Montana Academy of Sciences

2017 Annual Meeting

April 7-8, 2017

Montana Tech of the University of Montana - Butte, Montana

James G. Berardinelli, President, Montana Academy of Sciences
James Barron, Executive Director, Montana Academy of Sciences

INTRODUCTION

The Montana Academy of Sciences (MAS) was incorporated on the 20th day of March, 1961, as a non-profit, educational organization. The objectives of the Montana Academy of Sciences are to encourage interest and participation in the sciences and to promote public understanding of science and its contribution to society. The Academy accomplishes its objectives by conducting meetings of those interested in sciences and the education of scientists, by publishing contributions to scientific knowledge, by supporting research, by making awards to recognize accomplishments in science, by administering gifts and contributions to accomplish these aims, by assigning and cooperating with affiliated and other organizations with similar objectives, and by engaging in such other activities as deemed necessary to accomplish its objectives.

We held our 2017 Annual Meeting at Montana Tech in Butte, MT. on April 7 and 8. Over 100 registrants participated, viewing 22 contributed oral presentations and 20 poster presentations over the day and a half meeting. We present the abstracts from our meeting here so that the readers of the Intermountain Journal of Sciences can see the quality and types of science supported by MAS. Please mark your calendars for our next meeting, April 6 and 7, 2018 in Butte. Finally, the Board of Directors of MAS would like to thank the sponsors of our 2017 Annual Meeting:

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Presentation Abstracts

Alphabetical by First Author's Last Name

Characterization and Classification of a Montana Mycobacteriophage

Margeaux Black, Montana Tech of the University of Montana, Butte

Froghopper, a Mycobacteriophage discovered by Nikki Boyd in 2005 and stored in Dr. Marisa Pedulla's collection, was adopted in the fall of 2016. The bacteriophage was plated, or used to infect *Mycobacterium smegmatis* on Petri dishes, in order to determine the morphology of the resultant plaque. Froghopper was purified and amplified, and a high titer stock was made. DNA of the phage was extracted using phenol/chloroform. Restriction digests and agarose gel electrophoresis of Froghopper DNA were performed in order to compare the DNA of Froghopper to DNA of phages in the Actinobacteriophage database. The polymerase chain reaction (PCR) was used for preliminary determination of Froghopper's phage cluster. A phage cluster is a group of bacteriophages with similar DNA sequences. Phage clusters can be predicted by a set of primers used in PCR to determine genetic similarities to sequenced bacteriophages (Smith et al., 2013). Determination of the bacteriophage's structural morphology was determined by imaging the phage under transmission electron microscopy at the University of Montana. DNA of the bacteriophage was sent to the University of Pittsburgh for the DNA sequencing. Once sequenced, the DNA sequence was annotated; putative protein coding genes were identified and described in relation to other known sequences, and the annotated sequence was submitted to GenBank.

Fabrication and Characterization of Aligned Fibers on Nonconductive Substrates from a Novel Electrospinning System

Zachary Burckhard, Mechanical Engineering and Montana Tech Nanotechnology Laboratory, Montana Tech of the University of Montana, Butte
Jack L. Skinner, Mechanical Engineering and Montana Tech Nanotechnology Laboratory, Montana Tech of the University of Montana, Butte

Electrospinning has become a valuable technique for producing micro-to-nanoscale polymeric fibers with length scales from ~1 nm to 100 μm. Alignment of electrospun fibers further expands upon functionality by increasing reproducibility and improving predictive behavior of fibers in various environmental conditions. The utility of electrospun fibers can be subsequently increased with the ability to deposit directly onto a non-conductive/non-energized surface. Possible uses include displays and sensors for commercial or defense applications or in biomedical application for depositing on tissue. In order to accurately deposit electrospun fibers onto a nonconductive surface, we developed a new electrospinning apparatus. The set up for the device includes two grounded electrodes separated with a small gap that sheets of air were be forced through in order to prevent the fibers from contacting the electrodes. Fibers were deposited directly onto a nonconductive surface placed below the grounded electrodes. Details of the apparatus along with images and analysis of resultant fibers will be presented.

Rhetoric, Visual Rhetoric, and the 1950'S Betty Crocker Cookbooks

Barbara Cass, Professional and Technical Communication, Montana Tech of the University of Montana, Butte

This study explores the importance of Betty Crocker to her cookbooks in the 1950's. The Betty Crocker Cookbook was an instruction manual that fits within a particular genre of technical communication. These technical manuals included instruction for women on how to prepare and cook aesthetically pleasing and wholesome meals. The Betty Crocker Cookbook went beyond established norms of cookbook instruction by adding helpful hints on how to be a perfect housewife. Rhetorical and visual analysis of the 1950's Betty Crocker Cookbooks shows the importance of these particular cookbooks was Betty Crocker herself. Because she was an authority on all things pertaining to the kitchen, women accepted this authority, in part because of the ethos of Betty Crocker, a trusted figure and someone they felt a relationship with. She was with them through the Great Depression and World War II, and she was the voice on the radio that brought a sense of normalcy in a turbulent time, the fact that Betty Crocker was a fictional construct did not matter.

Rabbit Creek: Geochemistry of an Alkaline Deeply Sourced Hot Spring with Abundant Microbial Mats

Jordan Foster, LEGEND Lab, Department of Chemistry & Geochemistry, Montana Tech of the University of Montana
Shanna Law, LEGEND Lab, Department of Chemistry & Geochemistry, Montana Tech of the University of Montana
Mallory Nelson, LEGEND Lab, Department of Chemistry & Geochemistry, Montana Tech of the University of Montana
Georgia Dahlquist, LEGEND Lab, Department of Chemistry & Geochemistry, Montana Tech of the University of Montana
Alysia Cox, Department of Chemistry & Geochemistry, Montana Tech of the University of Montana

The Rabbit Creek hot springs in Yellowstone National Park are located along the edge of the Mallard Lake Dome in the Midway Geyser Basin. The principal source, Rabbit Creek hot spring, contains high concentrations of arsenic and antimony relative to hot springs throughout the area. This study investigates the water chemistry of the Rabbit Creek hot spring outflow, geologic explanations for the distinct differences in hot spring compositions of the area, and the implications for the abundant thermophilic microbial mats present in the outflow. The distribution of the microbial mats may be related to the concentrations of arsenic and antimony throughout the outflow. In addition, changes in the microbial mats related to temperature and sulfide concentrations are discussed. This study aids in our understanding of the hot springs in the Rabbit Creek area and of the potential effects of the Mallard Lake Dome on the Midway Geyser Basin.

