using both liquid broth culture and gastric mucus, the results will reveal the concentration-dependent effects of urea on each strain. This project

would provide information that would illuminate the optimal conditions for in vitro modeling of gastric mucus as a defense mechanism. This could aid in identifying a physiologically relevant in vitro model of the relationship between H. pylori and the gastric mucus in humans and the optimal conditions for infection.

Acknowledgements: USP - Undergraduate Scholars Program

#42 Afternoon

Designing and Assessing the Efficacy of Protein Inhibitors of IscB Endonucleases

Heidi Frances Hansch, Mathematical Sciences
Mentors: Mensur Dlakic, Microbiology & Immunology

Many bacteria possess Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and CRISPR associated (Cas) proteins, forming a CRISPR-Cas system that defends against viral infection. These bacteria incorporate fragments of viral DNA as spacers between short bacterial DNA repeats, then transcribe these regions of alternating spacers and CRISPR units into guide RNA (gRNA) sequences that form complexes with Cas proteins. Upon subsequent viral attack, the gRNA sequences bind regions of complementary viral DNA, and the Cas proteins act as endonucleases, cleaving the DNA to curb the infection. Due to its capacity for DNA recognition and cleavage, the CRISPR-Cas system has been adapted into a gene editing technology that propels advancements in medicine, agriculture, biotechnology, and other fields. Whether in the context of bacterial immune defense or gene editing, Cas endonucleases are an integral component of the CRISPR-Cas system. These endonucleases function as a result of the complex interactions between their various subunits, which must maintain a specific orientation and fit with one another. If an inhibitor protein successfully binds a Cas endonuclease subunit, this interruption of the careful intricacy of subunit interaction either limits or entirely disables the endonuclease's capacity for cleavage. This study seeks to design and assess the influence of inhibitor proteins on the function of the IscB endonuclease. Thus far, one inhibitor protein has been successfully cloned and its interaction with IscB is being tested using techniques including PCR, bacterial colony screening, electrophoresis, and column chromatography. In addition, there is currently one other protein in the lab that is also being targeted with synthetic inhibitors.

Acknowledgements: USP - Undergraduate Scholars Program

#43 Afternoon

Evaluating Microglia Markers via qPCR

Taylor Harding, Microbiology & Cell Biology
Mentors: Alyssa Evans, Microbiology & Immunology

The overall goal of the Evans Lab is to understand the neuropathogenesis of three viruses within the California serogroup of orthobunyaviruses. This project will aid in that goal by providing data regarding the microglial response of mouse brains to different reassortants of the viral segments of two of those viruses. The first virus, La Crosse virus, is the leading cause of pediatric arboviral encephalitis in the United States, and the second virus, Inkoo virus, is a good comparison due to its ability to cause encephalitis in humans but only having a few confirmed cases. Data gathered by the Evans lab suggests that interactions between the L and M segments of the viruses is critical for its ability to replicate and cause damage in the central nervous system, and the S segments potentially enhance this ability. Microglia are the immune cells found in the brain, and they play a wide variety of roles within this context. In a regulated microglial response, they function to protect, but if their response is over-excited, their response can be pathogenic instead. This analysis of microglial response will be performed by utilizing qPCR to evaluate different microglia-specific markers in the RNA

of brains of both clinical and nonclinical mice infected with these reassortants as compared to those with a mock inoculation. We anticipate that specific segments of LACV and INKV will elicit a microglial response. We previously observed that INKV elicits higher levels of microglial responses, and by performing qPCR of viral reassortants, associations will be able to be made as to which segments are responsible for different microglial responses.

Acknowledgements: USP - Undergraduate Scholars Program

#44 Afternoon

CRSPR

Conrad Holmes - Mentors: Michael Reidy, Co-Author/s: Cooper Gibson, Jamie Garrow, and Harley Ransom

Our research will examine the history of genetic engineering through an ethical lens evaluating the positive and negative contributions to society. We'll focus on understanding the politics of science that inspired this field of creation, how funding has influenced the research in this field, and the potential dangers. We will also talk about how we are using technological fixes to solve problems instead of the actual social issues at hand. Within genetic engineering we will focus on the new technology that is CRISPR. How beneficial is CRISPR really and are there any negative consequences or detrimental effects? Although Crispr can provide amazing solutions to the agents of disease in our world, its narrow technological scope distracts us from addressing the large social forces that truly cause these problems. We will be looking into MSU research specifically about CRSPR including an interview with Blake Wiedenhert, we will ask questions speficlaly on what specifically his lab is conducting research on, what they have found, and if they have any ethical dilemmas they are approaching or have an approached already.

#45 Afternoon

Growth of Cutibacterium acnes and Staphylococcus epidermidis in a defined, skin-relevant medium

Tess K. Kirkpatrick, Chemistry & Biochemistry
Mentors: Matthew Fields, Microbiology & Immunology, Chiachi Hwang - Co-Author/s: Shawn McConaughy, Industrial Affiliate

Characterization of microbial interactions of human microbiomes has been re-invigorated with realized appreciation of microbiomes in general and, specifically, potential applications to host health and productivity. The skin microbiome is an important component to overall human health, also serving as a major interface with the outside environment. We designed a modified sebum-based medium that could be used to characterize growth of Cutibacterium acnes and Staphylococcus epidermidis, two major populations of the human skin microbiome. We demonstrated that the media can be used for monoculture growth experiments with different carbohydrates, amino acid combinations, and varying dissolved oxygen levels. Results showed that C. acnes and S. epidermidis each had different carbohydrate consumption preferences, which also reflected differences in their amino acid utilization. We then performed coculture experiments under anoxic condition to explore how each species would affect each other's growth; for example, the occurrence of cross feeding and/ or substrate competition. Understanding their specific preferences for carbon and amino acid consumption, in corroboration with preliminary coculture data, will help us to better design future coculture experiments.

Acknowledgements: Industrial Partner

SPRING 2024 MSU STUDENT RESEARCH CELEBRATION

#46 Afternoon

Biofilm.jl Graphical User Interface

Coleman Y. Lewis, Computer Science
Mentors: Mark Owkes, Mechanical & Industrial Engineering, Phil Stewart, Biofilm Engineering

The goal of this project is to develop a user-friendly graphical user interface (GUI) desktop application for Biofilm.jl, an existing Julia program designed to simulate biofilm growth within a stirred tank environment. Biofilm.jl operates by accepting various parameters such as solute types, particulate properties, tank geometry, and simulation duration to generate insights into biofilm dynamics over time. However, the existing Biofilm.jl parameter input process poses challenges for users, particularly those without programming knowledge. The GUI application is developed using Python with the tkinter library and customTkinter wrapper. It seeks to streamline the parameter input process and enhance user experience and accessibility. Through the GUI, users can intuitively input simulation parameters, save and load parameter profiles, and invoke Biofilm.jl to generate detailed simulation results. The application will also eventually provide clear visualization of simulation data and generated figures. Ultimately, the goal is to deliver a robust desktop application that simplifies biofilm simulation for a broad user base of academic researchers and students. *Acknowledgements: USP & Center for Biofilm Engineering*

#45 Morning

Essentiality & Functionality of Pyridoxal Phosphate-Dependent Pathways

Zoe M. Seaford, Microbiology & Cell Biology
Mentors: Ed Schmidt, Microbiology & Immunology

Research conducted in the Schmidt Lab focuses on the reduction of cellular oxidants through thiol oxidation, particularly under conditions of significant oxidative stress. Investigations focus on the role of sulfur-containing methionine and cysteine amino acid metabolism in maintaining cellular redox balance. To quantify whole sulfur flux through metabolic pathways, we employ in vivo isotopic tracing in mouse models, enabling direct comparison between normal liver and mutant livers lacking the antioxidant enzymes Thioredoxin Reductase-1 and Glutathione reductase (TR/GR null). These models, exemplified by TRGR-null livers, are relevant for studying oxidative stress conditions that enzymes, cystathionine β-synthase (CBS) and cystathionine γ-lyase (CSE), can both form and cleave carbon-sulfur (C-S) bonds of amino acids including cystathionine, serine, cysteine, homocysteine, and others. Here we assessed the functionality of these enzymes present in a pathway that generates cystine from cysteine via an initial C-S bond cleavage in vitro. We have engineered the AAV genome by standard molecular cloning procedures in the lab to express sgRNA under the control of an RNA pol3 promoter from the human U6 gene in PAAV 2/8, pAd Delta f6 (AAV-trans plasmid). We then produced AAVs in the lab by transfecting HEK293T cells using a lipid-based transfection reagent with the plasmid containing this engineered viral genome and two helper plasmids that direct viral replication and packaging. The cells then released the virus into the media following production. The recombinant virus was then purified from the cell supernatant for use in vivo. The mice we use these in carry, in addition to our mutations in TR and GR, a transgene that directs expression of Cas9 protein in all hepatocytes of the liver. Administration of the sgRNA-expressing viruses to these mice result in CBS and/or CSE being knocked out in most hepatocytes. Efficiency is verified by T7 endonuclease assay, wherein the target site in the genome is amplified from liver DNA by PCR and mismatch "bubbles" in hetero-hybrid DNA are quantified based on their cleavage with T7 endonuclease. The loss of target proteins will be quantified via western-blotting.

