# Montana Academy of Sciences

## 2016 Annual Meeting

### April 8-9, 2016

### 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 2016 Annual Meeting at Montana Tech in Butte, MT. on April 8 and 9. Over 100 registrants participated, viewing 13 contributed oral presentations and 13 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 7 and 8, 2017 in Butte. Finally, the Board of Directors of MAS would like to thank the sponsors of our 2016 Annual Meeting:

Dr. Doug Coe, Dean, College of Letters, Sciences & Professional Studies, Montana Tech

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

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# Presentation Abstracts

**Alphabetical by First Author's Last Name**

## Corrosion Inhibition: The Investigation of Lanolin on the Corrosion of 1018 Carbon Steel in Commercial Sea Water

Stephen Broddy, Montana Tech, Butte

There is a high demand for an environmentally friendly and cost-effective corrosion inhibitor. Due to the relatively low viscosity (high capillary action), commercially available polymeric lanolin has been used as a biodegradable corrosion inhibitor in addition to a natural lubricant for marine steel applications. In this work, corrosion of lanolin-saturated 1018 steel was investigated while completely submerged in stagnant seawater under local atmospheric conditions. Samples were immersed in commercial sea salt solution and analyzed at regular intervals. Determination of corrosion rate change, hardness variation and variation in surface microstructure of each specimen was executed on both standard and lanolin-treated 1018 steel specimens. At this point in the work, lanolin-treated 1018 steel samples retain polymeric coat and infer a high resistance to corrosion under long-term submersion. SEM-based analysis has inferred substantial corrosion attack occurring at the standard sample periphery compared to lanolin-treated samples. The addition of lanolin to the surface of the sample displayed a relatively low consistency in corrosion rate calculations compared to the standard sample.

## Stormwater in Silver Bow and Blacktail Creeks: Implications for the Microbial Community

Jordan Foster, Chemistry and Geochemistry Department, Montana Tech, Butte
Dr. Alysia Cox. Chemistry and Geochemistry Department, Montana Tech, Butte

Silver Bow and Blacktail Creeks are the headwaters of the Clark Fork River and are impacted by historic mining activities in the area. Although metal concentrations of runoff into the creeks are monitored and reported in previous studies, the composition and diversity of microbial communities are unknown. We seek to identify the microbial communities present and investigate changes in community structure due to stormwater impact, thereby determining and monitoring the overall environmental health of the system. We sampled five sites in Silver Bow and Blacktail Creeks in Butte, MT for chemical and biological analyses during high stormwater flow events. Water samples were collected for analysis of major anions and cations, metal concentrations, dissolved inorganic and organic carbon and carbon isotopes and hydrogen and oxygen isotopes in water. In situ measurements of pH, temperature and dissolved oxygen were taken at the time of sampling. Redox sensitive species - total dissolved sulfide, dissolved silica and ferrous iron - were measured using wet chemical tests and field spectrophotometry. Concurrent biological samples were collected for microbial identification and diversity (DNA), activity (protein), quantity (cell counts) and culturing. Overall microbial results are in progress, but water chemistry data provide clues about microbial habitats available in the creeks. Results upstream in Butte will be compared to downstream areas such as Durant Canyon and the Warm Springs Settling Ponds. The relationship between water chemistry, microbes, and overall ecosystem health can be characterized by deciphering how water chemistry affects microbial activity and vice versa.

## Touchless Thermal Respiratory Monitor

Robin Hallett, Electrical Engineering, Montana Tech, Butte
Jonathan Schulz, Electrical Engineering, Montana Tech, Butte

An abnormal respiratory rate and changes in respiratory rate can give an early indication of physiological disorders such as a stroke or heart failure. Also, many drugs prescribed for pain or sedation carry the risk for respiratory depression. Medical devices used to track breathing today 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 a patient. The goal of the current project is to optimize the functionality of the sensor and prove functionality by testing on human subjects. The Touchless Thermal Respiratory Monitor was built using a thermal sensor, 3-D printed parts, and a laser. The thermal sensor was programmed to read temperature, and in this project, the location yielding the greatest temperature differential between the air that has been exhaled by the patient and the room temperature will be found. The laser will allow for proper alignment of the thermal sensor to this location. The temperature difference will be monitored and plotted in MATLAB in order to track the respiratory rate. Irregular signals or a lack of signal would indicate that the patient is having breathing problems, or that the patient has moved out of the sensors path.