Separation Features of Fine Particle Processing in a Crossflow Separator

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Avimanyu Das, Department of Metallurgical and Materials Engineering, Montana Tech of the University of Montana, Butte

A Cross Flow Separator works on the principle of hindered settling and liquid fluidization to accomplish gravity concentration of fine particulate mass. Heavier particles penetrate the fluidized suspension to settle at the bottom to be discharged as the underflow while the lighter particles remain at the top and are carried away by the upward flowing water to the overflow outlet. Influence of bed depth, feed rate and teeter water flow rate on the separation features along with the response of feed particle size was investigated with reference to a difficult fine coal (1.4 x 0.1 mm) having 33% ash. Characterization of the feed was followed by a detailed experimental program using response surface methodology. Products of each experiment were characterized to understand the separation mechanism and how various particles respond to the process conditions. The process responses were estimated in terms of mass yield, ash levels of both products and combustible recovery. The experimental data were analyzed to arrive at statistically significant correlations for the response variables. The process was optimized and under optimum conditions, clean coal with 24% ash at 63% mass yield and over 70% combustible recovery was obtained. Overall Ep was 0.34 with an effective separation density of 1.81 g/cc. It was concluded that a ratio of 10:1 between the top and the bottom sizes of the particles may be acceptable in the feed material. The importance of the flow behavior was discussed. The process features were also described phenomenologically vis-à-vis the experimental observations.

Potential Factors Driving Sandberg's Bluegrass Growth In Relation to Sagebrush Cover

Nate Haygood, Montana State University, Bozeman
Clayton Marlow, Department of Animal and Range Sciences, Montana State University, Bozeman

Sandberg's bluegrass (*Poa secunda*) is a native perennial bunchgrass found throughout most of the Intermountain West. Like many other cool season bunchgrass species, Sandberg's bluegrass is a valuable and readily attainable forage as winter snowpack thaws and recedes. Because a large percent of Western North American rangeland is co-dominated by shrubs, it is paramount that land managers have an adequate and increasingly broad understanding of the biology and relationship between grasses and shrubs. With this in mind, we measured water availability, soil temperature, and basal area of Sandberg's bluegrass plants inside and outside of the sagebrush canopy as well as a simple plant count with the purpose of evaluating potential drivers behind growth and success of this species. Basal areas were significantly greater inside the canopy versus outside ($P = 0.033$) which was consistent with our hypothesis. Soil temperature was significantly lower inside the canopy versus outside ($P = 0.049$) while soil water content was not significantly different. However, there was no significant correlation between basal area and soil water content or soil temperature. We infer from the data collected that Sandberg's bluegrass is indeed more robust and numerous within the canopy of sagebrush compared to outside the canopy; however, the primary driver for this is still unclear. It is our conclusion that future research is needed in order to evaluate and identify the reason for this occurrence.

Macroinvertebrates as Indicators of Water Quality in Blacktail Creek

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Blacktail Creek, located in Butte, Montana, has a long history of human-caused contamination. Mine waste has polluted parts of its streambed since the late 1800's, causing extensive loss of vegetative diversity along the creek, as well as a loss of aquatic life. The Blacktail Berm is an area currently estimated to contain 35,000 cubic yards of toxic mine tailings. The future removal of remaining mine tailings in Butte is not a certainty at this point, but planning removal and restoration of these contaminated areas has been discussed extensively in recent years. In order to help provide baseline data prior to future restoration efforts, this study was conducted to survey the aquatic macroinvertebrate populations in Blacktail Creek. Macroinvertebrates are often used as part of an assessment of stream health, particularly in relation to restoration work. The presence and abundance of specific aquatic macroinvertebrates can be used to get an idea of the water quality of the stream. Macroinvertebrate samples were collected at five locations along Blacktail Creek from September 13, 2016 through September 17, 2016. Along with stream conductivity, temperature, and dissolved oxygen, an Ephemeroptera, Plecoptera, and Trichoptera (EPT) index assessment was completed. The EPT index used for this assessment provided good, fair, or poor water quality ratings for Blacktail Creek based on the ratio of EPT macroinvertebrates to total macroinvertebrates in a single sample. The results will provide data useful in long-term monitoring of these macroinvertebrate populations before, during, and after the cleanup of Blacktail Creek.

Amphibian Risk Assessment in Montana

Alex Kurtz, Department of Biochemistry and Molecular Biology, Carroll College, Helena

The fungus, *Batrachochytrium dendrobatidis*, has been found to negatively impact amphibian populations around the world. This fungus can have multiple effects on frogs and salamander physiology, including changes in osmotic regulation that may lead to death. B. *dendrobatidis* has been shown to be the driving force for many amphibian population crashes and extinctions around the world. The purpose of this project was to build a predictive model of B. *dendrobatidis* infection, one that would be used to assess population susceptibility in order to identify populations of amphibians at risk of infection. This was accomplished by statistical analyses of several components that contribute to infection vulnerability, including amphibian antimicrobial peptide production, cutaneous bacterial colony structure, infection status for each frog and water nutrient composition. This project collected baseline data that will allow us to establish meaningful relationships between susceptibility factors and disease which will permit the identification of populations at risk. Although certifications may not provide a comprehensive solution to the challenges facing women in Costa Rica's coffee industry, the majority of women feel empowered through involvement in local organizations and women's groups. This research adds new perspectives to the growing body of literature regarding the efficacy of coffee certification schemes and has implications for certification agencies and local-level organizations in Costa Rica and other coffee producing countries.