Acknowledgements: USP - Undergraduate Scholars Program, McNair Scholars Program

#46 Morning

Heterologous Superinfection Exclusion Between Two Alphaherpesviruses

Katherine Steinjann, Plant Sciences & Plant Pathology- Mentors: Matthew Taylor, Microbiology & Immunology

Superinfection exclusion (SIE) is a viral mechanism that prevents a virus from infecting an already-infected cell. Two alphaherpesviruses, Herpes Simplex Virus Type 1 (HSV-1) and Pseudorabiesvirus (PRV), possess the ability to exclude the same viral species, but the mechanism for exclusion of similar and/or unrelated viral species is not well-understood. SIE mediated by HSV-1 or PRV against the other virus was evaluated using mouse embryonic fibroblasts (MEF) and viruses that expressed a fluorescent protein. Fluorescence microscopy showed that both HSV-1 and PRV could exclude the other virus when the second virus was applied three hours after the initial inoculation. Previous experiments have shown that these viruses have different mechanisms of SIE, so variation of the time at which the second virus is applied could lend further information about how SIE is being carried out.

Acknowledgements: USP - Undergraduate Scholars Program

#47 Morning

Investigating the mechanism of novel anti-CRISPR in Type I-E CRISPR systems

Kaiya Vierra, Chemistry & Biochemistry Mentors: Blake Wiedenheft, Microbiology & Immunology - Co-Author/s: Nathaniel Burman, Microbiology & Immunology

Viruses that infect bacteria (IE, bacteriophages) are the most abundant biological entity on earth, causing 10^21 infections every second. As a result of this constant predation, prokaryotes have evolved diverse defense systems, including CRISPRs (Clustered Regularly Interspersed Short Palindromic Repeats), which block viral infection and promote host survival. As a way to counteract this defense, bacteriophages have developed virally encoded Anti-CRISPR (Acr) proteins that inhibit CRISPR systems and restore infection. These proteins can be incredibly diverse and recent studies suggest that there is a unique Acr for most, if not all subclasses of CRISPR systems. Here we determine the structure of AcrIE9 bound to a type I-E CRISPR system from E. coli using cryo-electron microscopy (cryo-EM), which reveals how AcrIE9 blocks CRISPR function through interactions with the CasC subunit. This work provides an understanding of previously understudied mechanisms of Acr defense which will reveal potential application to advancing biotechnology.

Acknowledgements: USP - Undergraduate Scholars Program

NEUROSCIENCE

#47 Afternoon

Functional Implications of Multi-Neurotransmitter Neurons

Ann Morris, Microbiology & Cell Biology - Mentors: Steve Stowers, Microbiology & ImmunologyMartha Chaverra Research CentersCo-Author/s: John Paul Toney, Cell Biology and Neuroscience, Joe Wadhams, Cell Biology and Neuroscience Lizetta Ankringa, Cell Biology and Neuroscience, Jace Tolleson, Knee Cell Biology and Neuroscience

Drosophila (fruit fly) is a model genetic organism for neuroscience research that has allowed the mechanisms of neurons and neurotransmitters to be studied extensively. Multi-neurotransmitter neurons that involve the transmission of two or more neurotransmitters per neuron have been the focus of the research done at the Stower's lab. The signaling mechanisms that happen between the neurons and muscles at the neuromuscular junctions (NMJ) in the male Drosophila reproductive system is the center of this research. Neurons that innervate the male Drosophila reproductive system use the three small molecule neurotransmitters glutamate, tryptophan, and octopamine. The goal of studying these neurons is to determine the effects of multi-neurotransmitter signaling on the contraction of the muscles of the male reproductive system and how they regulate fertility. Various fertility and behavioral assays were performed that showed proof of mating when certain neurons were silenced, but did not show a significant change in fertility and mating duration. Contractions of the ejaculatory duct however, were affected by the addition and silencing of some neurons, especially serotonin. Further imaging using muscle specific GAL4 drivers will be presented to show proof of multi-neurotransmitter neurons innervating the male Drosophila reproductive system.

Acknowledgements: USP - Undergraduate Scholars Program

#48 Afternoon

Effects of nanomagnetic force modulation on neuronal cell communication.

Samuel L. Roberts, Chemical & Biological Engineering - Mentors: Anja Kunze, Electrical & Computer Engineering - Co-Author/s: Connor Beck, electrical and computer engineering

Calcium acts as a crucial messenger in various cells, particularly in neurons where it maintains cell function and communication. Recent studies demonstrate that mechanical stimuli like magnetic fields can modulate calcium dynamics, affecting neuronal communication. To better characterize the effect on neuronal communication, we sought to study the electrophysiology of the cell in response to continuous low-strength nanomagnetic forces (NMF). E18 primary rat cortical neurons were plated on microelectrode arrays (MEAs) coated with poly-D-lysine. Neuronal cultures were matured under standard conditions and then subjected to baseline recordings at two-hour intervals. Magnetic nanoparticles (MNPs) were introduced after 6 hours. After 24 hours of MNP exposure, cultures were exposed to either the strong or weak magnetic field, while control cultures had no magnetic fields. Electrophysiological activity was recorded using MEAs and analyzed using MATLAB to calculate mean spike rates, excluding noisy electrodes. The strong (10-100 fN) and weak (1-10 fN) magnetic fields were applied across the MEA surface. Baseline neuronal activity remained stable (0.29±0.40 spikes/s) over 6 hours. Minimal spike rate changes occurred at 2 hours post-MNP addition (0.29±0.18 spikes/s), decreasing at 4 hours (0.17±0.18 spikes/s) and 24 hours (0.19±0.16 spikes/s). Subsequent NMF application increased spiking rates. Initially, responses were consistent regardless of NMF strength (Strong: 0.22±0.02 spikes/s; Weak: 0.13±0.01 spikes/s). After 2 hours, strong NMF maintained its effect (0.22±0.02 spikes/s), while weak NMF showed significant spike rate increase (0.54±0.34 spikes/s). Weak NMF returned to baseline at hour 8 (0.14±0.15 spikes/s). This data suggests long-term NMF enhances neuronal firing.

Acknowledgements: USP & INBRE - IDeA Network for Biomedical Research Excellence

PHYSICAL CHEMISTRY

#48 Morning

Graphitization of Montana's Sub-bituminous Coal for Electrical Energy Storage Applications
Cody Morse, Chemical & Biological Engineering
Mentors: Nicholas Stadie, Chemistry & Biochemistry

Batteries play a considerable role in the transition to clean energy. Carbon based anodes are effective in storing lithium ions, but the capacity of silicon as an anode material far surpasses the capabilities of carbon. Silicon faces some issues such as volume expansion, but this can be negated by using carbon to create a carbon and silicon composite material. The focus of this research is to utilize coal from Montana's large coal reserves to create a precursor for carbon-silicon composite battery anodes. Purifying the raw coal is the first objective, and this is explored through acid digestion of the coal. The results of these tests will be analyzed using XRD, SEM, and Raman spectroscopy. Following digestion, thermal treatment will be used for further purification and graphitization of the carbon. Once a satisfactory coal based porous carbon material is created, silicon will be deposited on the material and an anode will be made of the resulting composite. If an anode material can be effectively created from Montana's sub-bituminous coal, then an ecofriendly avenue for utilizing Montana's large coal reserves can be created.