## Nuclear Magnetic Resonance Spectroscopy Metabolic Profiles to Distinguish Geographically Isolated Populations of Mountain Goats

M. Rashelle Herrygers, Department of Animal and Range Sciences, Montana State University, Bozeman
Jesse R. White, Department of Animal and Range Sciences, Montana State University, Bozeman
Jennifer M. Thomson, Department of Animal and Range Sciences, Montana State University, Bozeman
Valerie Copie, Department of Chemistry and Biochemistry, Montana State University, Bozeman
Brian Tripet, Department of Chemistry and Biochemistry, Montana State University, Bozeman

Basic physiological studies on mountain goats (*Oreamnos americanus*) are conspicuously lacking in the literature, and the physiology of this species is perhaps the least known of the high mountain ungulates. The objective of this study was to evaluate metabolic profiles of female mountain goats from five geographically distinct populations using Nuclear Magnetic Resonance (NMR) spectroscopy. Serum samples were collected from nannies located in Alaska in September (AK) from Glacier in August (GMT), from the Grand Tetons in November-December (GT), from NE Yellowstone in December (NEY) and from Absaroka in March (AB). Serum was extracted with acetone, dried and re-suspended in a standard NMR buffer. NMR spectra were analyzed with Chenomix™ software. Metabolites were identified and concentrations determined using the Chenomix™ database and the Human Metabolome Database. We identified 55 metabolites in the serum of mountain goats using this emerging technology. Of these 42 metabolites differed among the herds ($P < 0.05$). Of these 42 metabolites; creatinine, lactate and pyruvate distinguished ($P < 0.05$) each herd from another. Furthermore, using Principal Component Analyses of these metabolites allowed us to clearly differentiate metabolic profiles in carbohydrate, protein and lipid metabolism in nannies from these five populations. This study has the potential to enhance our understanding of how changes in nutrition, reproduction, susceptibility to disease, and survival rates drive population dynamics.

## 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

Samantha Miner, Chemistry Department, Montana Tech, Butte
Dr. Katie Hailer. Chemistry Department, Montana Tech, Butte

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.

## Piezoelectric Energy Harvesting System

Chau Duc Minh Ha, Geophysical Engineering Department, Montana Tech of the University of Montana, Butte

This project investigates the behavior of two types of piezoelectric harvester in response to different applied strains. Three tests are performed: two Deflection Amplitude vs. Voltage Generation tests and an Energy Charging Rate test. The two deflection tests are done on a Volture energy harvester and a piezoelectric disk. The energy charging rate test is done on a pair of piezoelectric disks. The strain test on the Volture energy harvester show inconsistent relationships between a piezoelectric harvester's natural frequency and its ability to generate voltage. The strain test on the piezoelectric disk are also not clear either since the voltage generated varies greatly after each tap. The results from the energy charging rate test indicate that a piezoelectric harvester generates energy at a higher rate when subjected to a higher-frequency vibration source than to a lower-frequency one. Future studies are recommended to make comprehensive conclusions regarding the relationships between a piezoelectric harvester's natural frequency and its ability to generate voltage. Further researches regarding vibration sources are also recommended as finding a suitable vibration source is found to be the most challenging part of this project.

## The Association of Lexile Level and Reading Comprehension While Multitasking

Colin Norick, Columbia Falls High School, Columbia Falls, MT

The purpose of this study is to provide data to examine the use of cellphones, specifically texting, in relation to reading comprehension, and analyzing the relationship with Lexile scores. The Lexile framework quantifies reading comprehension of the reader and of the text. Initially, 47 participants completed leveled reading comprehension tests, one without texting and one while texting. Students performed 9% worse on reading comprehension while texting

compared to non-texting and performed 6% worse on long-term memory questions on the material while texting. We conclude this is due to increasing the cognitive load by texting. As a follow up, 57 participants texted during both tests, one test at their Lexile and one test at a Lexile 250L lower. Participants performed 56% better on reading comprehension when the material was 250L below their level and 28% better on long-term memory questions. Overall, texting while completing reading comprehension tests had an adverse impact on performance, but decreasing the Lexile led to a statistically significant improvement over what should be expected through just decreasing the Lexile score by decreasing the cognitive load These results identify this relationship for more research and eventually might affect what reading level textbooks are written at to increase comprehension.

