Montana Academy of Sciences

2015 Annual Meeting

April 20 - 11, 2015

Montana Tech of the University of Montana - Butte, Montana

Phil Jensen, 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 2015 Annual Meeting at Montana Tech in Butte, MT. on April 10 and 11. Over 100 registrants participated, viewing 29 contributed oral presentations and 20 poster presentations over the day and a half meeting. The abstracts from this meeting are included in this issue of the Intermountain Journal of Sciences for archival and reference purposes. The Board of Directors of MAS would like to thank the sponsors of our 2015 Annual Meeting:

Dr. Bob Wilmouth, President, Rocky Mountain College

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Presentation Abstracts

Alphabetical by First Author's Last Name

Composition Operators on Weighted Bergman and S^P Spaces

Waleed Al-Rawashdeh, Montana Tech of the University of Montana, Butte MT. 59701

Let $varphi$ be an analytic self-map of open unit disk $mathbb{D}$. The operator given by $(C_{varphi}f)(z)=f(varphi(z))$, for $z in mathbb{D}$ and f analytic on $mathbb{D}$ is called composition operator. For each $pgeq 1$, let S^p be the space of analytic functions on $mathbb{D}$ whose derivatives belong to the Hardy space H^p. For $alpha > -1$ and $p > 0$ the weighted Bergman space A^{p}_{alpha} consists of all analytic functions in $L^{p}(mathbb{D}, dA_{alpha})$, where dA_{alpha} is the normalized weighted area measure. In this presentation, we characterize boundedness and compactness of composition operators act between weighted Bergman A_{alpha}^{p} and S^q spaces, $1leq p, q<infty$. Moreover, we give a lower bound for the essential norm of composition operator from A_{alpha}^{p} into S^q spaces, $1leq pleq q$.

Identification of Heavy Metal Hyper-Accumulating Fauna in the Butte Montana Region through the use of ICP Analysis

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In many parts of the country human activity has contaminated soils through mining operations. One of the major contaminates from mining are heavy metals like Lead, Cadmium, Copper, and Zinc in concentrations that exceed safe human exposure. Consequently, remediation of the contaminated soil is now needed in these areas. Remediation of contaminated soils can be expensive, labor intensive, and disruptive to the native habitat. Phytoremediation is a method of remediating soils by the use of plants that accumulate high levels of contaminates from the soil into the plant's tissue. Plants that are used for the removal of soil contaminates are known as hyper-accumulators; meaning plants that can accumulate metal levels exceeding that of the soil in which they reside. Ideally native plants are to be used in the phytoremediation to reduce the risk of introducing invasive species to the area. The list of known hyper-accumulators native to Montana, or accumulators that can grow in Montana, specifically the Butte-Silver Bow area is limited. Research was done on tissue samples collected from plants growing in the un-reclaimed Butte Priority Operative Soil Unit (BPOSU) that were analyzed by means of inductively coupled plasma mass spectrometry (ICP-MS) for the levels of heavy metals in the tissue, so the plant may be determined a hyper-accumulator or not. Parameter tests included analyzing the soil at the location of the each plant, and site evaluation of the plants location.

Determining Nitrate and Phosphate Levels in Blacktail Creek

Garrett Craig, Montana Tech- Undergraduate Research Program, Montana Tech of the University of Montana, Butte MT. 59701

Nitrates (NO3-) are nitrogen-oxygen chemical units which combine with various organic and inorganic compounds that are commonly used in fertilizers. Phosphates (PO43-) are inorganic chemicals that are important in biochemistry and ecology. In small quantities, both nitrates and phosphates are essential for the health of aquatic ecosystem. However, even a small increase in either nutrient can lead to an accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals.

Blacktail Creek in Butte has previously had high levels on contaminants, including the nitrates and phosphates that were evaluated. Blacktail Creek is approximately nine miles long and empties into Silver Bow Creek west of Butte. The sampling plan included an approximately 1.5 mile reach along Blacktail Creek's most contaminated section, with eight sites being analyzed. During field sampling, grab samples and water flow data were taken to obtain concentrations and to calculate Total Maximum Daily Loads for the nutrients of interest. The data was compared to previous analyzed data, and similar conclusions were reached. The majority of the sites had elevated nitrate and phosphate loading, with the phosphates being the most highly elevated contaminant. The lower four sites on the sampling reach had the highest nutrient loading levels, and all four of these sites have the similarity in being located below the mouth of Grove Gulch that flows into Blacktail Creek. This finding supports the conclusion that the Grove Gulch inlet contributes a significant level of nutrient loading to Blacktail Creek.

Analysis of Urban Humans and Their Spatial Allowance for Predators

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This research addresses varying degrees of social tolerance to wildlife within the urban environment. Rapid growth of the urban environment is thought to create new interactions between humans and wildlife. These new interactions are made unique by the modern urbanite's perspective of wildlife. In the summer of 2013, the occurrence of a mountain lion (*Puma concolor*) in a Butte, Montana neighborhood incited a variety of comments regarding public opinion of urban-wildlife. Research and wildlife managers suggest that to develop a strong, effective urban wildlife management strategy we must first have a comprehensive understanding of the local urbanites' disposition towards urban wildlife (Patterson, Montag, & Williams, 2003). A survey was developed using the tripartite model of attitude assessment to measure Butte residents' attitude towards urban –wildlife. The tripartite model assumes that an attitude is equally influenced by three factors, cognitive, behavioral, and affective. The survey asked respondents questions alluding to their wildlife-education, experiences, and past behaviors. Respondents were then scored according to the amount of influential factors involved in developing their attitude towards urban-wildlife. Respondents were also asked to rank wildlife based on the amount of tolerance afforded to an individual species within an urban setting. The respondents' attitude score was compared with their urban-wildlife tolerance ratings. This research suggests that the cognitive and behavioral attitude influences have the largest bearing on a Butte resident's attitude toward urban-wildlife.

Examining Antibodyto Sin Nombre Virus in Rodents Associated with Peridomestic Habitats in North East Montana.

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Dr. Amy Kuenzi, Department of Biological Sciences, Montana Tech of the University of Montana, Butte, MT. 59701

Hantaviruses are rodent-borne pathogens that produce chronic persistent infections in their reservoir hosts. Sin Nombre virus (SNV) is a type of hantavirus carried by deer mice (*Peromyscus maniculatus*). Infected deer mice shed virus in urine, saliva, or feces, and human contact with the virus can lead to a serious illness called hantavirus cardiopulmonary syndrome. Most studies examining SNV in the rodent host have been conducted in natural settings where human contact with the virus is unlikely. This study, performed in a peridomestic setting (in and around buildings), where contact with the virus is more likely, adds data to a previous study in west central Montana. Mice were live trapped for 3 consecutive nights every two weeks from May to August 2014, at 2 sites in NE Montana. Captured individuals were ear tagged,and species, body mass, sex, reproductive condition, presence of scars or wounds, and location of capture were recorded into a field journal. Blood samples were collected from the retro-orbital sinus of each captured animal. These blood samples were frozen until they could be analyzed. Blood samples were analyzed for antibodies (IgM) to SNV. Deer mice were the most common species captured at both study sites and antibody positive deer mice were detected at both study sites. Antibody prevalence was found to be variable both spatially and temporally with highest prevalence in the middle of the summer.