Acknowledgements: USP - Undergraduate Scholars Program

#49 Afternoon

Ketone Functionalization of Coronene for Electrochemical Energy Storage
Ian V. Niles, Chemical & Biological Engineering
Mentors: Nick Stadie, Chemistry & Biochemistry

The demand for high-capacity batteries is ever increasing, however, the methods used to extract the necessary metals are toxic to local environments and populations. Carbon-based materials provide many promising alternatives due to their low toxicity and the abundance of organic feedstocks. Research shows that carbon cathode materials can be prepared using ketone groups as lithium binding sites, with a specific capacity higher than some traditional cathodes such as lithium cobalt oxide and its variants. Other work has shown a pyrolyzed form of coronene, a large aromatic and organic compound without functional groups, to serve as an anode through the lithiation of edge hydrogens at low potentials. In this work, we are creating a material containing both ketone functional groups and coronene-based lithiation sites through the electrochemical functionalization and pyrolysis of coronene. The approach taken here is novel in its mission to post-synthetically add ketone groups to coronene, which allows for the systematic investigation of the role of the ketone groups on the electrochemical properties. We hypothesize that adding ketone groups to coronene should reduce the number of active binding sites at low potentials and sterically hinder the formation of the graphitic lattice present in pyrolyzed coronene. The ketone groups should also be redox-active with lithium at high potentials, making this a candidate lithium-ion cathode material.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.), USP - Undergraduate Scholars Program

PHYSICS & SPACE SCIENCE

#50 Afternoon

Estimating Thickness of Hexagonal Boron Nitride (hBN) via Color Refraction Within Flakes
Joelle M. Asson, Physics
Mentors: Nicholas Borys, Physics

Two-dimensional (2D) materials display unique behaviors compared to three-dimensional materials, offering opportunities for observing new physical phenomena. To study them, one approach involves assembling 2D heterostructures, which requires stacking monolayers of various materials. However, effectively observing these structures requires encapsulating them within thin layers of hBN, a process often hindered by the challenge of quickly identifying monolayers of hBN. The objective of this project is to develop an efficient method for locating monolayers of hBN. When viewed under an optical microscope, flakes of hBN appear with different colors corresponding to their thickness, due to the reflection and transmission of light waves within the flakes. This optical characteristic allows for an approximation of flake thickness based on coloration: for instance, shades of cyan may indicate a thickness of approximately 10 nm, while shades of yellow suggest thicker flakes approaching 20 nm. By establishing the correlation between flake coloration and thickness, the process of identifying monolayers of hBN could be simplified, hence reducing the time and effort required for sample preparation or identifcation. This enhanced efficiency not only accelerates the exploration of 2D heterostructures but also enables deeper investigations into the emergent properties within or of these materials.

#51 Afternoon

BUBO the "student Build Ultraviolet solar Burst Observer"
Christopher Entzel, Physics - Mentors: Charles Kankelborg, Physics - Co-Author/s: Sarah Pawlowski, Physics, Mila Kissinger, Physics

Solar flares are among the most powerful and energetic events in the solar system, releasing up to 1032 ergs of energy. Although these events are fairly common and well-studied by numerous instruments, their exact behavior is not well understood. BUBO, the “student-built ultraviolet
solar burst observer,” will help us better understand the behavior of solar plasma during these energetic events. BUBO is a three-channel radiometer sensitive to extreme ultraviolet (EUV), soft X-ray (SXR), and hard X-ray (HXR) emissions. The instrument will measure disk-integrated solar flare emissions at a rapid cadence with SXR source locating capability. BUBO will investigate if there are sub-second, quasi-periodic pulsations (QPPs) during a solar flare with its three channels. Previous instruments and literature suggest sub-second to centi-second QPPs in high-energy photon flux exist, but this hasn’t been directly measured due to the slower cadence of similar instruments. BUBO’s source locating capability allows it to investigate the dynamic
nature of flare ribbons. It has been suggested that the SXR hotspots created during solar flares have quick local movements that telescopes with relatively long exposure times have not previously measured. Additionally, BUBO will examine the thermal evolution of the late phase of a solar flare on a centi-second timescale using flux measurements in its closely related energy bands to determine temperature. BUBO will be part of the “multi-slit solar explorer” (MUSE), a satellite mission scheduled to fly in 2027. BUBO’s low noise and high sensitivity measurements will aid the MUSE mission and help characterize solar plasmas.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#52 Afternoon

CAPRI-SUN the "high CAdence low-energy Passband x-Ray detector with Integrated full-SUN field of view"
Christopher Entzel, Physics
Mentors: Charles Kankelborg, Physics
Co-Author/s: Sarah Pawlowski, Physics,
Mila Kissinger, Physics

Solar flares are highly energetic events that release up to 1032 ergs of energy. Although numerous instruments in many wavelengths have studied solar flares, many unknowns remain about their specific behavior. The spatial and temporal distribution of energy, the particular mechanisms of particle acceleration, and coronal plasma heating still need to be better understood. CAPRI-SUN is a soft X-ray (SXR) radiometer designed and built by MSU students, which takes measurements of SXR flux released during a solar flare at an unprecedented cadence of 1kHz. Previous missions and literature have suggested that sub-second to centi-second fluctuations in SXR signal may occur. Still, there has yet to be an instrument with a rapid enough cadence for these fluctuations to be directly observed. The detection of these fluctuations is significant because small perturbations in the SXR flux are essential clues to determining the mechanisms driving coronal heating, energy transport, and particle acceleration. CAPRI-SUN, the “high cadence low energy passband x-ray detector with integrated full-sun field of view,” will fly on a sounding rocket in April 2024 as part of the “high-resolution coronal imager” (HI-C) flare campaign. Preliminary testing has shown that CAPRI-SUN is sensitive to the correct passband and has the desired cadence of 1kHz. Once launched, CAPRI-SUN can detect rapid fluctuations in SXR flux during a solar flare. If successful, this mission provides a unique opportunity and essential data for studying solar flares. *Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)*

#53 Afternoon

Optimization of scintillation-based spectroscopy using low energy gamma radiation sources for the IMPRESS CubeSat mission
Allan Faulkner, Physics
Mentors: John Sample, Physics
Co-Author/s: William Setterberg, University of Minnesota School of Physics and Astronomy, Lindsay Glesener, University of Minnesota Shool of Physics and Astronomy Arch Robison, Physics at Clemmer University of Minnesota School of Physics and Astronomy

Solar flares are highly energetic events that occur due to magnetic reconnection in the solar atmosphere. During these events, particles, such as electrons, are accelerated along magnetic field lines looping out into space emitting hard X-rays. The Impulsive Phase Rapid Energetic Solar Spectrometer (IMPRESS) CubeSat mission hopes to study the acceleration mechanisms by observing short timescale fluctuations in X-ray emissions using four parallel scintillation detectors. To achieve this scientific objective, the detector must first be calibrated. The goal of this study is to optimize the scintillation detector for low energies (10 to 20 keV) using small disc sources emitting gamma radiation (1 to 10 μCi). Both commercially available products along with custom built hardware were used to study the effects that digital parameters and physical specifications had on energy spectra and pulse length. We show that CeBr scintillation crystals, spread out silicon photomultiplier (SiPM) chip arrangement, and thin optical pads produce the highest resolution low-energy spectra. Additionally, optimal digital settings are given such as gain and threshold values.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#54 Afternoon

Characterization of Young Central Star Clusters Producing AGN Signatures in the Mid-Infrared

Bayli L. Hayes, Physics
Mentors: Amy Reines, Physics
Co-Author/s: Megan Sturm, Letters and Science

Effectively finding and identifying active galactic nuclei (AGNs) in dwarf galaxies is an important step in studying black hole formation and evolution. However, extending typical diagnostics for detecting AGNs in the higher mass range to the dwarf regime is complicated by extreme star formation mimicking the expected emission from smaller, dimmer AGNs. This effect is particularly prominent for mid-Infrared (IR) AGN selection methods, with multiple studies finding an increase in AGN fraction at lower mass. This conclusion is inconsistent with observations at other wavelengths. In this work, the stellar properties of a sample of four dwarf galaxies that were originally classified as AGNs using mid-IR selection techniques are studied. In follow-up analysis, these were found to lie in the star-forming region of the Baldwin, Phillips, and Terlevich (BPT) diagram and exhibit no X-ray signatures indicating an AGN. Photometric measurements are performed on the central star clusters using Hubble Space Telescope optical imaging for our galaxies. Their colors are then compared to GALEV models of stellar population evolution. It is found that the clusters tend to be relatively young, with masses that are similar to the GALEV stellar evolution model condition. It is concluded that there seems to be a weak connection between the age of the stellar clusters and the masses calculated for most clusters. Further investigation may yield a larger correlation between these characteristics and their mid-IR signatures.