## Indices of Body Composition and Repeatability of Residual Feed Intake in Growing Columbia Ewes Fed the Same Diet

Katharine A. Perz, Department of Animal and Range Sciences, Montana State University, Bozeman
James G. Berardinelli, Department of Animal and Range Sciences, Montana State University, Bozeman
Lauren N. Park, Department of Animal and Range Sciences, Montana State University, Bozeman
Robin K. Pollard, Department of Animal and Range Sciences, Montana State University, Bozeman
Chad M. Page, Department of Animal and Range Sciences, Montana State University, Bozeman

Residual feed intake (RFI), an efficiency measurement based upon the difference in expected and actual feed intake, is used to improve production efficiency of livestock. The purpose of this study was to evaluate the repeatability of ewe RFI measured for two consecutive years, and to investigate the relationship between indices of body composition in yearling ewes and RFI. Two trials, using the same Columbia ewe lambs ($n$ = 17) were conducted in consecutive years (2014, 2015) using the same diet. RFI was calculated for each ewe each year. RFI did not differ ($P$ = 0.77) between years. Each year, ewes were separated into RFI classes (LOW (efficient); MOD (average); HIGH (inefficient)). In 2014, ewe lamb performance did not differ among classes ($P$ > 0.3). In 2015, dry matter intake was greater for HIGH ewes ($P$ < 0.0002). Ribeye area (REA; $cm^2$) and backfat thickness (BF; cm) were measured by ultrasound on day 0 (start of trial), 17, and 45 (end of trial) in 2015 and used to calculate estimates of final body composition. RFI classification did not affect REA or BF ($P$ > 0.25). There was a trend for whole-body muscle mass to differ among RFI classes ($P$ = 0.09), but no other body composition estimates were affected. Results suggest that RFI is repeatable; however, indices of body composition seem to be independent of RFI in Columbia ewes fed the same diet under similar conditions.

## Properties of 3D Printed PLA with Additives

Lucas Reif, Montana Tech, Butte

As the technology of 3D printing increases rapidly in today's world, so too does the list of properties desirable in a finished, printed project. One way to improve said properties is to include additives in the material a 3D printer utilizes. The research program combined talc and mica with the PLA plastic presently used in many 3D printers. The end purpose was to measure the additives' effects on the strength and other properties at different additive proportions. The behavior of the new PLA printing filament was evaluated so that an optimal additive amount could be recommended.

## Information Technology use at Montana Tech

Lance Revenaugh, Montana Tech, Butte
Gunnar Kayser, Montana Tech, Butte
Hunter Gappmayer. Montana Tech, Butte

In today's world, there is something very valuable that is ever changing and advancing every single day. That is technology. More specifically, the use of technology in educational settings, such as colleges and universities, has advanced phenomenally in the last fifteen years. Students, along with faculty/staff alike have been branching out and exploring new advances in technology for both personal and educational use. The purpose of our project was to find a connection between educational and personal usage of technology in students along with faculty and staff. With that, we plan to create an annual survey issued to both students and faculty, to ultimately find better ways to utilize technology in education for the population at Montana Tech.

## The Effects of Climate-Driven Phenological Shifts on Plant-Pollinator Interactions and Plant and Pollinator Reproductive Success

Anthony Slominski, Department of Ecology and Environmental Sciences, Montana State University, Bozeman

Climate-warming is causing shifts in seasonal flowering periods and pollinator emergence dates (i.e., phenologies) that are species-specific in magnitude and direction, which has altered the amount of phenological overlap between coevolved plant and pollinator species. The objective of this project was to experimentally investigate the effects of such phenological shifts on plant-pollinator interactions and plant and pollinator reproductive success. To achieve this, I controlled the phenologies of forbs and solitary bees such that spring and summer flowering forb species flowered at the same time and spring and summer emerging bees emerged at the same time. Blooming forbs and emerged bees were then placed in mesh-sided enclosures following a factorial design based on their phenological life histories (i.e., spring or summer). Forb-bee interaction patterns were assessed by conducting bee visitation observations and documenting the quantity and duration of bee visits to flowers. Plant reproductive success will be determined by quantifying the number and mass of seeds produced for each plant species. Bee reproductive success will be assessed by determining the identity and quantifying the number of offspring produced in bee nests housed within each enclosure. Empirical evidence generated by this study will elucidate underlying mechanisms driving the effects of climate change on plants and pollinators and will help pinpoint plant and pollinator species most vulnerable to the negative effects of climate change. Results will contribute to a better understanding of the ecological effects of climate change on species interactions and inform conservations strategies.