Chronic Fatigue Syndrome: A Study of Southwestern Montana Health Care Providers Diagnosis Criteria and the Treatment Plan

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This study is a way to qualitatively gauge the knowledge of Southwestern Montana Health Care Providers in regards to Chronic Fatigue Syndrome. CFS is “a debilitating and complex disorder characterized by profound fatigue that is not improved by bed rest and may be worsened by physical or mental activity” (CDC 2015). Additionally this study is used to better understand what diagnosis criteria is being used to determine and differentiate this difficult and controversial syndrome, and also the treatments which are being used to help in the healing process of patients suffering from CFS. This study will discuss the common practices in use in the Southwestern Montana region.

An Investigation of yhe Common Loon, (*Gavia Immer*), on Spencer Lake and Blanchard Lake, Montana: Identifying Populations of Banded and Non-Banded Birds of the Common Loon.

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Common Loon (*Gavia immer*) studies were conducted between May and August, 2014 at known loon territories in the Whitefish, Montana area. Data were collected on nesting pairs at Spencer Lake and Blanchard Lake, both of which are a few miles of Whitefish. Loon pairs were observed and behaviors recorded as well as leg-band identifications, foraging habits, territorial behaviors, chick stages, and nesting success. The study covered 46 hours of observational study. Based on prior data provided by the Montana Common Loon Working Group and the Flathead National Forest Service, it is possible to identify pairs that are returning to the same locations and remaining with the same breeding pair. This summer research provided valuable data including identification of nesting pairs on both Blanchard and Spencer Lake, adult band data from both of these lakes, and both lakes had chick hatch dates allowing for a comparison between both lakes of study noting their differences as possible causes for differing nest success and hatch dates between Spencer Lake and Blanchard Lake.

Metabolites, Metabolic Hormones, and Hematological Profiles in Mountain Goats (*Oreamnos Americanus*) Before the Breeding Season and During the First Trimester of Pregnancy

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Objectives were to evaluate the relationships among energy-related metabolites, hormones, and hematological variables in mountain goats (MG) before the breeding season and during the 1st trimester of pregnancy. Does were from herds in the Palisades (PAL) and NE Yellowstone (NEY) areas. Samples were collected from July to Aug. (before breeding season) and mid-Jan. (1st trimester of pregnancy). Sera was assayed for insulin (I), thyroxine (T4), triiodothyronine (T3), b-OH-butyrate (bOHB), blood urea nitrogen (BUN), and total protein (TP). Concentrations of TP did not differ ($P > 0.05$) between pregnant (P) and non-breeding season (NB) does. bOHB, I, BUN, and T3 concentrations, and the T3:T4 ratios were greater ($P < 0.05$) in NB does than in P does. Whereas, T4 concentrations were greater ($P < 0.05$) in P does than in NB does. Obviously, NB does have a different profiles of metabolites, metabolic hormones and select hematological variables compared to P does. In conclusion, these differences may be related to P does utilizing and partitioning nutrients to support placental and fetal growth and development. These differences may also be related to the effect of season, since there were no non-pregnant does were sampled in Jan. Another factor that may be important for interpretation of these differences is location. All NB does were sampled in the PAL, while all P does were sampled in the NEY.

BH3I-1 Derivatives Inhibit The Filamentous Growth of The Cea10 Strain of *Aspergillus Fumigatus*

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Recent and exciting advances in medical therapies for cancer and organ failures have greatly extended the life span of afflicted patients. However, these therapies often place the patient at risk for potentially lethal fungal infections. As the number of immunocompromised patients continues to rise, there has been an increase in associated opportunistic fungal infections. Treatment options for invasive mycoses caused by *Candida albicans* and *Aspergillus fumigatus* are surprisingly limited. *A. fumigatus* is the most common *Aspergillus* species associated with invasive pulmonary aspergillosis, accounting for over 60% of cases. *Aspergillus* grows as a filamentous mold with true hyphae originating from the germination of asexual conidia. *A. fumigatus* is not a dimorphic fungi as is the case with *C. albicans*, however, as both grow in hyphal form it seems possible that small molecules that inhibit the transition of *C. albicans* budded cells to hyphal growth (often referred to as the germination of blastoconidia) may also inhibit the germination of *Aspergillus* conidia. We tested BH3I-1 and derivatives against *A. fumigatus* strain CEA10 in YPD media. BH3I-1 and five of the derivatives inhibited at a 200μM concentration based on general observation via microscopy as well as eleven showing promising inhibition at possible different concentrations. Out of these inhibiting molecules, seven also shown inhibition within the prior *C. albicans* assay. We are currently employing a micro-plate reader to obtain quantitative levels of inhibition with increasing concentrations of molecule. Molecule 54 at the 300μM concentration showed similar inhibition to that of BH3I-1 at the same concentration.

Design And Development of Large Scale Data Collection for Eyes Free Text Entry

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Entering text on a touchscreen is challenging when users are unable to receive visual feedback due to their situation or disability. We are working on a recognition-based approach that attempts to infer the user's intended text from a sequence of noisy tap data. We need to gather large amounts of such eyes-free data to develop and test our recognizer. We first interviewed users in the low vision and blind community to explore the best ways to engage users in our data collection effort. With the information gathered in the interviews, we are developing a cross-platform data collection interface that will enable us to reach a large population of users who are visually-impaired. We will describe our current progress in the development of our eyes-free data collector.

Developing Reproducible Antibacterial Surfaces Using Thermal Imprint Technology

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Staphylococcus aureus is a naturally occurring bacterium carried in human respiratory systems and on skin. Dangerous *Staphylococcus* infections in hospitals are of specific concern due to the high traffic and open wounds that exist in such facilities. One way these facilities can prevent on-site contraction of *Staphylococcus* infections is through rigorous disinfection of surfaces exposed to human contact. While disinfection with cleaning solutions can be effective, this method provides only a temporary solution. In contrast to temporary disinfection of surfaces, another approach may be to prevent the spread of *Staphylococcus* infections by engineering surfaces that are inherently antibacterial. Physicochemical properties of bacteria and the surfaces on which they live can influence bacterial adhesion to a surface. Recently, studies have been conducted which examine the effect of nanoscale features on biological specimens. Researchers have found that particular patterns naturally dissuade bacteria from attaching to and contaminating surfaces.

To build on this research, further work to create a reliable, cost-efficient, and reproducible antibacterial surface is needed. In this project, potentially antibacterial surfaces will be developed using thermal imprinting. A non-pathogenic form of *Staphylococcus aureus* will be used as a model *Staphylococcus* organism to test and quantify bacterial health on such surfaces. Although medical facilities present an obvious market for such surfaces, these patterning techniques can be used on other surfaces such as door knobs and toilet seats. Because of the inexpensive fabrication methods and materials, this research could lead to antibacterial surfaces being made readily available to populations no matter their socioeconomic backgrounds.

Indigenous Community Impacts of Large Corporations in Arctic Communities: Specific Focus on Social Justice and Sustainability for the Swedish Sami.