#55 Afternoon

Breaking Down the Degeneracies: A systematic study to determine accurate parameters of globular clusters using photometry, spectroscopy, and astrometry

Sarah Heller, Physics
Mentors: David Nidever, Physics

Globular clusters are large groups of stars bound together by gravity which share many properties, including age, chemical composition (metallicity), and distance from Earth. These structures are common (the Milky Way alone has 150 known clusters) and essential for understanding stellar evolution, making them of high interest to astronomers. A primary technique for analyzing clusters is constructing H-R diagrams, which plot the luminosity vs the color of each individual star in the cluster, and then fitting an isochrone model to the diagram. However, due to the many cluster parameters that influence the shape of a H-R diagram, degeneracies such as the “age-metallicity degeneracy” can occur in the isochrone models, meaning two clusters can have identical isochrones even though their ages and metallicities differ. Thus, the objective of this project is to accurately determine Milky Way globular cluster parameters while avoiding possible degeneracies in the isochrone models. To achieve this, we measure individual parameters independently, then restrict the isochrone models with these values, thus reducing the chance of fitting an incorrect model. Spectrographic data from the APOGEE survey is used to calculate the mean metallicity of 44 viable globular clusters (those with 10 or more stars in the dataset) and astrometric data from the Gaia survey is used to calculate the mean distance to these clusters. Photometric data from the 2Mass survey is then used to create H-R diagrams and isochrone models for the clusters (restricted by the mean metallicity and distance), solving for the remaining parameters.

Acknowledgements: USP & MSGC - Montana Space Grant Consortium

#56 Afternoon

An Investigation ino the Longintudinal and Radial Spread of Suprathermal and Energetic Ion Co-Located with Coronal Mass Ejections

Abby High, Physics
Mentors: Rachael Filwett, Physics
Co-Author/s: Rachael Filwett, Physics, Robert Allen, Physics, Mayer Dayeh, Physics, Gang Li

The ISʘIS instrument onboard the Parker Solar Probe is a vital tool being used to analyze the energies and abundances of solar energetic particles (SEPs) as well as their characteristics and behavior. In this study, we examine hydrogen, carbon, oxygen, and iron ions. The dates being studied are Event 2020-335, 2021-148, 2021-325, 2022-266. This investigation, analyzing gradual SEP events, aims to observe the evolution and dynamics of these distinct solar particle events. In addition to the observations from the Parker Solar Probe, the investigation will incorporate data from complementary missions. The ACE Ultra-Low Energy Isotope Spectrometer (ULEIS) instrument and Solar Orbiter’s Electron Proton and Alpha Particle Detector (EPD) package will aid in combining data from multiple sources to seek a comprehensive insight into these events. The data acquired from these missions will provide insight into the complex processes governing gradual SEP events. Our focus during this study will be the examination of the time-intensity profiles for these heavy ions, showing their relative intensity and arrival time similarities and disparities. This analysis will highlight the transport and acceleration phenomena experienced by these ions.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#57 Afternoon

Advancing Aurora Detection Using AI

Courtlyn Ramirez, Department of Agricultural and Technology Education
Mentors: Paul Nugent, Department of Agricultural & Technology Education

Title: Advancing Aurora Detection Using AI Student: Courtlyn Wunneburger-Ramirez Mentor: Dr. Paul Nugent Institution: Montana State University, Department of Agriculture and Technology Education Introduction Aurora images capture the interplay between Earth's magnetic field and solar phenomena and offer insights into celestial mechanics. Despite regular appearances in mid-latitude locations like Montana, auroras often elude observation. Modern cameras, even those found in cellular phones, can reliably capture images of the aurora. However, we are still left with the challenge of not knowing when to look. This project endeavors to develop an artificial intelligence (AI)--based model to enhance the detection of auroras in such regions. This initiative has forged a tool that identifies auroral activities within images by implementing machine vision-based image classification using the Yolov8 model. This model was crafted from aurora imagery and non-aurora examples aggregated from public and collaborator-provided sources. Data were sorted for potential issues using unsupervised classification and human labeling. This effort produced a dataset of 3,865 images assigned 5,486 labels. This required diligence propelled by a passion for exploration and a desire to understand AI, striving toward application to auroral observation. The project created an educational program for elementary school students. This program seeks to narrow the gap between space science and AI technology. It aims to stimulate student interest in these fields by demystifying the complexities associated with AI. Preliminary findings show the potential of AI to enhance aurora detection. This research promises to advance our observational capabilities of aurora phenomena and enrich

educational content. It embodies an integration of AI with auroral studies, underscoring its dual significance in promoting scientific advancement and academic development, thereby opening new avenues for interdisciplinary research and practical applications in both fields.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.) MSGC - Montana Space Grant Consortium

#49 Morning

Employing Q-Transforms for Enhanced Visualization of Individual Gravitational Wave Characteristics

Channing Sebree Smith, Physics
Mentors: Neil Cornish, Physics
Co-Author/s: Noah Pearson, Physics

Examining gravitational wave data poses a formidable challenge, requiring specialized expertise to navigate the complexities of the data and extract meaningful insights. The motivation behind this endeavor lies in democratizing the analysis process, making it accessible to a broader audience of scientists and students alike. Our primary objective is to develop a Python-based code, leveraging the widespread adoption of this language within the scientific community, to facilitate seamless manipulation and implementation by a diverse range of users. This code aims to streamline the analysis of gravitational wave data, offering a comprehensive suite of functionalities tailored to simplify the complex task of data interpretation. Through intuitive visualization tools and quantitative outputs, the code aims to demystify the intricacies of data analysis, rendering the process more approachable and comprehensible for researchers and students alike. Ultimately, our initiative seeks to lower the barriers to entry in gravitational wave research, fostering broader participation and engagement within the scientific community.

PSYCHOLOGY

#50 Morning

Understanding the Dynamics of Existential Isolation and Persistence

Isaac Doll, Psychology
Mentors: Peter Helm, Psychology

The study also to identify critical factors in the relationship, such as chronic feelings of EI, situational influences, and interpersonal dynamics. I hypothesize that high trait EI will be negatively related to persistence on difficult tasks presented as easy because they feel unable to succeed. They may assume they lack the ability to persist, or even if they were to try, their persistence would be useless. Conversely, I predict that those with lower trait EI will be more likely to persist on a difficult task framed as easy because they should feel that their difficulties elicit feelings of EI, and thus they should seek to reduce the experience by persisting. The study measures persistence by tracking the amount of time participants spend on an impossible task, though they do not know it is impossible. We also measure participant's Existential Isolation to see if there is any relationship between the two. Data is still being collected so not conclusion has been made yet.

Acknowledgements: USP - Undergraduate Scholars Program

#51 Morning

The Impact of Hope and Fear Appeals on Pro-Environmental Behavioral Intentions for Varying Levels of Climate Change Anxiety, Eco-Anxiety, and Ecological Grief

Nichole Floener, Psychology
Mentors: Ian Handley, Psychology

The research outlined is an exploration of how hope and fear appeals influence the pro-environmental behavioral intentions of people with varying level of climate change anxiety, eco-anxiety, and ecological-grief. To curb climate change it is necessary for individuals to engage in more pro-environmental behaviors. Understanding the types of appeals that are effective at influencing change in behavioral intentions for people with varying levels of climate change anxiety, eco-anxiety, and ecological-grief is critical for effective climate communications intended to elicit behavioral change. This research measures the effectiveness of two appeals at eliciting emotional responses of fear and hope. Furthermore, this research uses the appeals to measure pro-environmental behavioral intentions for people in varying groups of climate change anxiety, eco-anxiety, and ecological grief. Differences in pro-environmental behavioral intentions responses amongst the different conditions indicates more or less effective appeal approaches for eliciting pro-environmental behavioral changes.