## 18-Beta-Glycyrrhetinic Acid Causes Increased Pigment Production and Decreased Adherence in Methicillin Resistant Staphylococcus Aureus Biofilms

Alan J. Weaver, Jr., Dept. of Chemistry & Biochemistry, Montana State University, Bozeman
Abigail Van Vuren, Dept. of Chemistry & Biochemistry, Montana State University, Bozeman
Dr. Valerie Copie, Dept. of Chemistry & Biochemistry, Montana State University, Bozeman
Dr. Martin Teintze, Dept. of Chemistry & Biochemistry, Montana State University, Bozeman
Dr. Mary Cloud B. Ammons, Dept. of Chemistry & Biochemistry, Montana State University, Bozeman
Dr. Jovanka Voyich, Dept. of Microbiology & Immunology, Montana State University, Bozeman

Infections caused by Methicillin Resistant Staphylococcus aureus (MRSA) are an ever growing concern in the health care field. While MRSA is most known for its resistance to beta-lactams (i.e. penicillin), it has also acquired resistance to a number of other antibiotics. MRSA plays a major role in chronic wounds due to its ability to form a biofilm, resulting in severe infections. Biofilms are naturally more resistant to antibiotics than planktonic cells which can be due to their extracellular polymeric substance and slow growing nature, as well as metabolic differences. This has resulted in biofilms becoming a major focus in the biomedical field. As MRSA rapidly acquires resistance to currently available antibiotics, there is an urgent need to develop novel antimicrobials. 18β-Glycyrrhetinic acid (GRA) is a compound isolated from *Glycyrrhiza glabra* and has been shown to be an effective antimicrobial against Staphylococcal planktonic cells; however, investigations on biofilm activity appear to be lacking. Our studies show GRA to have minimal to no effect on biofilm bacterial counts; however, post-treatment observations included an increase in yellow pigment and decreased adherence of biofilms. S. *aureus* pigments play an important role in virulence, including oxidative stress that may be introduced by antimicrobials like GRA. Crystal violet staining of GRA treated biofilms showed a quantified reduction in adherence compared to controls. This suggests that GRA may cause biofilm dispersal and therefore increased susceptibility to current antimicrobials. 1H NMR metabolomics is being conducted to investigate these results and other metabolic changes in GRA treated biofilms.

## Toxicity of Ammonia and Nitrite to Aquatic Macroinvertebrates

W. Tom Willingham, Dept. of Chemistry, Montana State University, Bozeman
Robert V. Thurston, Dept. of Chemistry, Montana State University, Bozeman
Robert J. Luedtke, U.S. Environmental Protection Agency, Office of Research and Development, Athens, GA
Rosemarie C. Russo. U.S. Environmental Protection Agency, Office of Research and Development, Athens, GA

The acute toxicity of ammonia was studied for six aquatic macroinvertebrate species (mayfly, stonefly, and caddisfly families). Two partial-chronic (24- and 30-day) tests were conducted on *Pteronarcella badia*. The acute toxicity of nitrite was studied for seven species, including one Diptera species; the mitigating effect of chloride ion on nitrite toxicity to two species was also investigated. For 6 tests on ammonia the median lethal concentration (96-hour LC50) values ranged from 1.8 to 5.0 mg/L un-ionized ammonia (NH3); in 19 tests less than 50% of the larvae died at the highest test concentration, so an LC50 could not be calculated. In the partial-chronic tests on P. *badia*, food consumption was not affected at concentrations up to 6.9 mg/L NH3, but concentrations in excess of 3.4 mg/L NH3 adversely

affected nymphal survival rates and emergence of adults. For nitrite toxicity, test results showed a wide range of tolerance. The 96-hour LC50 for the single species of Diptera exceeded 123 mg/liter NO2-N; the 96-hour LC50 range for the other tests was between 0.25 and 2.4 mg/liter NO2-N. The addition of 10 mg/liter chloride ion in nitrite tests on P. *badia* and *Ephemerella grandis* resulted in a 3- to 10-fold decrease in 96-hour LC50 values. The tolerance to ammonia of the most sensitive of the insect species tested was greater than that reported in the literature for most species of fishes. Except for A. *variegata*, the range of acute toxicity of nitrite to the insects tested was similar to that reported for fishes.

# Poster Abstracts

**Alphabetical by First Author's Last Name**

## The Effects of a Large River Impoundment on River Channel Complexity: Implications for Macroinvertebrate Community Structure (Poster)

Niall Clancy, Montana State University, Bozeman
Eric Scholl, Montana State University, Bozeman
Wyatt Cross, Montana State University, Bozeman

Nearly all major rivers are affected by impoundments or other forms of flow regulation. Downstream of dams, river geomorphology is often altered by changes in sediment load and flow regime, which may influence key habitats for biota. Our study examined the impact of Fort Peck Dam on downstream habitat complexity (i.e. proportion of off-channel habitats), and associated macroinvertebrate communities in the Missouri River, MT. We used aerial imagery and GIS software to quantify habitat complexity at four sites between Fort Peck Dam and Lake Sakakawea. Additionally, macroinvertebrates were sampled in the main channel and off-channel habitats in April and July 2015 at the same locations as habitat quantification. Following sampling, macroinvertebrates were taken to the laboratory where they were counted, identified to the lowest practical taxonomic level (usually genus), and measured to the nearest millimeter to estimate biomass using length-mass regressions. Preliminary data indicate that the number and area of off-channel habitats were significantly reduced immediately beneath the dam. Additionally, off-channel habitats contained unique macroinvertebrate communities that had higher abundance and biomass estimates compared to macroinvertebrates in the main-channel. These communities were primarily dominated by oligochaetes and chironomid midges.