Using Nuclear Magnetic Resonance (NMR) Metabolic Profiling to Distinguish Herds of Bighorn Sheep

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The objective of this study was to determine if nuclear magnetic resonance (NMR) metabolic profiling has the potential to serve as a management tool for evaluating herds of bighorn (*Ovis canadensis*) sheep. Two-hundred and forty bighorn sheep serum samples from 13 herds located in Montana and Wyoming were processed for NMR spectra, profiled for small molecule metabolites using Chenomx®, and then analyzed with MetaboAnalyst (v3.0). Fifty-six small molecule metabolites were identified in ungulate serum. To determine if NMR metabolic profiles can distinguish herds that are geographically distinct with access to different nutritional resources, herds collected in December were compared to herds collected in March. Partial least square discriminant analysis (PLS-DA) indicated a clear, majority separation of metabolic shifts with minor overlaps. Biomarker analysis identified 15 potential biomarkers from the compounds with variables of importance (VIP) scores greater than 1.0. These molecules enabled us to identify 'significantly' important metabolic pathways that discriminate herds sampled in December and herds sampled in March. Key biomarkers resulting from the pathway analysis, included: 2-oxoisocaproate, choline, tyrosine, creatinine, and trimethylamine n-oxide. To determine if metabolic profiling can distinguish individual herds within a month, herds in December, January and March were compared to a domestic, Rambouillet ewes (control) sampled during the sample months. PLS-DA of all herds showed clear metabolic shifts and complete separation between each individual herd and the control ewes for each month. Potential biomarkers for herds within a season that were found to be good discriminants for the December herds included: trimethylamine n-oxide and sarcosine; for January herds included: creatinine and asparagine; and, for March herd included, creatinine. Through identification of small molecule metabolites, it is possible to discriminate herds from each other within and between seasons. These biomarkers represent a potential panel of metabolites that may be used for assessing nutritional status, environmental stress, and herd health through the identification of significantly important metabolic pathways related to energy and protein balance.

High Saturated Fat-Enriched Diet Evokes Endoplasmic Reticulum Stress and Consequently Increases β- Site App Cleaving Enzyme 1 Activity in Amyloid-Beta Engenderment in the Brain

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Alzheimer's disease (AD) is the most common form of dementia in the elderly that is histo-pathologically characterized by extracellular accumulation of aggregated Amyloid-β (Aβ) peptide as neuritic senile plaques and the intracellular accumulation of aggregated hyperphosphorylated protein tau (τ) as neurofibrillary tangles. The aspartyl protease BACE1 is indispensable for the engenderment of Aβ and catalyzes the rate-limiting step in Aβ genesis from AβPP. The expression of BACE1 protein as well as its enzymatic activity is significantly augmented in the AD brain. The etiology of AD is multifactorial and egregiously comprehended, but epidemiological studies have implicated a diet rich in saturated free fatty acids (sFFA) as a significant risk factor for developing AD. Palmitic acid (palmitate) is the most abundant long-chain free saturated fatty acid in the brain and the diet and higher palmitate levels in the plasma, as observed in obesity and diabetes, inversely correlate with cognitive function. Recent cogent evidence has implicated endoplasmic reticulum (ER) stress as one of the culpable factors in initiating and fostering the deleterious neurodegenerative changes in AD. A multitude of studies have cogently demonstrated that sFFA such as palmitic acid evoke ER stress. In this study we demonstrate that palmitate evokes ER stress leading to the induction of CHOP expression which indispensably mediates the up-regulation in BACE1 expression and Aβ engenderment via the NF-κB signaling pathway. Our study unveils a novel ER stress/CHOP/NF-κB signaling pathway and delineates the molecular mechanism thereof that mediate the palmitate-induced up-regulation of BACE1 expression.

Design and Synthesis of Proligand Pyridine-2,6 Dithiocarboxylic Acid and Structural Derivatives for Use in Environmental Remediation of Carbon Tetrachloride

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Thomas Lewis, Department of Biological and Physical Sciences, Montana State University – Billings, Billings

Carbon Tetrachloride is a carcinogenic pollutant that has contaminated groundwater beneath former grain storage and industrial sites, such as the Department of Energy's Hanford site. Current remediation of these sites involve removal and subsequent treatment, which requires handling of the hazardous material as it is transferred to another location for final destruction. Professor Thomas Lewis has previously described the use of a small molecule (pyridine-2,6-dithiocarboxylic acid [PDTC]), that when complexed with copper has been shown to lead to complete dechlorination of pollutant carbon tetrachloride within atmospheric samples. The process results in conversion to non-toxic end-products (mostly

CO2) and complete removal of the problematic carbon-chlorine bonds. Synthetic chemistry can be employed to develop a series of PDTC derivatives that could increase water solubility and allow for on-site destruction of carbon tetrachloride. The current methods described in literature for the synthesis of proligand PDTC uses or produces large quantities of toxic hydrogen sulfide gas. A modified procedure for large-scale production of PDTC, with minimal hydrogen sulfide production, was successfully developed. However, this method will not be able to be utilized for synthesizing derivatives of PDTC, which defines the need for a novel approach to the development of proligand derivatives. An elegant approach using a dilithiated addition into carbonyl sulfide is currently under investigation to produce PDTC and several derivatives that could be functionalized for use in environmental remediation of carbon tetrachloride.

Finite-Difference Modeling of 2-D Compressional Wavefield

Chau Duc Minh Ha, Mathematical Sciences Department, Montana Tech of the Universityof Montana, Butte

This project discusses the derivation of the 2-D compressional wavefield (P-wave) and its finite-difference approximation. In developing this wavefield, we have two approximations. First, the subsurface density is assumed to be a constant. Second, the angle of wave propagation is less than 150 with respect to the surface (horizontal direction). The algorithms are used to demonstrate the propagation of P-wave through a simple subsurface model. Although not discussed in this project, the same algorithms are also able to model the propagation of P-wave in another complex model and the success of depth-imaging algorithms in recovering the subsurface structures indicates the accuracy of the approximations for most modeling purposes. Future studies include modeling P-wave in 3-D, modeling elastic wavefield in 2/3-D, and extending the angle of propagation to more accurately model incoming waves at the edge of the computational grid.