Acknowledgements: USP - Undergraduate Scholars Program

#58 Afternoon

Exercise, Attentional Control, and Reasoning

Amber F. Hofmeister, Psychology
Mentors: Keith Hutchison, Psychology

Performing aerobic exercises may increase the short-term, immediate cognitive ability of college students. Despite a wealth of research showing that long-term aerobic exercise interventions increase cognitive performance, hippocampal volume, and attentional control in adults, very little research explores the immediate cognitive effects of short-term aerobic exercise. These long-term interventions involve weeks of strict commitment to an aerobic exercise program. However, the busy schedules of college students may discourage students from seeking the cognitive benefits that aerobic exercise can provide. This experiment sought to examine the effects of a one-time, intense aerobic exercise intervention on individual cognitive performance. Cognitive performance was defined as individual performance on attentional control and

reasoning tasks. Thirty participants were randomly assigned to the exercise intervention, and thirty-one participants were randomly assigned to the control condition, which involved rating neutral images. Attentional control was assessed through a battery of computerized tasks, including a version of the Stroop task, the Flanker task, and the Simon task. After the attentional control tasks, individual reasoning performance was attained using a paper test consisting of Kahneman and Tversky heuristic paradigm questions and scientific reasoning questions. Anticipated findings suggest that individuals assigned to the exercise intervention demonstrate higher attentional control and reasoning performance, indicative of a reduced reliance on cognitive biases, than the control group. This study contributes to existing literature surrounding the intersection of exercise and cognitive psychology by exploring the potential of immediate cognitive effects from aerobic exercise. The present study may have practical implications for studying and test-taking practices. Acknowledgment: USP - Undergraduate Scholars Program

Acknowledgements: USP - Undergraduate Scholars Program

#59 Afternoon

Pupil Changes in Response to Goal Reminders on Stroop Task

Sarah Madison Kubicka, Psychology
Mentors: Keith Hutchison, Psychology

Attentional control refers to one's ability to orchestrate thought and action in accordance with internal goals and is a key component of working memory capacity (WMC). In this study, we are analyzing phasic pupil changes across trials while participants complete an attentional control task known as the Stroop task. Goal reminders are presented for half of the subjects in which subjects are instructed to recite the phrase, "The goal is to name the _____, not the _____, and fill in the blanks with "color" and "word". Previous research has found that individuals with lower working memory capacity perform worse on the Stroop task than individuals with higher working memory capacity, however, when presented with goal reminders, lower working memory capacity individuals will perform just as well. Research has also shown that pupils tend to dilate during periods of higher arousal involved in completing difficult tasks. Pupils tend to constrict during periods of low arousal, typically while completing easy tasks. Phasic pupil changes can indicate lapses in attention, influencing performance on attentional control tasks. We predict that when presented with goal reminders, the relationship between working memory capacity will be eliminated. Also, those with lower WMC will show similar pupil changes as those with higher WMC when presented with goal reminders prior to the onset of the stimulus, indicating greater engagement of preparatory control prior to each trial.

Acknowledgements: USP - Undergraduate Scholars Program

#52 Morning

The Effects of Existential Well-Being on Emerging Adult LGBTQ+ Self-Esteem

Nick Lambert, Psychology
Mentors: Peter Helm, Psychology

This research investigates the nexus between existential well-being (EWB) and self-esteem in emerging LGBTQ+ adults, addressing critical gaps in existing literature. With LGBTQ+ youth consistently experiencing higher depression rates and lower self-esteem, this study aims to uncover EWB's role as a resilience factor. Examining potential moderation by sexual orientation and buffering effects against threats, the mixed methods design involves diverse LGBTQ+ and heterosexual participants subjected to self-esteem threats. Utilizing established scales, the study seeks to deepen our understanding of the intricate relationship between EWB and self-esteem, with implications extending to tailored therapeutic strategies. The proposed research signifies a

crucial step in addressing disparities and contributing to the well-being of emerging LGBTQ+ adults.

Acknowledgements: USP - Undergraduate Scholars Program

#60 Afternoon

Vulnerability to the Consequences of Sleep Loss in Adolescence: Individual Differences in Age, Sex, Chronotype, and Psychopathology

Ashlyn Roxanne Murphy, Psychology
Mentors: Cara Palmer, Psychology

Insufficient sleep results in cognitive, motivational, and emotional deficits, but adult research suggests that individual differences in response to sleep loss exist. For example, the effects of sleep loss may be stronger for females and those with an evening chronotype ("night owls"). Individuals with depression may respond to sleep loss differently than non-clinical populations. However, research on individual differences in adolescents is lacking, yet nearly 90% of teens do not obtain sufficient sleep. It was expected that female adolescents and evening-type adolescents would experience greater consequences after insufficient sleep. We also examined age and psychopathology symptoms. A total of 175 adolescents ages 10-17 years) and their parents completed surveys. Teens reported on the consequences they experience after sleep loss using a new measure. Parents reported on sociodemographics (age, sex), adolescent chronotype, and psychopathology symptoms. An exploratory factor analysis examined the Consequences of Sleep Loss Questionnaire. Four components emerged, including:Avoidance of Negative Experiences, Low Motivation, Engagement in Risky Behavior, and Low Self-Regulation. Correlations indicated that older adolescents reported more deficits to self-regulation, motivation, and more avoidance following insufficient sleep. A t-test indicated that after sleep loss, boys reported more risky behavior ($p = .01$), whereas girls reported lower motivation ($p = .002$). An ANOVA indicated that evening chronotypes reported lower self-regulation and lower motivation after insufficient sleep when compared to morning types ($p's < .001$). Analyses examining associations between psychopathology symptoms and the consequences experienced after sleep loss are still ongoing, and will be presented. Implications for prevention and intervention will be discussed.

Acknowledgements: USP - Undergraduate Scholars Program

#53 Morning

The relationship between self-compassion, experiences of recent trauma, anxiety, and alcohol use in American Indian adults.

Jack Spicher, Psychology
Mentors: Neha John-Henderson, Psychology
Co-Author/s: Zack Wood, Psychology

The lives of American Indians (AI's) continue to be influenced by the lasting effects of the genocidal efforts of European colonialism during the founding of the United States. These effects can be seen in the way historical trauma and colonization efforts to erase AI culture have resulted in the development and perpetuation of negative psychological symptoms that are passed from generation to generation in the absence of culturally appropriate healing practices. Biological factors are not linked to AI risk for developing alcohol use disorders (AUD). AIs affected by AUD exhibit higher than average mortality rates. Our study examined results collected via survey from 729 AI's regarding anxiety, recent trauma exposure, and self compassion, to see how these factors relate to problematic alcohol use. Findings indicate that while recent traumatic experiences are directly associated with higher alcohol use disorder scores, this relationship is also mediated by anxiety. However, higher levels of self-compassion were associated with a weaker relationship between recent trauma and anxiety, and subsequently indicated lower AUD scores. These findings indicate that self-compassion may serve as a protective factor in

the context of recent trauma, reducing the risk of AUD by lessening the negative effects of recent trauma and anxiety. These findings encourage further exploration into the potential positive effects associated with higher levels of self-compassion, and highlight the importance of mental health in regards to resilience.

Acknowledgements: USP - Undergraduate Scholars Program

SOCIAL SCIENCES

#61 Afternoon

Why low socioeconomic households were more severely impacted by isolation during the Covid pandemic than households that earned more than 50k annually

Emma G. Baldwin - Mentors: Carol Chang, Michael Reidy -Co-Author/s: Emmett Renner, Alex Turk

During the COVID-19 pandemic in America, the mental and physical health of those in households of low socioeconomic status was impacted in a significantly more negative way than those living in a household that earned more than $50k annually. Low socioeconomic households suffered greater unemployment rates, caused by mandates “shut-downs” and isolation periods. This greatly affected jobs that were deemed unessential, and those in service professions that required business to be done in person. Those in low socioeconomic households were more likely to be uninsured, which limited essential healthcare access during a period of increased health risk. Inadequate social systems, such as educational systems, prevented children living in low socioeconomic areas from maintaining a constructive learning environment, which did negatively impact their education and future academic success. Those in low socioeconomic households were less likely to maintain the same amount of exercise they did before the pandemic. All negative effects of the Covid pandemic, such as job restrictions, healthcare shortages, and isolation periods, disproportionately affected Americas low socioeconomic households, and exposed the lack of essential social resources available to low income communities and individuals. It was these social issues that made the affects of the Covid Pandemic on low income households disproportionately severe.