## Snorkel Research on Anadromous Fishes (Poster)

Conner Holbrook, Dept. of Biological and Physical Sciences, Montana State University – Billings
Kim Apperson, Idaho Fish and Game, Boise
Matthew Amick. Idaho Fish and Game, Boise

Dam construction has had a large impact on anadromous fish in the Pacific Northwest. All anadromous salmonids in the Pacific Northwest have been deemed as endangered species. In addition, climate change, and commercial and sport fishing have also had an impact on the anadromous populations. As a result, state and federal organizations have made an effort to augment populations with hatcheries, habitat restoration, and improved fish passages through dam systems. In efforts to understand the tributaries and spawning grounds used by chinook

salmon and steelhead trout, the Idaho Department of Fish and Game has created population research groups in the form of snorkel crews. One goal of the snorkel crew was to gain a better understanding of which tributaries are frequented by each species of fish. Snorkel transects consisted of regular sites that were snorkeled annually, as well as sites chosen at random. Transects were lengths of water from 65 to 200 meters long. Snorkelers moved in a serpentine pattern through the stream to cover maximal area. Fish size, number and species were recorded only after fish were passed by a snorkeler. Periodically, the snorkeler would relay data to a person nearby designated to data collection. Sites were chosen at random to be evaluated using a mark re-sight method to estimate efficiency. Anglers fished an area, caught fish were marked and recorded and then released. After fishing the site was left untouched for at least 24 hours before it was snorkeled. After snorkeling an in depth habitat evaluation was conducted.

## The Intertwined Successional Development of the Lamb Gut Microbiota And Immune System (Poster)

M. M. Lachman, Department of Animal and Range Sciences, Montana State University, Bozeman
S. Ishaq, Department of Animal and Range Sciences, Montana State University, Bozeman
S. Olivo, Department of Animal and Range Sciences, Montana State University, Bozeman
M.R. Herrygers, Department of Animal and Range Sciences, Montana State University, Bozeman
J. Swartz, Department of Animal and Range Sciences, Montana State University, Bozeman

Gastrointestinal tract (GIT) microbes play critical roles in host nutrition, health and immunological development. For adult ruminants, GIT-dwelling microbes provide ~70% of daily energy requirements. The GIT also houses 70 % of the animal's immune system in the form of the Gut-associated Lymphatic Tissue (GALT), which houses 80% of all plasma cells and depends on microbial stimulation for maturation. Because nutrition and disease are two major factors in the economic sustainability of livestock production, our group set out to characterize the successional development of GIT microbiota and immune activity. Blood and GIT samples were collected from lambs immediately at birth through one-year of age, and from the dam's vagina, mouth, and rectum at parturition. Blood samples were profiled for serum titers of IgM, IgA and IgG, while microbiota were profiled in GIT samples by 16S rRNA gene sequencing. Lamb GIT microbiota initially resembled the dam's vaginal microbiota but following exposure to the dam, became rapidly more similar to the dam's teat. GIT samples eventually formed stable climax communities similar to the dams around 180 days of age. This corresponded to the peak serum titers for each immunoglobin, which, aside from a peak in IgG at birth (likely colostral transfer), had gradually increased prior to this time. Immunoglobins peaked and then return to a sub peak level between 180 and 365 days. These results indicate dam vaginal microbiota have a short-lived impact on the neonatal microbiota, with the GIT microbiota going through a dynamic successional development to 180 d when immune function appears to peak.