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In recent decades more global attention has focused on the Arctic. This can be seen in the both the development of industries as well as the expansion of the Arctic Council's membership. Countries with at least some part located above the Arctic Circle are; Norway, Greenland, Canada, United States, Russia, Finland, and Sweden. The focus on the indigenous people, specifically the Sami of Sweden, presents a good case for assessing impacts of development on northern, Arctic, communities. Population density in Sweden is recorded as 21.4 people per square kilometer, with a higher population density in southern Sweden. The majority of the Sami people live in small to medium-sized communities, in remote regions, resulting in a disconnect with the modern world. One industry that is already present in the Swedish Arctic is mining, especially for ore and carbon. However, now other industries, including multinational enterprises (MNE's), such as Facebook, which recently built a new five acre data center near the Arctic Circle, are beginning to realize the opportunities the Arctic region and its environment have to offer. The question of how sustainable business can be conducted in the Arctic will be answered by analyzing the impacts on the

Sami communities and how people react and should react to these changes within their communities. This study analyzed current events through literature review and interviews of representatives from the impacted Arctic regions. The increased development has resulted in both negative and positive impacts such as reduction of land use, but increased employment opportunities.

Preparation For Using Fiber Optic Cables To Monitor Distributed Strain And Temperature Profiles In An Underground Mine Setting

Hannah Kuchinsky, Montana Tech-Undergraduate Research Program, Montana Tech of the University of Montana, Butte MT. 59701

Early detection of rock movement signaling imminent underground space or pit wall collapse in mines has the potential to prevent loss of life and serious injuries from mine disasters. Unlike most traditional instrumentation that provides data at a single point, fiber optic cables can be deployed in a network that allows continuous monitoring of distributed profiles of ground movement and temperature variations.

Researchers at Montana Tech and UW-Madison are collaborating to demonstrate that this fiber optic-based Distributed Strain and Temperature (DST) technology can be employed in an underground mine to reliably and accurately detect ground deformation of different characters, and fluctuating temperature profiles. The focus of the research is a field experiment that will be conducted at Montana Tech's Underground Mining Education Center (UMEC). In order to demonstrate the field performance of the technology under a variety of conditions, strain-sensing cables will be attached to the rock faces with grout and epoxy, and grouted into boreholes, and a temperature-sensing cable will be submerged to significant depths in two flooded shafts, allowing continuous monitoring of the water in the shafts and the air in the drift between. Data will compared to that collected using traditional geotechnical instrumentation and to predictions made using numerical models. Laboratory experiments and tests will be conducted to support the field deployment and modeling aspects.

This presentation summarizes the preliminary work done to support the field deployment, focusing on preparation/calibration of the cables, design and implementation of the laboratory experiments, and development of the field instrumentation plans.

Using Click Chemistry to Modulate the Aggregation of the Parkinson's Disease Protein

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Parkinson's disease (PD) is a neurodegenerative disorder characterized by the presence of protein aggregates called Lewy bodies. These plaques are primarily composed of oligomers of the protein α-synuclein (αS), which is a small protein of 140 amino acids that is natively unfolded, however the folding of this protein has been found to be accelerated in the presence of metal ions, particularly copper. One ideology that has been used for therapeutic removal of endogenous metal ions is chelation therapy. Click chemistry, or the Copper-Catalyzed Azide-Alkyne Cycloaddition (CuAAC), involves the reaction of an alkyne and an azide, resulting in the formation of a 1,2,3-substituted triazole. This reaction is well known for being extremely versatile, accommodating a wide variety of functionalized alkynes and azides. Recently,

click chemistry was used to successfully generate a copper chelator in situ where copper ions within protein deposits acted as both the catalyst and target of the reaction. We are looking to extend this ideology to PD therapy, by preparing a small library of click reagents that will be selectively activated in the Cu-containing aggregates of αS. Following the click reaction, the newly formed products will act as a Cu-chelator, removing the Cu from the protein thus aiding in the degradation of the Lewy bodies.

Seasonal Differences in Hantavirus Prevalencein Deer Mice Captured in Ranch Buildings in Southwestern Montana

Richard McEwen, Montana Tech- Undergraduate Research Program, Montana Tech of the University of Montana, Butte MT. 59701

Hantaviruses are widespread emergent zoonotic agents that cause unapparent or limited disease in their rodent hosts, yet cause acute, often fatal pulmonary or renal infections in humans (Bagamian et al., 2013). In the United States one rodent species, the deer mice (*Peromyscus maniculatus*) are the principal host of Sin Nombre virus (SNV), which causes Hantavirus Pulmonary Syndrome (Childs et al. 1994, Nichol et al. 1993). Mice spread the virus to each other when they come in direct contact. Males spread the disease more because they are more aggressive and bite each other when they fight (Bagamian et al. 2013). A previous study (Kuenzi et al. 2001) has shown that mice that live inside of ranch buildings in western Montana have a higher prevalence of antibodies to SNV than outside populations. This study also found that male mice were more likely to be infected than female mice.

A similar study was conducted in southwestern Montana testing seasonal effects instead of location. Knowing that indoor mice have higher antibody prevalence to SNV, mice were trapped in two ranch buildings during the summer and fall to examine seasonal differences in SNV prevalence in these populations.

Seasonal Differences in Hantavirus Prevalence in Deer Mice Captured in Ranch Buildings in Southwestern Montana

Richard McEwen, Montana Tech- Undergraduate Research Program, Montana Tech of the University of Montana, Butte MT. 59701

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Isolation of Essential Oils from Indigenous Montana Flora and Their Antimicrobial Effectiveness as a Non-Toxic Sterilizing Reagent Against Bacteria That Cause Food Borne Illness.

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Bacterial resistance and the negative effects of chemicals used to kill them have become a growing worldwide public health concern. The widespread use of antibiotics in medicine and Animal husbandry have caused bacteria adaptation to antibiotics. New drug discovery has become vital in fighting the war against drug-resistant bacteria such as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella epidermis*, which have posed considerable medical problems. Essential oils are a safe, generally non-toxic and relatively inexpensive alternative to synthetic chemical based antibiotics. Essential oils hydro-distilled from indigenous Montana flora will be explored for their antimicrobial effectiveness as a non-toxic sterilizing reagent against bacteria. We hypothesis that the oils of *Lomatium dissectum*, *Arctostaphylos uva-ursi* (L.), *Chimaphila umbellate* (L.), W. Bart *Prunella vulgaris* L , *Artemisia dracunculus* L, Spreng *Medicago lupulina* L., and *Balsamorhiza sagittata* will have significant anti-bacterial properties and variability that works to reduce bacterium's resistance.

Use of Fiber Optic Cables to Monitor Strain and Temperature in A Borehole, and Temperature Profile in A Flooded Shaft

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Researchers at Montana Tech are investigating the use of fiber optic cables for distributed monitoring of ground movement and temperature profiles. The highlights of Montana Tech's research with this Distributed Strain and Temperature (DST) sensing technology are:

- Deployment of special strain-sensing cable in a 300' deep borehole at a nearby mine in January, 2013. The cable was installed along with traditional inclinometer and time domain reflectometry (TDR) instrumentation to allow direct comparison of these technologies. Monitoring scans conducted after installation show that the fiber optic system detected ground deformation more than a month earlier than the inclinometer (the TDR data were inconclusive) and provided a more definitive determination of the depth of the movement, suggesting that its sensitivity and precision are higher than those of the other types of instrumentation.
- More recent deployment (fall 2013/winter 2014) of two cables to depths of 20' and 300' in a flooded shaft in Montana Tech's Underground Mining Education Center. Periodic monitoring of the water temperature profiles suggests fluctuations down to a depth of about 200' that could be seasonal, and/or could be related to the geothermal heat exchanger present in the shaft. Also, differences in the readings made using the two cables suggest that they do not provide the same data accuracy.