#62 Afternoon

From Shepherd’s Staffs to Alpenstocks: A Brief History of 19th Century Mountaineering Equipment

Rudy Barkley, History & Philosophy
Mentors: Michael Reidy, History & Philosophy, Jacob Northcutt, History & Philosophy

Mountaineering in the nineteenth century was a fascinating time in the terms of human development and engineering marvels. My project describes the types of gear that early mountaineers used to accomplish their groundbreaking ascents and how this technology was invented when there were no field manuals on what type of equipment to use or what materials mountaineers use. During the 19th century most British climbers did not know what materials to use for these treks and they had to do some trial and error. Even elites had to rely on guides and locals to get them the gear they needed; but they had to get these items from locals because they did not bring their own equipment with them when they traveled from England. From ropes to jackets, crampons to ice picks, all the equipment that was needed to make these dangerous treks up the world’s most stunning peaks was no easy feat during this time period. My research also looks at the technical uses of this mountaineering equipment in order to better understand how the equipment was used during the nineteenth Century. To look at the equipment I use a mix of articles from mountaineering magazines and secondary sources in order to understand and explain how mountaineering equipment evolved during the long nineteenth century.

Acknowledgements: History Department

#54 Morning

Exploring Drag Culture in Montana
Lilyanna Justine Blevins, Sociology and Anthropology
Mentors: Tomomi Yamaguchi, Sociology & Anthropology

The Drag community is a space for creative expression and is a big part of queer culture here in Montana. My ethnographic field research highlights the Drag community in Montana by giving an in-depth perspective on performing, being immersed within the community, and the familial bonds that connect Drag performers. Due to the political climate of today, Montana's conservative values, and the direct attack on LGBTQ rights, Drag performers are regularly fighting for their rights every day. As a researcher, I have highlighted the diverse voices and perspectives of people often ignored within a conservative state. My goal for this research is to better understand the inner workings, dynamics, and bonds within the Montana Drag community and shed light on the issues many Drag communities are facing in America today. Through in-depth interviews and observing and engaging with Drag community events, I have learned how to combat hate and the perseverance it takes. I have learned about chosen family, accepting the people who love you, and embracing your real self. I have learned why the Drag community is important to LGBTQ people in Montana.

#63 Afternoon

How to Sell a Mountain: Albert Smith and Piccadilly
Thomas Daniel Burkhart, History & Philosophy
Mentors: Michael Reidy, History & Philosophy

“The journey should, of course, be undertaken by two persons, — not only for the sake of society, but for economy; as many little expenses do for both, which would have to be paid just the same for one; and the three most important items in the knapsack should be a knife, a ball of string, and some sticking-plaster. A soldier's old knapsack can always be procured in Paris, and a common round tin candlebox in a ticking cover should be strapped to the top, in place of the carton fixed there. It is useful to hold the toilet things only wanted for a night, since, when the knapsack becomes fully packed, in doing it, and doing it up again, maybe a matter of some trouble. The dandy oil-skin and Mackintosh knapsacks sold at the trunk-shops in London are utterly useless.” Albert Smith set a precedent for advertising and selling mountains. Albert Smith and others like him helped to create some of the tourist destinations in the Alps today. He achieved this primarily through a performance at Piccadilly Circus in which he dramatized his ascent of Mont Blanc. Smith hoped to profit and gain from his ascent of the mountain, primarily through his show, but also through his writing and other memorabilia. Smith's successful show and writings furthered British interest in mountains generally and the Alps specifically during the nineteenth century. In his writings, Smith goes into every detail of his ascent of Mount Blanc, and gives tips and advice for other mountaineers and travelers wishing to visit the Alps and climb mountains. Albert Smith was a pivotal figure in the history of British mountaineering and culture in the nineteenth century. My project examines this curious figure through a mixture of primary and secondary sources. Citation Smith, Albert. 1845. The Story Of Mont Blanc. 1st ed. New York: G, P Putnam and Co.10 Park Place.

#64 Afternoon

Montana Society and Climate Change
Clara M. Jones, Education
Mentors: Michael Reidy, History & Philosophy
Co-Author/s: Tanner Harms, Owen Miller

The impact of climate change in Montana is evident through multiple different aspects of the environment from declining snowpack to precipitation patterns, though while studies through MSU support these claims, it is the societal impacts such as recreational use and agriculture that drive the state towards action, not the problem of environmental impact itself. Historically climate change has been reported and researched by scientists in Montana. Between 2000 and 2007, the state saw a notable increase in extremely hot days. Statistics like this have been well known for some time, but have been no more than acknowledged. With recent developments in local climate, studies like those done by Cathy Whitlock at Montana State, are finally receiving serious consideration into what those statistics really mean for the future of the state. Thanks to dramatically decreasing snowpack, farmers have experienced less reliable irrigation capacity among other various negatives. Though there has also been found positives towards the change in climate that benefit Montana agriculture, such as a longer growing season. This has led to controversy of action by multiple related parties. There has also been controversy from governmental action such as House Bill 971, which barres agencies from considering climate impacts in project reviews, which directly links to local business and infrastructure. These controversies and impacts are directly linked to the social life for communities and tourism for the state, creating a regard towards change in a manner more pronounced than seen in the past.

#55 Morning

Climate Anxiety and the Unseen Pressures on Adolescents
Aemily Madole, Land Resources & Environmental Sciences
Mentors: Paul Lachapelle, Political Sciece

Climate change is a largely known, controversial topic that has encroached on almost every scientific conversation within the last 5 years. Often within these conversations, the question of what the world will look like for future generations is brought up. A less-known, but still vitally important part of these conversations is what the future generations will have to face within themselves as they grow up in a rapidly changing world. Climate anxiety has become a more and more common phenomenon in adolescents, especially early teens and young adults, and is a direct side-effect of the boiling pot that is the climate change discussion. In recent years, several studies have been conducted on the effect of grief, anxiety, and depression on adolescents, as well as the connection between these mental health struggles and climate change. Using results from these studies, as well as information on climate change, this project outlines the psychological impact climate change has on the youth of this generation which is presented as both a research paper and a final presentation. Using this information, my hope is that going forward more people will be exposed to possible ramifications of climate change outside of the environment, and will begin to look for ways to help adolescents cope with and confront these new issues they are facing.

#65 Afternoon

The Influence of Theory of Mind on Language Comprehension in Rural Neurodivergent Children

Kate E. Pliska, Chemistry & Biochemistry
Mentors: Nadezhda Modyanova, Mechanical & Industrial EngineeringBernadette McCrory Mechanical & Industrial Engineering

The purpose of this project was twofold. First, to determine the influence of theory of mind (TOM, awareness of other people's mental states) in distinguishing language challenges between neurodivergent children with autism spectrum disorder (ASD) and developmental language disorder (DLD). Second, whether using hand gestures while speaking can help with improving language comprehension in neurotypical and neurodivergent children. This research will improve health equity in rural areas by providing caregivers with communication skills due to limited or no access to speech-language pathologists (SLP). The influence of TOM was measured by tasks presenting low verbal videos where characters have different mental states. The influence of gestures on comprehension of language was measured via an interactive computer game. For both tasks, participants' eye gaze is recorded to assess attention. Analysis of results is ongoing; however, preliminary analyses by colleagues and findings within literature point towards the following. After comparing data from children and adults with ASD/DLD, we will show that gestures may help improve comprehension of determiners in some participants; knowledge of TOM may correlate with comprehension of determiners in some participants; children and adults may have similar eye tracking signals, indicating some confusion with TOM and/or language, even though adults may answer correctly. Data analysis was performed using Excel, RStudio, and Gazepoint to identify and visualize proportion of looks to areas of interest during eye tracking processes. Our findings indicate TOM and gestures may influence language comprehension, and children with ASD/DLD may benefit from language and cognitive support.