## Determining the Place of AQP-3B in the WNT/CA2+ Noncanonical Pathway (Poster)

Oscar Machado, Cell Biology and Neuroscience Department, Montana State University, Bozeman
Jennifer Forecki, Cell Biology and Neuroscience Department, Montana State University, Bozeman
Christa Merzdorf, Cell Biology and Neuroscience Department, Montana State University, Bozeman

During *Xenopus laevis* gastrulation, convergent extension is required for the mesoderm to extend into the embryo and shape the embryonic body plan. Recent results from our lab suggest that the inhibition of aqp-3b prevents convergent extension of the mesoderm and that aqp-3b acts through noncanonical Wnt signaling. Wnt signaling is a key signal pathway for embryo and tissue development. There are two types of Wnt signaling pathways, the canonical and the noncanonical pathways. There are three separate branches to noncanonical Wnt signaling. Our lab has shown that aqp-3b acts through the noncanonical Wnt/Ca2+ pathway and that it acts upstream of the cytoplasmic Wnt signaling pathway member Disheveled. The Frizzled7 membrane receptor is part of the noncanonical Wnt/Ca2+ pathway and also acts upstream of Disheveled. I will test, whether in this signaling cascade, aqp-3b acts upstream or downstream of Frizzled 7. Thus, I will test whether Frizzled 7 activates aqp-3b, if aqp-3b activates Frizzled 7, or if aqp-3b is bypassed and Frizzled 7 activates disheveled. When Frizzled 7 is active, GFP-labeled protein kinase C (PKC-GFP) relocates from the cytoplasm to the plasma membrane. Thus, I will inject either PKC-GFP alone, PKC-GFP + fz7, or PKC-GFP + fz7 +aqp-3bMO (to inhibit aqp3b) into two-cell *Xenopus* embryos and examine under a fluorescence microscope whether the PKC is bound to the membrane (Wnt signaling active) or remains in the cytoplasm (no Wnt signaling). With this procedure the place of aqp-3b within the Wnt/Ca2+ pathway will be determined.

## CRISPR/CAS9 Gene Editing to Study Mammalian Iron Transport and Iron Homeostasis (Poster)

Katy Martin, Biochemistry, Montana State University, Bozeman
Sarah Bloch, Biochemistry, Montana State University, Bozeman
Martin Lawrence, Biochemistry, Montana State University, Bozeman

The CRISPR-Cas9 gene editing system is a 2 component system that utilizes the Cas9 protein and a sgRNA to target and knock-out a desired gene. The target gene is physically mutated by creating a double strand break in the DNA sequence of the targeted portion of DNA. Subsequent repair of the double strand break by cellular machinery typically leads to insertions or deletions (indels) that disrupt the gene, such that the gene is rendered nonfunctional. We are using CRISPR-Cas9 to knock-out genes involved in mammalian iron transport, specifically those of the transferrin cycle. Our first target is Steap3, a transmembrane ferric-reductase that reduces Fe(III) to Fe(II) for subsequent transport across the membrane into the cell by DMT1 (Divalent Metal Iron Transporter 1). Our specific strategy for the CRISPR/Cas9 knock-out of Steap3 and our progress towards this goal will be presented.

## Characterization of the Effects of Small Molecules on Mountain Pine Bark Better Fungal Symbionts (Poster)

Stephanie Maxwell, Dept. of Biological and Physical Sciences, Montana State University, Billings
Joy Goffena, Dept. of Biological and Physical Sciences, Montana State University, Billings
David Butler, Dept. of Biological and Physical Sciences, Montana State University, Billings
Kurt Toenjes, Dept. of Biological and Physical Sciences, Montana State University, Billings

Several species of the bark beetle, in particular the Mountain Pine Beetle (*Dendroctonus ponderosae*), are responsible for killing large numbers of trees over vast areas in western North America, including over 31 million trees in Montana. Most or all of these bark beetle species are host to a variety of ophiostomatoid fungi. Many of these fungi are carried in the mycangia, a specialized structure of the exoskeleton, and are critical nutritional mutualists to the beetle's life cycle. Thus, one possible means of controlling or managing a beetle outbreak is to inhibit the growth of their associated fungi. These fungal spores are also indirectly introduced to the tree interior where they invade the phloem and sometimes the xylem of the tree that can possibly disrupt the water flow. Therefore, another possible prevention method might be inhibiting the fungi from mycelial growth on the tree itself. The first stage of this research is to test whether small molecule inhibitors are able to prevent growth for the fungal species associated with mountain pine beetles, (*Grosmannia clavigera* and *Ophiostoma montium*). The fungal species have shown sensitivity to the small molecule inhibitor, BH3I, especially G. clavigera. Because BH3I has potent antifungal activity, we will test its derivatives in hopes of finding additional small inhibitor molecules to effectively obstruct fungal growth. We can then begin testing different concentrations of the effective small molecules on the fungi, and furthermore, we can develop a tree-like environment to begin examining the effects of the inhibitors on the xylem and phloem of trees.