Extension Theory in Coarse Geometry

Atish Mitra, Department of Mathematical Sciences, Montana Tech of the University on Montana, Butte

LSAEs (Large Scale Absolute Extensors) were introduced by J. Dydak and the author to study the coarse geometry of metric spaces. In this talk we will discuss how this concept can be used to study extensions of proper large scale Lipschitz functions between metric spaces.

Essentially Normal Composition Operators on the Hardy Space

Jeff Preston, Montana Tech of the University on Montana, Butte

Waleed Al-Rawashdeh, Department of Mathematical Sciences, Montana Tech of the University on Montana, Butte

In this presentation, we will explore composition operators on the Hardy space. We will investigate what it means for such composition operators to be essentially normal. The following question will be answered in this presentation: Are there any composition operators on the Hardy space which are essentially normal but which are not compact?

Growth of Finitely Generated Groups

Jeff Preston, Montana Tech at University of Montana, Butte
Atish Mitra, Department of Mathematical Sciences, Montana Tech of the University of Montana, Butte

Given a finitely generated group, we study various growth functions and growth series. We calculate growth functions for certain groups of polynomial and exponential growth, and study R. Grigorchuk's example of a group with intermediate growth. We examine relations between algebraic properties of a finitely generated group and the equivalence class of its growth functions.

Relationship of Athletic Injuries to Athletic Season

Jessica Ream, University of Great Falls, Great Falls

In the world of sport, to be an excellent athlete, one must have the necessary physical attributes, appropriate environment, and personality variables to succeed. However, a critical variable that affects every aspect of athletic ability is athletic injury. Injuries have negative consequences for the athlete's health, training, and competitive performance. Maintaining an absence of injuries is pivotal for the athletic individual and the team as a whole. This research characterizes the relationship between type and duration of athletic injuries in different sports and months of occurrence during the period 2012-2015. Archival data was collected from the University of Great Falls, Montana State University, and Westminster College. Due to the higher injury rates, the sports of focus were women's volleyball, women's softball, women's basketball, men's wrestling, and co-ed cheer. This presentation will summarize findings and implications for athletic trainers, coaches, and players.

Automating the Process of Fitting New Planetary Transit Data with Python

Ailey Robinson, Hellgate High School, Missoula

The study of exoplanets has aided astronomers in understanding the behaviors of solar systems and continued the search for extraterrestrial life. Photometry, the measurement of light flux caused by a planetary object transiting a star, is one of the main methods to detecting exoplanets. Because of atmospheric variations and experimental uncertainty, the photometric data is modeled with a line of best fit. To create the fit for the data, a person must input values for seven parameters iteratively until the accuracy of the fit is satisfactory. This process is time-consuming and limits the accuracy of the model. This project presents a new program coded in Python that will automate the process for new transit data by allowing a user to input one set of estimated parameters. The program alters the inputted parameters repeatedly to create multiple fits, and then presents the parameters for the fit with the lowest residual data. Planets with high chances of transiting their parent star were chosen for observation. Two planets with previously confirmed transits and thirteen planets without confirmed transits were observed using four, 0.7meter telescopes. Data were analyzed using the current method of data analysis and with the program developed in this project. This program could serve as a practical application for astronomers that provide more accurate and efficient results. The purpose of the experiment is to see how environmental and chemical factors, such as caffeine, induce different stress responses based off of zebrafish behavior and cortisol assay results.

Women's Experiences and Perspectives of Certification Schemes and Empowerment in the Costa Rican Coffee Industry

Laura Stein, W.A. Franke College of Forestry and Conservation, University of Montana, Missoula

Coffee certification schemes, such as Fair Trade, Rainforest Alliance, and Organic, influence the environmental, economic, and social conditions of the global coffee industry by promoting sustainable production practices and equitable trade relations. Over the past three decades, studies show that adhering to environmental standards supports ecological conservation in agricultural communities. However, research examining the economic and social impacts among producers yields mixed results due to context-specific factors such as management strategies, landholding size, and market conditions. Furthermore, although many certification schemes incorporate gender equality and women's empowerment initiatives, little attention has been given to the perspectives of women producers, many of whom confront challenges due to socially constructed gender norms. This research addresses this gap in knowledge through case study analysis of two organizations in southern Costa Rica: CoopeAgri, a mixed-gender producer cooperative, and ASOMOBI, an all-women's coffee association. Data were gathered through in-depth interviews, document analysis, and participant observation within each organization. Preliminary results suggest that while the majority of women believe certifications can provide benefits, there are significant costs (i.e., money, time, energy), and the actual benefits received can be minimal.

The Word Problem for Hyperbolic Groups

Tyler Taylor, Montana Tech at University on Montana, Butte
Atish Mitra, Mathematics Department, Montana Tech at University on Montana, Butte

Max Dehn's word problem asks us the following: Given a finitely generated group in terms of generators and relations, is there an algorithmic procedure to determine if an arbitrary word represents the identity element? In this undergraduate research project, we define the notion of hyperbolicity of a metric space and present a geometric proof that all hyperbolic groups have solvable word problems.

Continuous Nowhere Differentiable Functions

Tyler Taylor, Montana Tech at University of Montana, Butte
Waleed Al-Rawashdeh, Department of Mathematical Sciences, Montana Tech of the University of Montana, Butte

In this presentation we study functions that are continuous everywhere on their domain but differentiable nowhere. One such function is the function whose graph is called the Kiesswetter curve. First we construct the curve and the piece-wise function that represents that curve. We prove several key properties of the function that gives us insight to why this function is continuous on the unit interval. We then prove the continuity and non-differentiability of the function.