Acknowledgements: USP - Undergraduate Scholars Program, INBRE - IDeA Network for Biomedical Research Excellence & Statistical Consulting and Research Services (SCRS) of Montana State University (MSU) Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

GRADUATE PRESENTERS

#56 Morning

High dose of cottonseed oil and olive oil differentially modulates the exercise-induced inflammation

Prabina Bhattarai, Health & Human Development - Mentors: Mary Miles, Health & Human Development - Co-Author/s: Katy Kropatsch, Health and Human Development, Alexandria Lotstein, Health and Human Development Marcy Gaston, Health and Human Development, Morgan Chamberlin

Different dietary interventions have been employed to understand the preventative strategies of reducing exercise-induced inflammation. One such intervention is the supplementation with cottonseed oil (CSO), which has shown anti-inflammatory potential in animals compared to olive oil (OO). Given a lack of human intervention studies, this study aimed to determine the effect of supplementing CSO on human inflammatory markers. Purpose: To compare the effect of CSO (30 g and 60 g) and OO (30 g and 60 g) on exercise-induced plasma inflammatory markers (IL-6, IL-1ra, TNF-alpha, IL-8, IFN-gamma, IL-1 beta, IL-10) in healthy individuals. Methods: A 28–30-day double-blinded parallel trial was done where 47 healthy participants (BMI<27 kg/m^2, 18-55 years) were randomly assigned to smoothies containing 60 g CSO, 60 g OO, 30 g CSO, or 30 g OO. Participants did 30 minutes of uphill treadmill walking or running (75% VO2 max) before and after the intervention. Blood was taken before and 15 minutes after the exercise test on each visit. Plasma was analyzed for inflammatory markers using the Ella Automated Immunoassay System. Linear mixed-effects tests (LMM) were separately done to determine the effect of exercise on inflammatory markers. Percent changes in inflammatory markers was modeled as an outcome using LMM, where the Treatment*Time interaction test was done to observe the treatment effect on the percent changes. Results: At baseline, exercise-induced increases of 0.981 pg/ml (95% CI: 0.71-1.25, p-value < 0.05) for IL-6, 0.32 pg/ml (95% CI: 0.08-0.55, p-value < 0.05) for IL-8 and 14.02 pg/ml (95% CI: 4.85 - 23.18, p-value < 0.05) for IL-1ra. Compared to 60 g OO, the percent change in IL-1ra was 16.8% (95% CI: 2.2% - 31.5%, p-value < 0.05) higher post-intervention in the 60 g CSO group. Compared to 60 g OO, the percent change in IL-10 was 22.2% (95% CI: 1.7% - 42.6%, p-value < 0.05) higher post-intervention in the 60 g CSO group. Conclusion: A high dose of cottonseed and olive oil differentially modulates the inflammatory markers induced through exercise. Note: This abstract is accepted by American college of sports medicine (ACSM). Therefore, the word count exceeds 250 words.

Acknowledgements: Cotton Incorporated 22-070

#57 Morning

Mujeres Unidas: A Pilot Study to Empower Latina Women

Danika Lee Comey, Health & Human Development - Mentors: Sally Moyce, Co-Author/s: Cassidy Crawford, Education, Health and Human Development, Isabela Romero, Education, Health and Human Development, Reyna Sundell, Education, Health and Human Development

Access to healthcare services remains a top need in Montana among the Latino immigrant population. Southwest Montana is a new immigrant destination that lacks infrastructure to provide culturally and linguistically sensitive care to Spanish speakers. We analyzed the needs of the growing Latino immigrant population moving to southwest Montana. Based on community input, we implemented a pilot program called Mujeres Unidas. The program is a six-week intervention of group-based classes that teach stress management, mindfulness, nutrition, and healthy behaviors to Latina women. All classes were taught by Native Spanish speakers. We hypothesized that women

who participate in group-based educational interventions will gain knowledge and social support to encourage lifestyle modifications. Mujeres Unidas specifically focuses on health equity, gender equality, and providing culturally competent education. Participant recruitment occurred at community health events and word-of-mouth referrals. The cohort consisted of 10 mono-lingual Spanish speaking women. Quantitative data was collected using the Perceived Stress Scale, the Patient Health Questionnaire, and the General Anxiety Disorder scale at the beginning and end of the intervention. Pre and post intervention measures for blood pressure, A1C, and body mass index were also measured. Women who participated in the intervention saw a significant decrease of their systolic blood pressure and average PHQ2 scores and average GAD7 scores decreased significantly. The pilot program empowers women who participated in a group-based educational intervention. Results suggest that women who participate make positive lifestyle changes that affect health outcomes. Future work will include expanding the program to reach more women.

Acknowledgements: Caring Foundation

#58 Morning

Sustainable Cocoa Value Chain in the eyes of Indigenous Wisdom: A Comparative Study

Chidimma Linda Ifeh, Health & Human Development - Mentors: Wan-Yuan Kuo, Health & Human Development - Co-Author/s: Helen Agu, Food Science and Technology, Fernanda Santos, Food, Bioprocessing and Nutrition Sciences

Addressing the challenges cocoa farmers, chocolatiers, and chocolate companies face is essential for ensuring the long-term viability of cocoa production while maintaining environmental sustainability and economic growth. A sustainable value chain can benefit from collaborative efforts between cocoa farmers, chocolatiers, and chocolate companies, integrating indigenous wisdom with modern practices. This study explores the practices, challenges, and interests in achieving a sustainable cocoa bean-to-bar practice by interviewing smallholder cocoa farmers (n = 4) and chocolate companies (n = 2) in Ondo, Nigeria, and chocolatiers (n = 2) in Montana, USA. The results from the interview were analyzed by reflexive thematic analysis. The interviewed farmers discussed the importance of cacao planting, market pricing, climate impact, and lack of youth involvement. Direct bean sourcing and product innovation are shared priorities for chocolate companies and US chocolatiers. Power supply issues and high equipment costs are issues faced by US chocolatiers, while chocolate companies need help with financial constraints, equipment reliability, and adapting to market dynamics. We identified farmers' indigenous knowledge, including upcycling cocoa pods for black soap, fermenting cocoa using the box and heap method for flavor and quality, and planting plantain to shield cocoa trees, control weeds, and diversify income. The study sheds light on the intricate dynamics of the cocoa value chain and underscores the importance of indigenous knowledge in sustainable cocoa farming and processing practices. Challenges identified by farmers, chocolatiers, and chocolate companies highlight the need for holistic approaches to address issues such as youth involvement, climate resilience, and market accessibility.

Acknowledgements: Forrest E. Mars, Jr. Chocolate History Grant. College of Education, Health and Human Development Travel Funding.

#59 Morning

Impact of Fecal Microbial Transplant Donor Inflammatory Phenotype on Tissue Inflammation in Humanized Mouse Models After a High-Fat Diet

Lindsay Lee, Health & Human Development
Mentors: Mary Miles, Health & Human Development - Co-Author/s: Stephanie Wilson, Seth Walk

High-fat diets (HFD) can induce low-grade inflammation and obesity-related pathologies. While there is research on the inflammatory effects of HFDs and their role in obesity-related pathologies, there remains a gap in understanding the impact of donor inflammation status on inflammation, particularly in humanized mouse models after an HFD. The aim of this pilot study was to investigate how donor inflammation status impacts inflammation in the metabolically active tissues in humanized mice after an HFD. Germ-free mice received a fecal transplant from one of two human stool donors that were metabolically similar but differed in systemic inflammation (low, high). Mice underwent a 6-week HFD (40.6% fat) rich in sugars and trans-fatty acids. After sacrifice, liver and muscle tissues were harvested for RNA extraction and quantitative PCR (qPCR). qPCR yielded threshold cycle (CT) values for genes of interest (C-Reactive Protein, CRP; Interleukin, IL-10, IL-1ß, IL-6). The 2-ΔCT was calculated to determine the relative expression of the target gene(s) to a housekeeping gene. The fold change of observed differences of high and low donor phenotypes was used, given the small pilot sample size (n =13). Mice had a fold change (2-ΔCT high/2-ΔCT low) in hepatic inflammatory gene expression for CRP of 1.3-fold, IL-10 of 6.9-fold, and IL-1ß of 3.1-fold. Mice also had a fold change for IL-6 of 3.9-fold (n=8) in muscle. Cytokine expression in the liver and muscle of humanized mice on an HFD was donor-dependent. These data provide preliminary evidence that inflammation phenotype may be transferred with the gut microbiota and that low-inflammatory phenotypes may protect against the inflammatory effects linked with a high-fat diet, opening new avenues for further investigation into potential strategies for inflammation management associated with HFD and its related complications.