## Screening Montana Native Grass Species for Resitance to Spotted Knapweed Exudate Catechin (Poster)

Christopher Prescott, Rocky Mountain College, Billings, MT
Dr. Mark Osterlund, Rocky Mountain College, Billings, MT

It has been reported that catechin is an exudate of spotted knapweed (*Centaurea maculosa*). Documented to have chelating, antimicrobial and phytotoxic properties, catechin is believed to contribute to spotted knapweed's ability to displace native plant communities. Originating in Europe, it is considered an invasive species in the Western United States and is recorded to have established populations in all fifty-six counties in Montana. Select plant species in Europe have demonstrated resistance to catechin without community displacement. It is hypothesized that the degree of resistance to catechin of neighboring plant species determines the degree of knapweed invasiveness. Using agar plates and several Montana grassland species, a bioassay was created to assess the degree of resistance of native grassland seeds to catechin. Assessed through percent germination, root length, and shoot length, the degree of resistance for each species was assessed. Identifying a Montana native grassland species with catechin resistance could provide potential means for knapweed prevention.

## Follicular Development of Beef Heifers Exposed to Bulls During an Estrus Synchronization Protocol that Included a 14-D CIDR, PGF2 ALPHA and Timed Artificial Insemination (AI) and GNRH (Poster)

Luis E. Ramos, Montana State University, Bozeman
Shaun A. Tauck, Montana State University, Bozeman
Jarod R .C. Wilkinson, Montana State University, Bozeman
Jesse R. Olsen, Montana State University, Bozeman
Tiothy Gibbs, Montana State University, Bozeman

The objective was to evaluate the effect of presence of a bull on ovarian follicular development and its relationship to fertility in beef heifers using an estrus synchronization protocol that included a progesterone (P4)-containing, controlled internal drug release devices (CIDR) for 14 days, PGF 2alpha (PG, and, timed AI (TAI) and GnRH. Heifers were then assigned randomly to be exposed to bulls (BE; $n = 41$) or not exposed to bulls (NE; $n = 38$). Heifers were exposed to bulls on the day of CIDR insertion (d -32) and remained with bulls until day 3 (d 0 = day of PG injection). The heifer bull ratio was 20 to 1. CIDRs were removed 14 days (d -18) after insertion. On day 0 each heifer was injected with PG and bulls removed from BE heifers. Ovaries of each heifer were imaged ultrasonically. Heifers were observed for estrus during the next 60 h, 2x daily. Diameters of the DF at the time of CIDR removal and PG injection (d 0) did not differ between BE and NE heifers and averaged 10.3 ± 0.3 mm (mean ± SE) and 10.9 ± 0.3 mm, respectively. There was no difference in number of antral follicles between BE- and NE-treated heifers (1.7 ± 0.1 and 1.5 ± 0.1, respectively). Diameter of DF did not affect the proportion of heifers that showed estrus or time to estrus of heifers in either treatment. Diameter of DF increased ($P < 0.05$) linearly as body condition score (BSC) increased. Presence of mature bulls during an estrus synchronization protocol that included a CIDR for 14 days does not appear to influence ovarian follicular dynamics or the expression of estrus after PG in beef heifers. This may not be the mechanism whereby the presence of bulls increases fertility in the bovine. However, the relationship between DF diameter and BCS supports the concept that "more fit" females ovulate larger follicles which in turn improve fertility.

## Relationship of Athletic Injuries to the Sport's Season (Poster)

Jessica Ream, University of Great Falls, Great Falls, MT
Chloe Cross, University of Great Falls, Great Falls, MT
Robert Packer, University of Great Falls, Great Falls, MT

There are many factors that contribute to a college athlete's risk for injury. Previous studies have shown that life stress can be a predictor for injury. The current study investigated if academic stress plays a role in athletic injury rate. Data collected from the university athletic trainer between 2012 and 2015 on athletic injuries was analyzed. Results indicate that season start and end dates play a role in when injuries occur. No evidence was found for academic events such as mid-terms and finals influencing the rate of injury. These findings suggest that the rate of injury for a given sport may be classified as being predominantly early-season, predominantly late-season, or predominately mid-season. Further research is needed to determine the individual factors for each sport that may explain the changes in rate of injury.