Although preliminary inspection of the data from these two field experiments provided some insight, a thorough analysis was not performed. This presentation will summarize the field deployment and data collection activities, along with interpretations based on comprehensive data analysis.

Designing an Edna Assay for River Otter (*Lontra canadensis*) Detection in Streams

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Environmental DNA (eDNA) is a highly promising field of survey science that hasn't been fully explored on mammalian species. The river otter species (*Lontra canadensis*), is a prime candidate for testing eDNA's uses and limitations with mammals. An eDNA primer was therefore designed that fully amplifies river otter DNA, but does not amplify any other species, including closely related ones . Candidate primer sets were generated using the computer programs BioEdit 7.2.5 , Mega6 , eprimer3 , and Life Technologies. Once primer set possibilities were identified, those with the most base pair differences in non-target species were selected and purchased. Then, using qPCR techniques, two primer sets (OTTER_2 and OTTER_3) were tested against thirteen target DNA samples and seventeen varying non-targets. The primers were effective in amplifying all target species, but also amplified many non-target species in later PCR cycles. Hence, an internal probe was additionally designed to add specificity for the OTTER_2 primer set. The probe was not as effective as decreasing non-target amplification as hypothesized, which lead to the prediction that the samples themselves may have been contaminated with river otter DNA. To test this, the non-targets that amplified despite the additional probe were re-extracted and run through qPCR with the OTTER_2 primer set. Any amplified results will be sequenced. If sequenced results produces otter DNA, the samples are contaminated and not indicative of assay specificity, if it produces non-target DNA, then the assay must be redesigned. It is the eventual goal to use this assay in management scenarios.

Evaluation of Differences in Body Composition and Carcass Characteristics in Lambs Divergent in Residual Feed Intake

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The objective of this study was to evaluate differences in growth performance, carcass characteristics and quality, and body composition in lambs selected for divergent residual feed intake (RFI). Mixed-breed 4-mo-old wether lambs (n = 65) were placed on a 47 d feeding trial in September, 2014 to obtain an estimate of individual intake. Residual feed intake, an efficiency measurement based upon the difference in actual and expected feed intake, was calculated for each lamb. Wethers with an RFI of one standard deviation greater (HIGH; less efficient; n = 6) or lower (LOW; more efficient; n = 6) than the mean RFI (approximately 0) of the 65 wethers were used in the present study. Lambs were processed, and organ weights and carcass data were collected in December, 2014. Performance measures were not affected ($P > 0.05$) by RFI class. Back fat thickness (BF) and yield grade (YG) were greater ($P < 0.03$) in HIGH lamb carcasses, while rumen weight ($P<0.005$), total GIT and viscera weights ($P<0.03$), and lung and trachea weights ($P<0.03$) were greater in LOW lamb carcasses. Regression of lung weight on hot carcass weight (HCW) indicated that lighter carcasses had

heavier lungs ($P < 0.02$, $R2=0.45$); this relationship was observed in both RFI classes (HIGH: $P < 0.04$; $R2 = 0.68$; LOW: $P < 0.04$; $R2 = 0.68$). In growing lambs, selection for RFI seems to affect fat deposition and visceral organ weights, although more research is necessary to understand the relationship between lung weight, RFI, and HCW.

Analysis of Craniofacial Skeletal and Soft Tissue Anatomy of the Eye in Relation to Reduced Visual Acuity in Humans

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Despite nearly 100 years of research, the etiology of juvenile-onset myopia is still unknown. However, given that millions of years of brain expansion and reduced facial prognathism have brought the frontal lobes to rest directly above the eyes, while the face has become situated directly beneath them, it is likely that these adjacent craniofacial characteristics are associated with functional constraints of the visual system. As a result, this study examined to what extent the myopic eye is associated with circumscribing hard and soft tissues of the skull.

This was carried out using magnetic resonance images and associated de-identified clinical data for 112 subjects. Linear and volumetric measurements of the eye, orbit, and craniofacial anatomy were obtained using AMIRA, and linear regression analysis and ANOVA were used to test for relationships between variables, and differences among vision groups.

Results showed that increased eye ($F = 2.93$, $p = 0.05$), orbital ($F = 7.28$, $p = 0.00$), and to a lesser extent ocular fat volumes ($F = 2.26$, $p = 0.109$), were associated with reduced visual acuity across the study sample. A larger eye relative to orbital volume was also associated with diminished vision ($F = 2.55$, $p = 0.083$) though at slightly above $\alpha = 0.05$. However, this relationship became statistically significant ($F = 3.13$, $p = 0.048$) when ocular fat was also considered (eye/fat+orbit). Outside of these eye, ocular fat, and orbital relationships, no other skeletal trait of the face or cranium were found to be associated with visual acuity.

Utilization of Electrospinning Technique to Decorate Nanofibers for Biomedical Applications

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Hydroxyapatite has long been recognized for its biocompatible properties. Because a modified form of this substance is found in up to 80% of human bone, the human immune system does not recognize it as foreign and therefore does not initiate an immune system attack. Hydroxyapatite has been used as scaffolding for bone repair, as well as for coating metallic implants. Additionally, hydroxyapatite has the ability to promote bone growth without dissolving in the human system. This substance presents great potential for treatment and repair applications in a physiological system.

Although hydroxyapatite has been demonstrated to have great biological applications, these applications all require a substrate for administration. Electrospinning technique provides technology for creating such a substrate. Electrospinning has been used to create drug delivery systems and scaffolds for tissue regeneration. The electrospinner manufactures tiny nano- or micro-sized fibers and when these nanofibers are layered, a thick nanofiber mesh results. This nanofiber mesh provides a surface for hydroxyapatite nanoparticle attachment.

In addition to electrospinning technique, the electrospinner also has the capabilities to "electrospray," or to create individual nanoparticles laid down on a metal collector plate. In

my research, I intend to electrospin a fiber mesh, and then use electrospraying to decorate the mesh with iron-doped hydroxyapatite nanoparticles. This endeavor involves the development and characterization of fabrication techniques for biomedical applications.

The Fantastic and the Modern Experience

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The genre of Fantastic literature deals with intersections of the natural and supernatural worlds. The fantastic experience is one of doubt, felt both by reader and protagonists as they attempt to reconcile a possible supernatural occurrence with the rules of the natural world. Cocteau's Les Enfants Terribles, examines the fantastic's role in the divide between childhood and adulthood, in which the fantastic and the natural worlds become the spheres of childhood and adulthood, respectively. Creative play allows children to fully experience the fantastic. However, the fantastic, like childhood, is fleeting and attempts to maintain it result in ostracism; the fantastic violates the accepted norms of the natural adult world. This research broadened the scope of research on the fantastic as a genre. Theories of the fantastic have been applied to literary texts written in the late 18th and 19th century, but have not been previously applied to modern texts, which go beyond the conventional fantastic experiences detailed in the works of Tzvetan Todorov and Rosemary Jackson. Todorov's definition of the fantastic classifies fantastic experiences themselves as brief, while Jackson's list of recurrent fantastic themes are best suited to works written before the establishment of the prevailing scientific paradigm. Modern literary perspective is rooted in psychological explanations for what was previously classified as fantastic. In modern literature, the fantastic's place as the divide between the "marvelous" and the "uncanny" is unsustainable and must be redefined so that modern fantastic experiences may occupy the spaces between freewheeling creativity and abnormal psychology.