Acknowledgements: Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

#60 Morning

Decolonizing Curriculum: Critical Content Analysis of a Classroom Reading Resource

Christina Pavlovich, Education
Mentors: Sweeney Windchief, Education

This study analyzed an excerpt from National Geographic's 2017 edition of the Reach for Reading fifth grade textbook. The textbook was published under a partnership between Cengage and National Geographic and was removed from print as a result of this study. The company has textbook subscriptions from school districts in all 50 states, and its efficacy studies rely on teacher fidelity as a significant variable in success (National Geographic Learning, 2020). The study examined the representation of diverse perspectives, particularly focusing on Indigenous portrayals, using a critical lens to assess their impact on shaping narratives within classroom settings. By analyzing a specific textbook, the study uncovers inherent biases and power dynamics perpetuated through language, imagery, and narrative construction. Through a series of correspondence with National Geographic, the publisher of the textbook, efforts were made to address and rectify these issues. However, the study highlights that this victory does not fully address the enduring implications of existing textbooks already in circulation. Recognizing the complexity of systemic issues within educational narratives, the study advocates for collaborative efforts among educators, academics, community members, and publishing companies to promote more inclusive and accurate representations in educational materials. Additionally, ethical considerations

surrounding the commercialization of educational resources and the tension between profitability and social responsibility are raised.

Acknowledgements: EHHD Scholarship

#61 Morning

Human Metabolomic Responses to Conventional versus Organic Grass-fed Beef

Meghan L. Spears, Health & Human Development - Mentors: Mary Miles, Health & Human Development - Co-Author/s: Gwendolyn Cooper, Biochemistry, Brett Sather, Biochemistry Jane Boles, Animal and Range Sciences

The purpose of this study was to determine if there are differences in postprandial metabolomic responses to conventional (CON) and organic grass-fed (GRA) beef. Participants (n=10) were on two occasions, separated by at least 7 days, fed a 6 oz beef steak from each condition (CON and GRA). Fasting and postprandial (every 30 min for 4 hours) serum samples were analyzed for metabolite profiles using untargeted LC/MS. After filtering identified metabolites for presence in > 80% of samples, VIP > 1.0 were used to determine differentiating metabolites within CON and GRA. Net area under the curve (AUC) was calculated to determine relative metabolite differences between conditions using ANOVA. Timepoint comparisons between conditions were done to determine metabolite changes over the time. Of the 17 metabolites with qualifying VIP scores, Bis(2-furanylmethyl) sulfide had a larger AUC in GRA ($P = 0.047$). Time course analysis showed two metabolites, Camelliol A and Squaraine, differentiated two or more timepoints ($P < 0.05$). Camelliol A, a member of the sesquiterpenoid class, was relatively greater at 0 and 30 min in CON. Squaraine was relatively greater in GRA at 30 min then become greater in CON at 150 and 180 min. AUC and time course evaluation suggests that there is a difference in the abundance of specific metabolites seen in the human postprandial response to a steak from GRA and CON. Identified metabolites have potential importance to amino acid and fat metabolism. This shows that cattle feeding style may have an impact on certain metabolic pathways.

Acknowledgements: Funding provided by the Organic Advisory and Education Committee (OAEC)

#62 Morning

Speciation's Role in Evolutionary Divergence Is Systematically Underestimated in Comparative Studies

Kevin Surya, Mathematical Sciences
Mentors: John Borkowski, Mathematical Sciences Chris Organ, Earth SciencesCo-Author/s: Jacob Gardner, School of Biological Sciences, University of Reading

Speciation is driven by microevolutionary forces that have macroevolutionary consequences. The theory of punctuated evolution predicts that evolutionary change correlates with the frequency of speciation events. The rationale is that evolution tends to occur faster during speciation, as a small subpopulation splitting from its ancestral population is subject to strong genetic drift or a new selection regime when it moves into a different environment. Phylogenetic comparative studies estimate that approximately 16% of molecular evolution in animals, plants, and fungi is attributable to net speciation events. The effect of taxonomic sampling for estimating punctuated evolution has not been studied. Due to pervasive extinction and data collection biases, much of the information required to reconstruct evolutionary patterns is inaccessible. We conducted simulations that show taxon undersampling leads to a systematic underestimation of speciation's role in evolutionary divergence. Even when simulating a scenario where 100% of evolutionary divergence is attributable to speciation, the commonly used comparative model, correlating root-to-tip path length with node count, detects just 30% on average, revealing widespread underestimation of speciation's influences on the variation of evolutionary rates. We consider

several ways to correct this systematic bias. Our results have broad implications regarding the contributions of drift/selection and dispersal/vicariance.

#63 Morning

Adapting to Thrive: Exploring Students' Academic Adaptability and Absorptive Capacity in Higher Education

Emmanuel T. Teye, Education
Mentors: Bryce Hughes, Education

In contemporary higher education settings, students confront diverse academic demands and uncertainties, and their progression and commitment to educational structures is dependent on their satisfaction within the academic milieu. This quantitative study, employing a cross-sectional survey with 209 college students investigates the influence of students' adaptability and absorptive capacity on their academic life satisfaction. Through descriptive statistics and multiple regression with STATA 17, we explored the levels of adaptability skills and the ability to absorb new knowledge, shedding light on their impact on overall satisfaction with academic experiences. Results show mean levels of academic adaptability (Mean=5.782), absorptive capacity (Mean=5.831), and academic-life-satisfaction (Mean=5.014) are above the average, signifying favorable levels. Notably, absorptive capacity (Beta = 0.3191944***), exhibited a robust positive relationship with academic-life-satisfaction slightly surpassing the observed positive correlation with academic adaptability (Beta = 0.2943806***) in the overall regression model. Our study not only contributes empirical insights for educators and administrators but also empowers students to comprehend the enhancement of psycho-cognitive resources crucial for coping, adjusting, and learning in the academic space. We conclude that nurturing academic adaptability and absorptive capacity is critical for improving students' well-being and persistence in higher education institutions, particularly in developing economies like Ghana.

#64 Morning

Application of implementation strategies for Turtle Island Tales, an evidence-based obesity prevention program with Native American communities

Teresa Warne, Health & Human Development
Mentors: Emily Tomayko, Health & Human Development - Co-Author/s: Emily Tomayko, Health and Human Development, Paul Estabrooks, University of Utah - Health and Kinesiology, Alexandra Adams, Center for American Indian and Rural Health Equity

Turtle Island Tales-is a home-based childhood obesity prevention intervention delivered monthly over one year to facilitate family interaction and promote health. The intervention was developed using community-based participatory research methods with and for Native American (NA) families. The purpose of this presentation is to describe an approach to scale up Turtle Island Tales for NA families who live in persistent poverty census tracts. Community engaged dissemination and implementation (CEDI) principles are used to identify and document strategies to improve scale up across 3 states and increase reach into NA families. Four primary strategies were identified to improve reach including (1) the development of a project steering committee with membership from potential delivery systems, key community partners, and the scientific team, (2) local community implementation teams focused on implementing strategies to increase reach, adoption, implementation quality, and program maintenance, (3) pursuing and achieving recognition in an evidence-based intervention in the SNAP-ED intervention repository, and (4) creating a centralized distribution center to reduce the complexity of local program implementation. Identifying strategies to improve scale up of evidence-based interventions in persistent poverty areas and underserved communities—adoption and reach, in particular—has the potential to fast-track implementation and increase community impact.

Federal funding through research mentor (NSF, NIH, NASA, DOE, etc.)

ALPHABETICAL LIST OF PRESENTERS

Morning Session: 10AM-12PM
Break & Transition: 12PM-1PM
Afternoon Session: 1PM-3PM

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Lydia Bushey	*DETECTING THE BIOMAGNIFICATION OF PERFLUOROOCTANOIC ACID (PFOA) IN STREAM ECOSYSTEMS WITH CLOSE PROXIMITY TO SKI TRAILS*	20	Afternoon	22
John Cambria	*Expression, isolation, purification, and characterization of galectin-3 and domains*	3	Morning	6
Claire Cassellia	*Is ExxonMobil Legally Liable of our Planets Demise?*	15	Afternoon	19
Calla Castro	*Thermophilic Degradation of Plastic Wastes*	24	Afternoon	24
Cassidy Citron	*Investigating the mechanisms of a temperature-dependent survival effect in Pseudomonas Protegens (Pf-5)*	1	Afternoon	1
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Isaac Doll	*Understanding the Dynamics of Existential Isolation and Persistence*	50	Morning	59
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