## Rescuing Convergent Extension after Inhibition of an Aquaporin (Poster)

Kaitlyn See, Department of Cell Biology and Neuroscience, Montana State University, Bozeman
Christa Merzdorf, Department of Cell Biology and Neuroscience, Montana State University, Bozeman

Much is known about how aquaporins function within individual cells. Aquaporins are membrane protein channels that are permeable to water and a subset, aquaglyceroporins, are also permeable to glycerol. Little research has been conducted on how they contribute to larger processes such as gastrulation. Gastrulation organizes cells into germ layers, which will later form different body tissues. Convergent extension cell movements are critical in driving gastrulation. During convergent extension, cells that folded into the embryo at the dorsal lip of the blastopore 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, which we assay using Keller tissue explants from gastrula embryos. The aquaporin aqp2 and aquaglyceroporins aqp7 and aqp9 were cloned in order to conduct rescue experiments to determine whether it is the water or glycerol permeability of Aqp3b that functions in convergent extension. I have successfully cloned the aqp7 coding region, but errors made by Taq polymerase introduced mutations into the aqp2 and aqp9 sequences. I am still working to resolve these issues. In the meantime, I have begun to determine how Aqp3b interacts with noncanonical Wnt signaling, the primary signaling pathway involved in convergent extension, utilizing the same techniques. The embryos are injected with the aqp3b morpholino oligonucleotide, as well as the mRNA for a protein involved in noncanonical Wnt signaling. If convergent extension is rescued in the explants, then Aqp3b acts though noncanonical Wnt signaling.

## Inquiry, Pedagogy and Technology: Automated Textual Analysis of 30 Refereed Journal Articles (Poster)

David A. Thomas, University of Great Falls, Great Falls, MT

The storehouse of human knowledge and experience is vast, complex, messy and growing exponentially. To cope with the information explosion, scholars in many knowledge domains rely on sophisticated information technologies to search for and retrieve records and publications pertinent to their research interests. But what is a scholar to do when a search identifies hundreds of documents, any of which might be vital or irrelevant to his/her work? More and more scholars are turning to automated content analysis technologies to achieve what they do not have time to do themselves; characterize the global features of a large corpus of work and identify relationships between significant concepts and themes. This study is an informal analysis of 30 refereed journal articles identified using Google Scholar and the keyword set {inquiry, pedagogy, technology, and mathematics or science}. Mathematics (15) and science articles (15) published between 2014 and 2016 were selected, downloaded, and analyzed using Leximancer (http://info.leximancer.com/), a textual analytics tool that extracts an unbiased dictionary of terms from source documents, discovers concepts, and constructs a thesaurus of terms associated with each concept. Findings are presented using textual, tabular, and graphical formats.

## Characterization of the Effects of Exogenous Camp Combined on *C. Albicans* Morphogenesis in Strains Lacking NRG1P, RFG1P, or TUP1P (Poster)

Brandon Van Tassel, Dept. of Biological & Physical Sciences, Montana State University, Billings
Kurt A. Toenjes. Dept. of Biological & Physical Sciences, Montana State University, Billings

The opportunistic human pathogen *Candida albicans* causes both superficial and lifethreatening 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. Many studies have implicated cAMP in the regulation of morphogenesis. cAMP acts to activate 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 oHWP1 in the absence of each of the negative regulators. This will help us better understand the signal transduction cascade that controls morphogenesis in C. *albicans*.

## Using Nuclear Magnetic Resonance Spectroscopy to Develop Physiological Profiles for Bighorn Sheep (Poster)

Jesse R. White, Department of Animal and Range Sciences, Montana State University, Bozeman
M. Rashelle Herrygers, Department of Animal and Range Sciences, Montana State University, Bozeman
Jennifer M. Thomson, Department of Animal and Range Sciences, Montana State University, Bozeman
Valerie Copie, Department of Chemistry and Biochemistry, Montana State University, Bozeman
Brian Tripet, Department of Chemistry and Biochemistry, Montana State University, Bozeman

This study employs new techniques using nuclear magnetic resonance (NMR) to assess the relative health, physiological condition, and reproductive function of wild bighorn sheep (*Ovis canadensis*) in Montana and Wyoming. Ongoing bighorn studies in Montana and the Greater Yellowstone Ecosystem are focused on herd attributes and the population dynamics which are affected by disease, climate, habitat and physiology. Indices of herd health and physiological status are typically obtained through expensive and time consuming lab assays and field measurements. Recently, NMR spectroscopy has been used to revolutionize the assessment of human metabolic health, and we expect that there is similar potential for studies of wildlife populations. Using NMR spectroscopy to assess metabolites associated with disease, nutrition and stress may eliminate the need for many traditional assays and techniques used today. NMR can be used to evaluate a large suite of metabolites associated with a variety of physiological functions from as little as 500 uL of serum or plasma. Blood samples from 242 sheep from 13 different herds were collected during the winters of 2013-14 and 2014-15 to develop a comprehensive metabolite panel for bighorn sheep. We have used a recently developed statistical program known as MetaboAnalyst™ to begin to analyze and evaluate differences in NMR metabolic profiles among herds and across the fall-winter season when nutritional and physiological stress is expected to be acute. We will be presenting the results of this preliminary study and discussing the potential for application in wildlife management.