Poster Abstracts

Alphabetical by First Author's Last Name

Cardiac and Perceptual Responses to Performing Tandem Cardiopulmonary Resuscitation (Poster)

Jacob Bone, Department of Health and Human Performance, Montana State University-Billings
Alex Shafer, Department of Health and Human Performance, Montana State University- Billings

Introduction: Information regarding the physiological and perceptual response of the human body in the act of performing tandem cardiopulmonary resuscitation (CPR) relative to solo CPR is lacking. Purpose: The purpose of this investigation is to compare rescuer heart rate (HR), rating of perceived exertion (RPE), and CPR quality during Tandem-CPR and Solo-CPR. Methods: Thirteen healthy young adults (aged 26.5±4.3 yrs) were recruited from MSUB campus community. Participants completed two 6-minute bouts of CPR during a single session. Tandem and solo techniques were counterbalanced, with a 15-minute rest period separating the bouts. Values for HR and RPE were recorded using a Polar V800 HR monitor and Adult OMNI-RPE scale, respectively. A Laerdal Resusci-Anne CPR manikin was used to record compression score (0-100%), which is a value that incorporates compression rate and depth to illustrate CPR quality. Mean HR, peak RPE and CPR compression scores were examined with dependent t-tests between CPR techniques. Statistical significance was accepted at $p<0.05$. Results: Sample mean HR per bout was significantly lower in Tandem-CPR than in Solo-CPR (111.2±16.8 vs. 126.1±19.3, $p<0.0001$). Peak RPE was significantly lower during Tandem-CPR compared to Solo-CPR (3.2±2.0 vs. 5.0±2.5, $p<0.05$). Compression scores were significantly higher for Tandem-CPR when compared to Solo-CPR (96±3% vs. 94±5%, $p<0.05$). Discussion: Current findings call for a professional recommendation that tandem CPR be used when available, based on perception, performance, and physiological differences. This confirms professional guidelines. This study does not account for the anecdotally reported stress incited in CPR context; further research should examine this aspect.

Behavioral Ecology in the Northern Scorpion (Poster)

Synda Boumediene, Montana State University, Billings
Summit Parcell, Montana State University, Billings
Lea Henderson, Montana State University, Billings
Sarah Gallup, Montana State University, Billings
Colleen Tallon, Montana State University, Billings
Amanda Klein, Montana State University, Billings
James Barron, Department of Biological and Physical Sciences, Montana State University, Billings

The Northern Scorpion (*Paruroctonus boreus*) is a predatory arachnid. Although occurring at relatively high densities in local areas, conspecifics have seldom been observed sharing cover items. We investigated territoriality of scorpions by analyzing pairs of scorpions introduced into a habitat with a single, small cover item. We used mono- and bisexual pairs, similar and differently sized pairs, and pairs from the same or different populations. Scorpions were collected from two populations in south-central Montana. Results indicate that scorpions do interact over cover items, though not to the extent that we had anticipated. When scorpions were housed singly, they spent 80% of their time under cover. When size-matched pairs were offered a single cover item, up to 60% of the time

at least one scorpion was not under cover. Further, when differently-sized scorpions were paired, a similar result obtained with the larger scorpion excluding the smaller most often. Interestingly, these results all differed by population and sex. Scorpions from the naturally more-dense population excluded others more frequently than scorpions from the less-dense population. Additionally, males excluded other males more frequently than mixed-sex pairings excluded one sex or the other, or than females excluded other females. Finally, late in the experimental season (early Spring), there were six instances of cannibalism. In each case, females killed and consumed males. Though cannibalism has been previously documented in this genus, it has not been observed to be "seasonal" and has been attributed to size differential and not simply sex. In one of our cases, a smaller female killed and consumed a larger male. This pilot project provides several interesting questions to pursue regarding behavioral ecology in this species.

The Use of Trichostatin a to Rescue TRKA+ Neurons in a Mouse Model of Familial Dysautonomia (Poster)

Richard Buksch, Montana State University, Billings

Familial dysautonomia is a severe, recessive disease that devastates the peripheral nervous system, culminating in death of most patients by age 40. Studies have shown that there is a reduced number of both TrkA+ neurons and acetylation in familial dysautonomia patients and our mouse model of familial dysautonomia. Another feature of familial dysautonomia is a decrease in histone acetylation. This study evaluated the ability of the histone deacetylase inhibitor, Trichostatin A, to rescue the reduced number of TrkA+ neurons in the dorsal root ganglia in our mouse model of familial dysautonomia. Pregnant dams were treated with either 1mg/kg of Trichostatin A (experimental) or vehicle alone (control), at E8.5, E10.5, and E12.5, a time frame corresponding to neurogenesis in the mouse dorsal root ganglia. Immunohistochemistry was used to quantify the number of TrkA+ neurons at E17.5. Trichostatin A-treated knockout embryos (n=3) showed a significant increase in the number of TrkA+ neurons over vehicle only knockout embryos (n=3) (132.9% increase; $p<.00001$). Trichostatin A (1mg/kg) effectively rescues the number of TrkA+ neurons in our mouse model. Further studies will explore the cellular mechanisms via which histone deacetylase inhibition prevents neuronal cell death as well as the possible benefits of using these therapeutics for familial dysautonomia symptom management.

Oxidation of D-Glucose and D-Mannose (Poster)

Katelyn Duncan, University of Great Falls, Great Falls
Grace Ibsen, University of Great Falls, Great Falls
Chrissie Carpenter, Chemistry Department, University of Great Falls, Great Falls

The study of monosaccharides has been around and researched since the 1800's. In this experiment, D-glucose will undergo benchtop oxidation using nitric acid and heat to produce gluconic acid and glucaric acid. The same oxidation process will then be done using D-mannose. The resulting aldonic and aldaric acids of each compound will then be compared to determine if stereochemistry effects the ease at which an aldohexose can be oxidized at C-1 and C-6.