Blogging and Tweeting about Teaching: Teachers' Perceptions of Informal Online Professional Networks

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This is a case study of teachers that use blogs and/or Twitter to connect with other teachers online. This purpose of the study was to examine the perceived benefits of teachers who use blogs and/or Twitter to connect with other teachers. Social media has the potential to create a connected network of professional colleagues beyond the constraints of face-to-face meetings. In this study bloggers were contacted and interviewed in regards to the benefits to participating in online interactions. Interview data were analyzed to determine perceptions about the benefits of blogging and/or Twittering. Preliminary analysis suggests that participants identified of potential benefits such as one that creates some emotional distance that it is more convenient to interact on their own time schedule, and that they are able to learn from these interactions. The results of the study indicate that online networks can help to overcome many barriers that prevent teachers from interacting face-to-face. Although these networks may not fit into traditional professional development schema, it is clear that teachers feel that they benefit professionally from their participation in these professional networks. However, the type of interactions that participants preferred (e.g. Skype, Twitter, blogs) were influenced by the specific barriers faced by the participant in building their face-to-face professional network.

Touchless Thermal Respiratory Monitor

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The ability to track a person's respiratory rate is a vital technology that has applications in medical procedures, sleep studies, and patient monitoring. Safety devices used to track breathing today, however, often require the use of wires and sensors that can create obvious restrictions in the patient's motion, ability to maneuver, or even sleep. The long-term objective of this research project is to build a system that can monitor breathing without coming into contact with the patient. The Touchless Respiratory Thermal Monitor will be built using a 1 pixel thermal sensor, 3-D printed parts, and a laser. The thermal sensor will be programmed to simply read temperature. In a later project improvements will be made to look for a temperature differential between the air that has been exhaled by the patient and the room temperature while the laser allows for proper alignment on the upper lip of the subject. A lack of this temperature difference would indicate that the patient has stopped breathing. Though the design is rather simple, complications are expected on replicating the respiratory pattern of a human. This design will incorporate a 3-D printed mouth and nose attached to a ventilator, a flow rate monitor, and a temperature-controlled bucket of water kept at 100°F. This will be compared to a human's respiratory pattern to ensure proper replication.

Life History Traits of Solitary Bees as Mediators of Responses to Climate-Warming: Phenological Shifts, Body Size, and Life Span

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Climate change threatens pollinators and plants due to temperature-sensitive species traits that affect pollinator-plant interactions. For example, climate-warming is causing shifts in seasonal pollinator activity and flowering periods (i.e. phenologies) that are species-specific in magnitude and direction, which has uncoupled pollinator-plant interactions. Additionally, environmental temperature during development may affect pollinator body size and life span, with implications for pollinator-plant interactions and pollinator fecundity. Species-specific responses to climate-warming indicate that certain pollinator and plant species may be more vulnerable to the negative effects of climate-warming than others. The goal of this study was to help pinpoint species of concern by experimentally determining the role of solitary bee overwintering life stage (adult vs. prepupae) as a mediator of responses to climate-warming. Using multiple bee species and temperature-controlled chambers, I subjected bees to eight manipulations, i.e. factorial combinations of two temperatures (warm vs. cool) and two durations of fall and winter (i.e. short and long). Bee emergence date, weight (before and after manipulations), and longevity following emergence were recorded. Results suggest that increased temperature may cause bees that overwinter as prepupae to advance their phenology more than bees that overwinter as adults, while bees that overwinter as adults showed a greater reduction in body size and life span compared to bees that overwinter as prepupae. These results indicate the potential for overwintering life stage to mediate bee responses to climate-warming and suggests that certain species may be more prone to either phenological responses or altered body size and life span.

Knee Joint Prosthesis: Mechanical Properties Evaluation of a Titanium Based Biomedical Alloy

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Although the technology behind biomedical implantations has grown vastly in the past few years many complications still exist. One of the most difficult of these complications to overcome is the difference in the mechanical properties of human bone and of current prosthetic implants. The research completed in this study investigated the change in mechanical properties, induced via heat treatment, of Ti-6Al-2Sn-4Zr-2Mo (Ti-6-2-4-2); a titanium based alloy containing: 6% aluminum, 2% tin, 4% zirconium, and 2% molybdenum. Ti-6-2-4-2 is a near alpha titanium alloy containing both alpha and beta phase stabilizers. These phase stabilizers allow for the formation of the material in two different crystal structures. The ratio of the crystal structures present in the final material induces a variety of changes in the mechanical properties of the material. A various range of heat treatments was carried out as to effect the amount of alpha and beta phase present in the material, and the tensile strength and microstructure of the material was then examined. From these two pieces of data many mechanical properties can be investigated and explained. Experimental research such this provides important preliminary information about the tested alloy's usefulness in the field of biomedical implantations.

Concurrency in a Real-Time Multi-User Simulation

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Current methods of Real-Time simulation involving multiple users are non-scalable, difficult to develop, difficult to maintain, and expensive. Concurrent computer usage is exploding. The ability to edit documents, 3D models, and interact with multi-user simulations by users who are remote from one another is an emerging technology. Current techniques do not scale well and require a large infrastructure investment. This research addressed issues in which existing infrastructure of the clients' PCs can be leveraged to the computational demands of distributed interaction. In this research, I investigated the feasibility, of a thin server – peer client architecture for real-time multi-user simulation. This project involved a number of issues in simulating a shared environment on multiple computers, with multiple users in real-time. These issues included: latency, synchronization of state, events, clients coming into or leaving the simulation, security, and privacy. Solutions for data conflict resolution that were investigated included distributed state verification (peer voting) and master-client (one or more clients are designated as arbiters of truth).

Macroinvertebrate Community Assemblage from Canyon Ferry to Great Falls Along the Missouri River

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The Missouri River represents a major resource for the state of Montana, both environmentally and economically. Understanding macroinvertebrate community assemblage provides insight into food web structure, helping to construct a biological foundation from

which water quality can be monitored now and in the future. A comprehensive description of macroinvertebrate assemblage between Canyon Ferry Dam and the mouth of the Sun River near Great Falls also serves as a marker for comparison of biologically similar reaches. In order to examine macroinvertebrate community structure between these locations, we used samples previously collected by Montana Fish, Wildlife, and Parks for a walleye larval study. After fish larvae were removed from samples, we sorted the macroinvertebrates as well as casings from debris and daphnia. Debris and daphnia were dried and weighed to obtain a comparative biomass, and macroinvertebrates were sorted and identified to the lowest taxonomic level (order or family, species dependent). They were also sorted into functional feeding groups for further analysis of community structure between these locations. Daphniidae were determined to be predominant in Canyon Ferry, Hauser, and Holter samples, while Ephemerellidae and Baetidae were also very common across all sample locations.