Riverine Carbon Cycling as a Function of Seasonality (Poster)

Christine Foreman, Center for Biofilm Engineering, Chemical and Biological Engineering, Montana State University, Bozeman
Emily Hultin, Center for Biofilm Engineering, Chemical and Biological Engineering, Montana State University, Bozeman
Juliana D'Andrilli, Department of Land Resources and Environmental Science, Montana State University, Bozeman

Montana has one of the most dynamic climate regimes in all of the United States, with seasonal changes spanning a large range of temperatures. In Montana, we depend on water originating from snow and glacial melt. These freshwater ecosystems are considered to be some of the most vulnerable to climate change on Earth. Glacially fed ecosystems are unique habitats for a vast array of life and geochemical processes, including carbon cycling. In order to study carbon cycling in environments vulnerable to change, an interdisciplinary approach including biogeochemical analyses of river DOM production and external allochthonous inputs is necessary to evaluate the impacts of climate change. The overarching hypothesis for this work is: Seasonal changes in Montana rivers will cause shifts in carbon cycling as ecosystems respond to changes in temperature. Unlike our initial hypothesis that the amount of sunlight and temperature would play a bigger role in what was happening, the time of the year was much more significant. In Big Sky OC levels in June for the sunny and canopy covered reaches were similar, 1.24 and 1.23 mg C/L, respectively; whereas at the end of July OC in the sunny reach was 0.42 mg C/Land the canopy cover reach was 0.955 mg C/L. The same trend is seen for the urban location in Bozeman. Cell abundance in the reaches followed similar trends, which were not solely based on temperature.

Analysis of BH31-1 Derivative's Effect on *Candida* Species (Poster)

Alexander Fryett, Montana State University, Billings
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Candida species are the most common and arguably the most important causative agents of human fungal infections. Oropharyngeal, esophageal, vulvovaginal, and cutaneous candidiasis leads to significant morbidity while systemic infections in immunocompromised patients (patients with AIDS, tissue transplants, central venous catheters, or those undergoing chemotherapy) has a 35% mortality rate. During infection, it is essential that the dimorphic *Candida* species switch between different morphological states including transitions between budded or yeast-like cells and hyphal forms. The small molecule BH3I-1 has shown promising results at inhibiting hyphal formation in several *Candida* species. The goal of this study is to find a BH3I-1 derivative that inhibits hyphal formation in several Candida species at a lower minimum inhibitory concentration (MIC) than BH3I-1. A derivative with a low MIC that affects several *Candida* species may have a potential to be a broad-spectrum antifungal drug. The *Candida* species being tested against the BH3I-1 derivatives are: C. *albicans*, C. *glabrata*, C. *rugosa*, C. *krusei,* C. *tropicalis*, C. *lusitaniae*, C. *dubliniesis*, and C. *parapsilosis*. Currently, 36 BH3I-1 derivatives have been tested. Molecule 25 has an MIC about 4 times lower than BH3I-1 in *Candida* albicans and has also been shown to work in other *Candida* species at inhibiting hyphal formation. Other derivatives such as molecule #10 did not inhibit many of the tested *Candida* species, but showed a much lower MIC than molecule #25 in C. *rugosa*. Out of the 36 tested derivatives, molecule #25 has shown the promise for a broad-ranged antifungal drug.

Synthesis Of [CU(PDTC)L] Coordination Series (Poster)

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Carbon tetrachloride (CCl_4) is a potential environmental contaminant in water, and soil. We are interested in studying potential CCl_4 environmental remediation technologies. Specifically we are interested in 2,6-pyridinedithiocarboxylic (PDTC) and the dechlorination properties of its copper based coordination compounds, $[Cu(PDTC)L]^X$. In the interest of creating better performing more soluble coordination compounds we seek to understand the link between coordination compound electronic structure and reactivity. With this ultimate goal in mind we present IR, UV-Vis and NMR evidence for the successful synthesis of a series of $[Cu(PDTC)_yL]^x$ coordination compounds. Here L=Cl, Br, I, CN, PPh_3 as well as the dimer species $[Cu(PDTC)_2]$.

Factors Influencing Owners' Willing to Pay for Veterinary Medicine Services for Pet Dogs: A Pilot Study (Poster)

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The field of veterinary medicine has been changing dramatically over recent decades, as society changes its perspective on animals. Throughout human history, people have seen animals as a resource; now we are seeing them as companions or friends. A way to measure this changing perspective is to look at the amount of money that people are willing to spend on their pets. This study looked at dogs, in particular, and utilized a survey method to analyze factors that could influence people's willingness to pay for veterinary medicine services. Factor analyzed included the severity of the condition (life-saving aspect of surgery). likelihood of normal recovery, age of the dog, income level of owner, amount of owner's dog experience, and whether the owner was a health professional of any kind. Results: People were more willing to pay when the surgery was life-saving and when there was high likelihood of recovery. People were willing to pay more for younger dogs. Not surprisingly, there was a positive correlation between income level and owners' willingness to pay for veterinary services. Amount of experience with dogs had a varied effect on willingness to spend. It appeared that the owners' connection with health care professions also had an impact, although it did not reach statistical significance: those that were connected to the healthcare fields seemed more likely to pay. This study has implications for the practice of veterinary medicine today.

The Effects of Chronic Cortisol Exposure on the Innate Immune Response of Larval *Danio Rerio* (Poster)

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Chronic stress is known to cause a variety of health complications linked to a dysregulated immune response, which could be an outcome of chronically elevated stress signaling mediated by the glucocorticoid steroid hormone cortisol. Previous research has shown that zebrafish embryos treated with cortisol for the first 5 days of development matured into pro-inflammatory adults with atypical regulation of immune-related genes (Hartig et al., 10.1242/bio.020065, 2016). The purpose of this study was to determine how chronic exposure to cortisol affects the innate immune response in larval zebrafish. To that end, the migration of neutrophils and macrophages were monitored following tail fin amputation. Results from this study provide evidence that cortisol-treated larvae had an increased number of macrophages near the amputation site, while the number of neutrophils was not significantly affected by cortisol exposure. These results suggest that chronically elevated glucocorticoid signaling specifically up-regulates the macrophage response to injury.