Poster Abstracts

Late Summer-Early Fall Photosynthesis in Cottonwood (*Populus deltoides*)

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Photosynthesis was investigated during late summer and early fall in a population of mature cottonwood (*Populus deltoides*) trees growing on the campus of MSU-Billings in southcentral Montana. Parameters related to photosynthesis were measured in situ with a Licor 6400XT Photosynthesis system. A diurnal fluctuation in assimilation was observed with a peak value of 17.0 uM m-2 s-1 CO2 fixed during mid-day. We examined the capacity for assimilation at a PAR of 4000 uM m-2 s-1 (approx. 200% full sunlight) and observed assimilation values as high as 17.6 uM CO2 m-2 s-1 with no indication of photoinhibition. *P.deltoides* also responded to high ambient CO2 (1600 umol M-1) where assimilation increased to 31.5 umol CO2 m-2 s-1 under 1000 uM m-2 s-1 PAR. We used an ACi curve fitting utility to obtain values of 104 mmol m-2 s-1, 117 mmol m-2 s-1 and 8.6 mmol m-2 s-1 for rubisco Vcmax, electron flow rate and triose phosphate utilization, respectively. Transpiration was 0.1-6.1 mmol m-2 s-1 and correlated with assimilation. Assimilation declined 37% from the earliest measurements on 23Sep to those taken on 15Oct. We conclude that photosynthesis continues in leaves of *P.deltoides* well into autumn despite shorter days and cooler temperatures, but with an adaptive response resulting in less CO2 fixation. Leaves can photosynthetically fix carbon, presumably stored as reserve carbohydrates well into late fall before the onset of autumnal leaf senescence.

Analysis of Human Versus Machine Translation Accuracy

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The purpose of this study was to determine whether significant differences exist in Chinese-to-English translation accuracy between moderate to higher-level human translators and commonly employed freely available machine translation tools. A Chinese-to-English language proficiency structure test and a Chinese-to-English phrase and sentence translation

test were given to a large sample of machine (n=10) and human translators (n=133) who are native Chinese speakers with at least 15 years of familiarity with the English language. Results demonstrated that native Chinese speakers with this minimum level of English proficiency were significantly better at translating sentences and phrases from Chinese to English, compared to the ten freely available online machine translation applications, which unexpectedly showed a considerable degree of variation in translation accuracy among them. These results indicate that humans with at least a moderate level of exposure to a non-native language make far fewer translation errors compared to machine translation tools. This outcome is understandable, given the unique human ability to take into account subtle linguistic variants, context, and capricious meaning associated with the language and culture of different groups.

Isolation and Characterization of an Allelochemical from Russian Olive, Elaeagnus Angustifolia.

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Plants excrete compounds that can be beneficial or detrimental to the receiving organism. The detrimental compounds are referred to as allelochemicals and typically inhibit growth, delay germination, and may result in death. Previous unpublished work at Rocky Mountain College has indicated that leaves of the invasive tree species, Russian olive, contain a substance that causes delayed germination and stunted root growth in radish bioassays. The main goal of this study is to extract, isolate, and characterize the compounds causing this delayed germination via bioassays and analytical chemistry techniques. Our current results indicate that extractions of leaves using polar solvents may contain an allelochemical. Future work will include separation of the extract with chromatography and the characterization of the compound. Implications off this research include better infestation management practices and potential applications in agriculture.

Pain Tolerance: Differences According to Sex and Sport

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Numerous studies have independently examined gender differences in experimental pain, but few have examined the different surfaces of play that may influence an athlete's pain tolerance. The present experiment examined the effects of race, gender, and sport on experimental pain tolerance and threshold.

Forty (10 female basketball, 10 male basketball, 10 female soccer, 10 male soccer) collegiate athletes were given two pain tolerance tests consisting of a cold water intolerance test (CWIT) and a tourniquet pain test (TPT). The CWIT measured the maximum length of time that each athlete could place his/her hand in an ice cold bucket of water (2°C). The TPT measured the maximum length of time that each athlete could repeatedly squeeze a hand grip dynamometer while blood was occluded from the arm. A series of ANOVA tests determined if there were significant differences in pain tolerances between race, gender, and sport.

Based on the results, there are no differences in pain tolerance when comparing sport;

however, there is a significance difference ($p < 0.05$) in pain tolerance when comparing race and gender. The CWIT shows that white females have a significantly higher pain tolerance than non-white females; however, there is no significant data that shows that white males have a higher pain tolerance than non-white males.

This data is beneficial for physicians, trainers, coaches, etc. because they now know to treat injuries of both males and females of indoor and outdoor sports equally because sport has no effect on pain tolerance.

Measuring Algal Growth in Agar for use on the International Space Station

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Through a NASA Hunch grant, we are attempting to grow algae in a semi-solid agar media for oxygen production on the International Space Station (ISS). Novel growing conditions are necessary to sustain algal cultures in the microgravity environment of space. The results show that algae can be grown on earth, embedded in agar, with a uniform growth pattern. A 3% agar growth media is cooled to 47OC and inoculated using a saturated liquid culture. The inoculated agar is poured into impact-resistant Nalgene® containers. Once solidified, the agar is exposed to near-IR (infrared) and near-UV (ultraviolet) lights for 13 hour light / 11 hour dark cycles. Within a Nanoracks one unit aluminum box, we are able to fit 3 Nalgene® containers, two of which have algae and one does not. An exact duplicate of this experiment will be launched to the ISS in July 2015 to compare algal growth in microgravity with algal growth in the lab. The long-term goal of this project addresses the use of algae to produce oxygen from carbon dioxide on the ISS.

An Entomological Study of the Transfer of Melatonin, Nicotine, and Zeranol from Tissue to Maggot

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Throughout daily life humans consume substances that are metabolized by the body and eventually secreted. When death occurs metabolism stops and substances are trapped inside the body for a limited amount of time. If the body is left out, eventually flies and other bugs will make their way to it and lay eggs. When the eggs hatch, maggots begin to eat the tissue of the body. Since the tissue contains the consumed substances they should be transferred to the maggots. This is important in forensics because any substances that have dissipated from the tissue of the body may still be found in the maggots. If the maggots are collected they can be analyzed to determine what substances they contain. Knowing what can and cannot be transferred is important, as well as knowledge of how long it will take different substances to dissipate from the body. To imitate dead human tissue, skinned pig muscle was soaked in solutions of melatonin, nicotine, and zeranol (an animal steroid). Maggots were introduced and allowed to feed on the tissue for 72 hours. Samples of maggots were collected

every 12 hours, as well as a sample of tissue at the beginning and end of the experiment. All samples were digested in nitric acid. Analysis on the GC-MS of each sample was compared to standards to identify the substances they contained.

Mycobacterium Tuberculosis Resistance to PZA

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The aim of this project is to understand the mechanism of horizontal gene transfer and, more specifically, how resistance arises via mutations in *Mycobacterium tuberculosis* (TB). In particular, its resistance to the drug Pyrazinamide (PZA) will be examined. I will conduct two phases of this research. The first will be to observe horizontal gene transfer in everyday bacteria. The second phase will be to insert the mutant pncA gene that confers PZA resistance to a competent, non-virulent bacteria, *E. coli,* and study the rate of transfer in PZA-resistant TB. By doing this, it will be possible to better understand the mechanisms by which PZA-resistant bacteria transfer resistance and learn more about the mutations of this disease.