CBU_1932: A Hypothetical Dna-Binding Protein of the Q Fever Pathogen *Coxiella Burnetii* (Poster)

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Coxiella burnetii is an obligate intracellular bacterial pathogen that resides within a lysosome-like acidic compartment of the eukaryotic host cell and may cause acute and chronic human infections. Our recent transcriptome analysis of C. *burnetii* demonstrated that the CBU_1932 open reading frame displayed an exceptionally high transcript level at 11,481 transcripts per million (TPM), well above average transcript quantity for remaining ORFs in the genome. Due to it's high transcript level we hypothesize the corresponding protein may play an important role for *Coxiella*. Analysis of the CBU_1932 locus indicates that one of the adjacent ORFs, CBU_1933 is a hypothetical DNA binding protein. The protein encoded by CBU_1932 ORF consists of 66 amino acid residues with an unusually high percentage (42%) of residues being basic, including 20 lysines. Using BLAST algorithms we found CBU_1932 had no similarity with currently defined proteins, but has orthologues in other human intracellular pathogens such as *Legionella* and *Chlamydia*. Due to the high number of basic residues in CBU_1932, and linkage with a hypothetical DNA binding protein (CBU_1933), we hypothesize that CBU_1932 may also encode a protein involved with binding DNA or other negatively charged substrates. To address this hypothesis, we are in the process of cloning the 201-base pair CBU_1932 ORF into pMAL-c5x expression plasmid and analyzing the recombinant protein using DNA-binding protocols including electrophoretic mobility-shift assay EMSA. We are confident that characterization of this high-level transcript/highly basic protein will lead to a better understanding of the unique metabolism of *Coxiella* and other intracellular pathogens.

Determination Of Solubility Limits for Pdtc and Cu[Pdtc]Br (Poster)

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Carbon tetrachloride (CCl4) is an organic compound that once widely used as an industrial solvent, degreaser, and grain fumigant. Improper disposal and ground water solubility issues led to CCl4 being listed as a priority pollutant by the U.S. EPA. We are currently investigating the use of 2,6-pyridinedithiocarboxylic (PDTC) and its copper coordination compound $[Cu(PDTC)L]^x$ as a potential CCl4 environmental remediation technology. PDTC and Cu[PDTC]Cl have a very low solubility in water, which decreases the effectiveness of the molecule as a remediation technique. Using a ligated iron UV-Vis spectroscopy assay PDTC's solubility was determined to be 39 mM in a pH 7.6 (check this number) buffer. The solubility of Cu(PDTC)Br in pH 7.6 buffer was determined to be 50 mM via oversaturation UV-VIS assay. The results from both solubility studies were used to confirm a high throughput assay based on dynamic light scattering. The solubilities determined in this study will act as an initial benchmark for the comparison of future novel PDTC derivatives.

The Effect of the Cluffy Wedge on the Average Vertical Jump Height of Volleyball Athletes (Poster)

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The aim of this study was to determine if placing the big toe in a dorsaflexed position affects the average vertical jump height of volleyball players and whether the grade of functional hallux limitus (FHL) limits its effectiveness. A polyurethane wedge (Cluffy Wedge) was placed under the big toe of 30 volleyball athletes. Two sets of three vertical test jumps were completed for each individual and t-tests of average jump heights showed no difference with or without the Cluffy Wedge. The subjects were then tested for FHL. Results showed slight significance in average jump heights for FHL grade 0 ($p= 0.1401$), while showing no significance in FHL grade 1 ($p= 0.6949$) and 2 ($p= 0.9045$). In conclusion, using a Cluffy Wedge to induce dorsiflexion of the big toe did not affect the average jump height of volleyball athletes and the FHL grade had no influence.

Zebrafish Stress Synapse (Poster)

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Stress is a behavior characterized by uneasiness, nervousness, and fear that all organisms are faced with every day. Both environmental and chemical factors can trigger stress responses within the body. In this experiment, zebrafish (*Danio* species) will be stressed with environmental and chemical factors. Their cortisol levels, which is produced when stressed, will be tested by performing cortisol assays. The environmental factors that will be tested with light/dark apparatus that will investigate how environmental conditions stress the zebrafish. A beaker stressor will be used to investigate how the size of the environment effects stress on the zebrafish. Caffeine will be the chemical factor tested because it is addictive. Different concentrations of caffeine will be administered and the effects of these concentrations will use the cortisol assays. An ANOVA test will be done to quantify the data.

Endoplasmic Reticulum-Activated C/EBP Homologous Protein Mediates the Palmitate-Enriched Diet Induced Increase in the Lipogenic Expression in the Liver (Poster)

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Non-alcoholic fatty liver disease (NAFLD) is a wide spectrum pathophysiological disorder characterized by insulin resistance, hepatic steatosis, and inflammation. Diets rich in saturated fat are known to evoke insulin resistance, ER stress, and de novo lipogenesis and thereby contribute to the pathogenic mechanisms involved in NAFLD. Palmitic acid (palmitate) is the most abundant saturated fatty acid in the diet and palmitate-enriched diets are known to cause NAFLD in a multitude of rodent models of NAFLD. Palmitate-enriched diets are known to induce steatosis by inducing the expression of genes involved in de novo lipogenesis. However, the signaling mechanisms and the downstream molecular mediators involved have not been elucidated. In this study, we explored the role of palmitate-induced ER stress and subsequent induction of C/EBP Homologous Protein (CHOP) expression in the modulation of expression and transcriptional activities of Liver X Receptor alpha (LXRα) and Sterol Response Element Binding Protein 1c (SREBP1c), two indispensable transcription factors and master regulators of genes involved in de novo lipogenesis. We demonstrate, in exogenous palmitate-treated HepG2 cells and in the livers of palmitate-enriched diet-fed mice, that palmitate evokes ER stress leading to the induction of CHOP expression. We further show that CHOP mediates the up-regulation in expression levels and transcriptional activities of LXRα and SREBP1c. Our study identifies a unique ER stress-CHOP-LXRα/SREBP1c signaling pathway that mediates palmitate-induced up-regulation of lipogenic gene expression in the liver that may play a critical role in the etiopathogenesis of NAFLD.

Modeling the Distribution of Pollutants for a Mine (Poster)

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The institution of new mining facilities is a constant threat to environmental persistence and abundance. This issue can be minimalized with greater insight into how pollutants spread. Understanding the dispersal of pollutants allows cleanup efforts to be directed in an extremely efficient manner. To determine the spread of pollutants, the Belt Creek Drainage which has several mining facilities was chosen to be tested for specifically Arsenic, Selenium, and Lead. Using ICP (Inductively Coupled Plasma) the concentrations of each pollutant was determined at various points along the drainage system. The data retrieved was then synthesized in GIS (Geographic Information Systems) to create a gradient showing the concentration changes across distance within the river system. This type of analysis is extremely applicable to understanding how and where pollutants can be predicted to accumulate and can enhance the effectiveness of pollutant cleanup efforts.

Developing a Yeast Model of Amyotrophic Lateral Sclerosis Involving the SOD1 Gene (Poster)

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Amyotrophic lateral sclerosis (ALS), one of the most common neuromuscular diseases in the world, is an unremittingly progressive disease that degenerates motor neurons in the brain and spinal cord. Roughly 10% of ALS cases are considered familial and can result from mutations in more than dozen different genes. The most common mutations in familial ALS occur in the SOD1 gene. SOD1 encodes a copper-zinc superoxide dismutase that detoxifies oxygen free radicals. To date, approximately 140 mutations in SOD1 (many of which are missense) have been linked to familial ALS. Evidence suggests that these mutations induce SOD1 protein misfolding and aggregation into cytotoxic structures. We are developing a yeast model of ALS based on the expression of mutant human SOD1 proteins. Such a yeast system will permit high throughput genetic screens to identify genes that enhance or suppress the toxic phenotypes associated with mutant SOD1 expression (thereby identifying critical supporting or suppressing pathways), as well as chemical screens to identify compounds that inhibit mutant SOD1 toxicity.

Proximate Analysisof Fish Feed (Poster)

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An aquaponic system shows evidence of increasing economic efficiency and environmental sustainability. An efficient aquaponic system is heavily dependent on the quality of aquatic life in it. In order to ensure the quality of the aquatic life, the quality of its feed must be ensured as well. This research uses proximate analysis to analyze fish feed in terms of percent moisture, fat content, crude fiber extraction and crude protein extraction and correlate these with fish body composition as well.

How AQP3B Influences Convergent Extension Through Noncanonical WNT Signaling (Poster)

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Aquaporin-3b, Aqp3b, is an aquaglyceroporin, a membrane water channel that is present during gastrulation and various other stages of development. Gastrulation organizes cells, via convergent extension, into germ layers, which will later form different body tissues. During gastrulation, cells fold into the embryo, then merge by convergent extension to form the long body axis. These cell movements are regulated by noncanonical Wnt signaling, an intercellular signaling pathway that controls the migration and polarity of tissues. When Aqp3b is inhibited using a morpholino oligonucleotide (MO), convergent extension does not occur properly, suggesting a link between Aqp3b and noncanonical Wnt signaling. To assay these defects, we use the Keller tissue explanting method to observe convergent extension. Our goal is to determine which parts of the Wnt signaling pathway are influenced by Aqp3b. We conducted rescue experiments by inhibiting Aqp3b and injecting an RNA or DNA construct of several proteins involved in Wnt signaling. Successful rescue with Dvl1ΔDix and Dvl2ΔDix constructs indicated that Aqp3b is involved in noncanonical Wnt signaling, since DvlΔDix acts in all noncanonical Wnt signaling. Further, Aqp3b acts through the Wnt/Ca2+ subpathway, indicated by rescue by PKC, and through a branch of the Wnt/PCP pathway, indicated by successful rescue with RhoA but not with Rac1. Aqp3b does not directly affect the Wnt/Ror2 pathway. In conclusion, I have demonstrated that the ability of Aqp3b to influence convergent extension is dependent on noncanonical Wnt signaling, specifically the Wnt/Ca2+ pathway and the RhoA branch of Wnt/PCP pathway. I am collecting additional data to ensure statistical significance.

Characteristics of the Effect of Exogenous Camp on C. Albicans Morphogenesis in Strains Lacking NRG1P, RFG1P, or TUP1P (Poster)

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The opportunistic human pathogen *Candida albicans* causes both superficial and life threatening systemic infections and is a leading cause of fungal disease in immunocompromised individuals such as those with AIDS. C. *albicans* can grow in different cell shapes, also known as morphologies, including yeast-like cells and a variety of filamentous forms, such as true hyphae and pseudohyphae. Yeast, hyphae and pseudohyphae, have been observed at the sites of *Candida* infection and there is strong evidence that morphogenesis, the transition between yeast and filamentous growth forms, is essential for its virulence. Many studies have implicated the second messenger molecule cAMP in the regulation of morphogenesis due to its role in activating filamentation. Our lab and others have previously characterized the impact of the negative regulators, Nrg1, Rfg1, and Tup1 on the expression of HWP1, a hyphal specific gene. The goal of this project is to characterize whether the addition of exogenous cAMP will increase the expression of HWP1 in the absence of each of the negative regulators as well as test a small molecule derivative of BH3I's effects in conjunction with the exogenous cAMP. This will help us better understand the signal transduction cascade that controls morphogenesis in *C. albicans*.

Does the Misregulation of Codon-Biased Genes in the Anterior Pituitary Contribute to Familial Dysautonomia? (Poster)

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Familial Dysautonomia (FD) is a devastating neurodevelopmental and neurodegenerative childhood disease characterized by a diminished number of autonomic neurons. FD children suffer from a multitude of autonomic symptoms including cardiovascular instability, gastrointestinal incoordination, and respiratory dysfunction. FD patients also exhibit an abnormal autonomic stress response, tend to be small in stature, and have difficulty gaining and maintaining weight. FD results from a mutation in the IKBKAP gene and diminished levels of the corresponding protein IKAP, a scaffold that assembles the multi-subunit complex, Elongator. Elongator functions in the modification of tRNAs that mediate translation of AA- and AG-ending codons. IKAP is expressed throughout the autonomic nervous system and historically FD symptoms have been attributed to autonomic dysfunction. Here we show that IKAP is also robustly expressed in the pituitary gland, both during development and in the adult. We hypothesize that many FD symptoms may actually result from aberrant pituitary regulation of the autonomic nervous system. To test this hypothesis we are currently generating a conditional knockout mouse where Ikbkap will be selectively ablated in the anterior pituitary. While waiting for our mouse model, we have been optimizing techniques for quantifying pituitary specific genes that are likely candidates for Elongator regulation based on their content of AA- and AG-ending codons.