Spatiotemporal Variationin Grassland Biomass and Forage Quality Across the Upper Yellowstone River Basin

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Spatial and temporal heterogeneity in the abundance of high quality forage is known to play an important role in migratory ungulate ecology. While many studies have documented how variations in the timing of start of growth and land use affect the availability of high quality forage across temperate landscapes, few studies have quantified how the abundance of high quality forage varies across these gradients. In this study we quantified how aboveground biomass, crude protein, and digestibility varied throughout the growing season in (1) grasslands that start growth early, mid, and late in the season and (2) in irrigated agriculture, private grasslands, and public grasslands and then used these estimates to (3)assess how the seasonal abundance of high quality forage differed in these start of season and land use classes in the Upper Yellowstone River Basin. We found that grasslands that start growth late in the season had up to 150% greater aboveground biomass, 20% greater crude protein, and 15% greater digestibility at its seasonal peak than grasslands that start growth mid and early in the season. Irrigated agriculture had up to 500% greater aboveground biomass, 90% greater crude protein, and 10% greater digestibility at its seasonal peak than private and public grasslands. Overall, the abundance of high quality forage was greater in the late start of season and irrigated agriculture grasslands. Understanding these landscape-scale variations in the abundance of high quality forage may provide important information for migratory ungulate research and management.

Online Professional Learning Networks

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As technological advancements are made in the social media world, more people are connecting for professional development this way. This study served as an update to a 2011 study conducted by Dr. Hilary Risser. The previous study established a base network of teachers that used blogs to communicate educational practices. The purpose of this investigation is to analyze the differences, similarities, and benefits of online versus face-to-face communication. Interviews with multiple math and science teachers were conducted first with an online survey, and followed up via Skype. Their blogs were examined to identify connections between these teachers so that a new network of communication could be established. Preliminary results show that since 2011, networks have grown. Moving forward, the contents of each blog will be assessed. One future goal is that the conclusion of this study could lead to better equipped online social media for education professionals to grow.

An Investigation of the Common Loon, (*Gavia immer*), on Spencer Lake and Blanchard Lake, Montana: Identifying Populations of Banded and Non-Banded Birds of the Common Loon.

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Common Loon (*Gavia immer*) studies were conducted between May and August, 2014 at known loon territories in the Whitefish, Montana area. Data were collected on nesting pairs at Spencer Lake and Blanchard Lake, both of which are a few miles of Whitefish. Loon pairs were observed and behaviors recorded as well as leg-band identifications, foraging habits, territorial behaviors, chick stages, and nesting success. The study covered 46 hours of observational study. Based on prior data provided by the Montana Common Loon Working Group and the Flathead National Forest Service, it is possible to identify pairs that are returning to the same locations and remaining with the same breeding pair. This summer research provided valuable data including identification of nesting pairs on both Blanchard and Spencer Lake, adult band data from both of these lakes, and both lakes had chick hatch dates allowing for a comparison between both lakes of study noting their differences as possible causes for differing nest success and hatch dates between Spencer Lake and Blanchard Lake.

In-Vitro Reconstitution of Sulfite Reductase from *Pseudomonas aeruginosa*

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Recent work has established a link between a ferredoxin:NAD(P)H oxidoreductase (FprA) and sulfite assimilation in members of the genus *Pseudomonas*. This suggested that FprA is a component of a novel sulfite reductase enzyme. That hypothesis is consistent with the fact that only one component of the well-characterized E. coli a8β4 sulfite reductase has been identified in *Pseudomonas* genomes; i.e the β siroheme subunit CysI is present but not the a flavoprotein subunit CysJ. This led to the hypothesis that FprA is a component of a novel sulfite reductase enzyme. Our aim is to test that hypothesis by in-vitro reconstitution using the purified proteins CysI and FprA. We have successfully overexpressed and purified FprA from *Pseudomonas aeruginosa*. The strategy for production of purified CysI has been complicated by the requirement for concomitant expression of CysG (siroheme synthase). We are also investigating the possibility that a downstream, overlapping reading frame (PA1837) may also be necessary for functional CysI production.

Forensic Application of Larvae Analysis to Detect Chemicals in Muscle Tissue

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Past events cannot be observed, that is where forensic toxicology comes into play regarding the detection of toxic amounts of chemicals. This is useful in the forensic science field because it allows death investigators to deduce if the body at the scene had been under the influence of any chemicals before death. The purpose of this research is to determine if maggots can uptake trace amounts of chemicals from muscle and to determine if this uptake can be detected and quantified. This research will specifically examine the toxicology of three common chemicals (alcohol, caffeine, and penicillin) as absorbed by fetal pig muscle. To do such, fetal pig thighs were removed and skinned then placed in individual solutions of alcohol, caffeine, or penicillin to soak for 24 hours. Once all the liquid was removed, maggots were placed on the muscle. Samples of maggots were collected every 12 hours for a total of 72 hours. The maggots were then frozen and later placed in a nitric acid digestion to create a liquid solution that was later analyzed using the GC-MS.

Biochemical and Functional Characterization of a Potential 2', 3'-Cyclic-Nucleotide 3'-Phosphodiesterase (CNPase) Found in Tumorigenic Fish Retroviruses

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Tumorigenic retroviruses cause seasonal cancer in fish. Many of these retroviruses contain an interesting unknown gene of cellular origin. Computational programs predict that this gene encodes a CNPase (2',3'-Cyclic-nucleotide 3'-phosphodiesterase). In mammals, the natural function of CNPase is unknown. The purpose of the experiment is to isolate and characterize the potential viral CNPase. Utilizing a vector from zebrafish endogenous retrovirus (ZFERV), the potential CNPase genetic sequence will be isolated and analyzed. Thereafter, the potential CNPase protein will be expressed and purified, and characterization will include enzymatic activity assays, inhibition activity studies, and NMR studies. Future studies involve functional characterization of the potential CNPase, including binding and transformation studies. Potential CNPase is predicted to function as an oncogene that promotes tumorigenesis in fish. Exploring this potential CNPase may aide in the treatment of affected fish as well as provide insight into the function of this enzyme in humans.

Identification of Potential Targets of the Grr1p SCF Ubiquitin Ligase in Fungi

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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. *C. albicans* can grow in different cell shapes, or 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 virulence. Several studies have implicated ubiquitin-dependent proteolysis in the regulation of morphogenesis, yet the mechanism by which this pathway does so is largely unknown. Previously, we have shown that deletion of the GRR1 gene results in the constitutive formation of filamentous growth forms. The Grr1 protein is a component of an SCF ubiquitin ligase system that selectively targets proteins for degradation. Thus, the loss of Grr1-mediated proteolysis presumably leads to the aberrant accumulation, and inappropriate activity, of a protein or proteins that induce filamentous growth. The spectrum of proteins targeted for degradation by Grr1 is not known. The goal of this project is to identify Grr1 targets in *Saccharomyces cerevisiae*, an experimentally tractable model system for pathogenic fungi. We are using a novel proteomics-based approach to isolate and characterize proteins that are ubiquitinated in a Grr1-dependent fashion. The successful identification of Grr1p targets will be important for developing a

working model of the pathways involved in the yeast to filamentous growth transition in pathogenic fungi.

Analysis of TacA Overexpression on Phenotypic Characteristics of *Sinorhizobium meliloti*

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Sinorhizobium meliloti is a nitrogen-fixing bacterium that forms a symbiosis with legumes. These bacteria colonize plant roots within nodules and undergo a novel cell cycle as a symbiont. Free-living in soil, it undergoes asymmetrical cell division with one round of DNA replication per cell cycle. We are interested in identifying cell cycle regulators and understanding their function during free-living growth and symbiosis. We hypothesize that TacA is a cell cycle regulator since deletion of the TacA ortholog in *Caulobacter crescentus* shows morphology, motility, and cell membrane defects. To test this, we examined IPTG-induced overexpression of tacA for exopolysaccharide, membrane, and motility defects. Our results show low IPTG levels decrease motility of wild type and ΔcbrA strains. Surprisingly, higher amounts of IPTG restore motility to each strain's original level. Additionally, tacA overexpression causes a membrane defect in WT that is similar to ΔcbrA, while tacA does not appear to regulate exopolysaccharide production. In conclusion, tacA overexpression has several cell cycle phenotypes, which makes it a good candidate for further investigation. *S. meliloti* is an important model organism, not only for its potential to replace synthetic nitrogen fertilizers, but also because it is related to bacteria that cause brucellosis and plant tumors.

The Role of Zic1 in Cranial Suture Formation

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The zic1 gene plays an important role in embryonic development, in part by regulating the expression of many other genes including the engrailed gene. Previous investigators have reported that abnormal engrailed expression shifts the location of cranial suture formation and affects gene expression in the developing sutures (Deckelbaum et al. 2012). Such defects may cause a premature fusion of cranial sutures, leading to a serious birth defect known as craniosynostosis. Dr. Andrew Wilkie (Oxford University) has found that mutations in the human ZIC1 gene cause craniosynostosis. He hypothesizes that the engrailed gene is abnormally regulated in patients with these ZIC1 mutations. In collaboration with the Wilkie lab, we are testing this hypothesis by injecting RNA derived from the human ZIC1 mutants into *Xenopus* frog embryos. The goal of our experiments is to observe whether the mutated human ZIC1 genes affect the expression of the engrailed gene in frog embryos, which we were able to show by in situ hybridization. The degree of abnormality of engrailed expression caused by the various human ZIC1 mutations corresponds to the severity of the patients' phenotypes. These findings provide a better understanding of the molecular mechanisms underlying craniosynostosis and suggest possible gene regulatory pathways.

A Bioassay of Montana Grassland Plant Resistance to Catechin: an Exudate of Spotted Knapweed, *Centaurea maculosa*

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Centaurea maculosa, or Spotted knapweed, is considered an invasive species in the Western United States, including Montana. It has established sizeable populations and displaced native plant communities through what is believed to be a result of the plant's exudate, catechin. Catechin is an allelochemical documented to have phytotoxic, antimicrobial, and chelating properties. Current methods of remediation (biological, mechanical, and chemical) have demonstrated limited degrees of success. It is hypothesized that the degree of resistance to catechin of neighboring plant species determines the degree of knapweed invasiveness. The goal of this research is to test Montana native grassland species for resistance to catechin. Assembling a bioassay on agar plates, Montana grassland seeds will be grown in the presence and absence of catechin. The degree of resistance for each respective grassland species will be assessed through percent germination, root length, and shoot length. In identifying a Montana native grassland species with catechin resistance, the species could provide potential means of remediation and prevention.

Rescuing Convergent Extension after Inhibition of an Aquaporin

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Much is known about the function of aquaporins within individual cells. Aquaporins are membrane protein channels that are permeable to water and a subset, the aquaglyceroporins, are also permeable to glycerol. Little research has been conducted on how they contribute to larger processes such as gastrulation. Gastrulation organizes embryos into germ layers, which will later form different body tissues. Convergent extension cell movements are critical for driving gastrulation. During convergent extension, cells fold into the embryo at the dorsal lip of the blastopore and then merge to help form the long body axis. An aquaglyceroporin, aqp3b, is expressed during convergent extension. When it is inhibited using a morpholino oligonucleotide, convergent extension does not occur properly. Since this process is difficult to manipulate in whole embryos, I explant and culture the dorsal lip of the blastopore region of embryos, which then undergoes convergent extension by growing long and narrow protrusions. When aqp3b is inhibited, these protrusions do not develop. My project focuses on rescuing the convergent extension defects caused by inhibiting. If rescue methods are successful, explants will form a long and narrow protrusion as observed in control embryos. For these experiments, 4-cell embryos are injected into the dorsal blastomeres and explants are cut at early gastrula stage. So far, I have achieved 25-35% convergent extension in control explants. I plan to achieve 80% convergent extension and will then begin the rescue experiments.

Riverine Dissolved Organic Matter Decomposition and Dynamics

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Aquatic and terrestrial ecosystems are intimately linked through the transfer of energy and materials. A common example of ecosystem linkage is the input of terrestrial dissolved organic matter (DOM) to rivers and streams. DOM can play a variety of roles in stream ecosystem function by fueling local food webs, influencing trophic state, and affecting the dissolved nutrient availability. Microorganisms utilize, transform, and produce DOM during microbial metabolism, a relationship that links microbes to DOM quality and quantity. Chemical and physical properties are known to vary with DOM source, and thus the type of terrestrial input may dictate how DOM is processed in a stream. Using laboratory microcosms, and added terrestrial organic matter substrates, we carried out a leaching experiment over forty-five days. We employed a suite of complementary techniques to determine the effect of leaching DOM sources on microorganisms, DOM processing, and ecosystem function. Microbial community composition changed from the original stream water inoculum and depended on DOM source. Cell abundances for all DOM sources spiked after two days, after which abundances dropped and remained relatively steady until the end of the experiment. DOM concentrations decreased exponentially with the maximum amount of carbon utilization taking place within the first five days. The DOM fluorescent signature, initially influenced by amino acid-like fluorescence shifts to more humic-like character over the course of the experiment, indicating DOM humification over time. Our results showcase the advantages of interdisciplinary tools to elucidate the connection of microbial processing, DOM chemistry, and ecosystem function.

Sequencing and Characterization of Canine Viral Genomes

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Some viruses, like canine parvoviruses, are known to infect both human and canine hosts. Currently there is a significant lack of information about canine viruses, as a result there is no conclusive way to evaluate whether a virus is capable of cross species infection. Another problem that stems from this lack of information is that screening for viruses in sick canines is rarely practiced and instead antibiotics are almost exclusively the choice remedy. Improper use of antibiotics will not stop viral infection and may create antibiotic resistance as well as cause further discomfort to sick dogs. The goal of this research project is to isolate and sequence viral strains, to drastically improve the genome databases for other scientists to use, and conduct phylogenetic analysis to characterize found viruses. To accomplish these goals, fecal samples will be taken from sick and healthy canines noting in detail any symptoms the dog is exhibiting. The viral DNA/RNA is extracted and purified using a specially designed kit. After extraction the viral DNA/RNA is amplified and the products are sequenced.

The newly sequenced viruses will be compared to each other as well as known strains to aid in characterizing their type. Using the information that corresponds to each sample, characterized viruses will be correlated to symptoms found in canines. By expanding the known information about viruses, it may be used later to determine more viruses that infect both human and canine hosts as well as a way to better diagnose sick dogs.