2016 STUDENT RESEARCH CELEBRATION

GRADUATE ABSTRACTS

Sorted by Student Major

COLLEGE OF AGRICULTURE

Melissa Rashelle Herrygers: Animal & Range Sciences
Mentor: James Berardinelli, Robert Garrott -- Animal & Range Sciences, Ecology

Pregnancy rates, metabolites and metabolic hormones in bighorn sheep during and after the breeding season

Wildlife managers routinely draw blood and harvest serum when bighorn sheep and other ungulates are captured for management and research purposes. Serum samples are routinely submitted to state livestock labs that perform a panel of assays to access exposure to a variety of important pathogens that cause disease, providing managers important insights. Wildlife managers would also benefit from similar procedures that could provide assessments of reproduction, nutrition, and physiological status. The objectives of this preliminary study were to evaluate pregnancy rates, energy-related metabolites and hormones among herds of Montana and Wyoming bighorn sheep during and after the breeding season in order to assess the general 'health' of herds. Metabolites and metabolic hormones are frequently used in domestic animals to evaluate nutrition, reproduction and energy balance, and potentially may provide the same insights in wildlife for managers. A total of 240 bighorn ewes were sampled from 13 herds between December 2014 and March 2015. Samples were assayed for progesterone (P4) and pregnancy specific protein B (PSPBs) to assess reproductive cycling and pregnancy. Assays were also performed for non-esterified fatty acid, insulin, triiodothyronine and thyroxine which are metabolites and metabolic hormones that indicate nutritional and energy states of animals. We will be presenting the results of this preliminary study and discussing the relationship between pregnancy rates, energy-related metabolites and hormones and how they might be used to inform wildlife management.

Acknowledgements: Jesse White (MSU Undergrad Student) - Cell Biology & Neuroscience, Carson Butler (MSU Graduate Student) - Ecology,

Katharine Perz: Animal & Range Sciences
Mentor: Jennifer Thomson -- Animal & Range Sciences

Repeatability of residual feed intake and indices of body composition in growing Columbia ewes fed the same diet

Residual feed intake (RFI), an efficiency measurement based upon the difference in expected feed intake for a given weight and growth rate and actual feed intake, is used to improve production efficiency of domestic ruminants. The purpose of this study was to evaluate the repeatability of RFI of sheep measured for two consecutive years, and to investigate the relationship of indices of body composition in yearling ewes and RFI. Two trials, using the same Columbia ewe lambs (n = 17 per trial) were conducted in consecutive years (2014, 2015). Ewe were fed for 47 and 45 days, respectively, beginning in September of each year. The diet, an alfalfa-barley pellet, was the same feed for both years. RFI was calculated for each ewe in each year. RFI did not differ (P = 0.77) between years, indicating that on the same diet and environmental conditions, RFI does not appear to change with age. In 2015, ribeye area (REA; cm2) and backfat thickness (BF; cm) were measured by ultrasonography on day 0 (start of trial), 17, and 45 (end of trial). These variables were used as indices of body composition for determining if low RFI (efficient) or high (inefficient) ewes partition nutrients into either muscle or fat. RFI classification did not affect REA (P = 0.15) or BF (P = 0.25). Interestingly, both REA and BF increased (P < 0.01) from day 0 to 17 and BF increased again from day 17 to 45. Within each day, BF and REA were linearly related (P < 0.04). Thus, RFI is repeatable; however, indices of body composition seem to be independent of RFI in Columbia ewes fed the same diet under similar conditions.

Acknowledgements: Chad Page (MSU Graduate Student) - Animal & Range Sciences, James Berardinelli (MSU Faculty Member) - Animal & Range Sciences

COLLEGE OF ENGINEERING

Barkan Sidar: Chemical & Biological Engineering
Mentor: James Wilking, Seth Walk, Diane Bimczok -- Chemical & Biological Engineering, Microbiology & Immunology
Human Intestinal Organoids on a Millifluidic Chip

Organoids are millimeter-scale tissues that replicate the structure and function of naturally formed organs. These tissues are grown in the lab through the directed differentiation of stem cells and have potential uses in biotechnology. Human intestinal organoids (HIOs) serve as a model system for the small intestine and offer potential in regenerative medicine, drug formulation testing, and microbiome research. HIOs are roughly spherical in shape, with an inner volume of aqueous liquid enclosed by a tissue shell. This closed structure is adequate for short-term experiments, but lack of liquid flow through the intraluminal space leads to buildup of waste and cellular debris and precludes the use of organoids for experiments lasting longer than several weeks. Here, we describe the use of millifluidic techniques to structure the HIO in such a way as to facilitate advective transport, thus extending the time over which HIO are viable. Our results could enable the use of HIOs for long-term experimentation.

Acknowledgements: Jonathan Martinson (MSU Graduate Student) - Microbiology & Immunology, Jason Spence (University of Michigan) - Cell and Developmental Biology, Thomas Sebrell (MSU Postdoc/Research Scientist)

INTERDISIPLINARY PROGRAMS

Jordan Richards: Health & Medical Sciences (WWAMI)
Mentor: Florence Dunkel -- Plant Sciences & Plant Pathology
Malaria's Connection with Nutrition, Pre-Inoculation and Post- Disease State; as applied to the village Sanambele, Mali

Malaria and malnutrition (under-nutrition, protein energy malnutrition) have been recognized as two of the world's most prominent epidemics, specifically in Africa. Although the topics are important to understand individually, their relevance is critical to one another. The epidemic is much more complicated than just assessing malaria and malnutrition. It is a combination of availability of food, time, climate, education, and family dynamics. This paper looks at the connection between nutritional and health status and the severity of cerebral malarial (*Plasmodium falciparum*) symptoms and the relevance of the connection to the availability of food in the village of Sanambele, Mali. Information was obtained by an extensive peer-referred literature search using three different databases. Secondly, in-depth interviews with health professionals, nutritionists, and Mali site mentors were conducted to glean detailed information about specific topics. It was concluded that a state of malnutrition has negative effects on the performance of the immune system when fighting off a disease and infection, specifically malaria. When availability of food supplies is at their lowest, the state of malnutrition increases, unfortunately this coincides with the onset of the malaria season in sub-Saharan Africa, including Sanambele.

Acknowledgements: Ibrahima Traore (Principal) – Bamako, Mali

COLLEGE OF LETTERS & SCIENCE

Christopher Barbour: Mathematical Sciences
Mentor: Mark Greenwood -- Mathematical Sciences
Supervised Clustering of CSF Proteins to Examine Disease Severity in Multiple Sclerosis Patients

Traditional clustering is considered an unsupervised learning technique, where we do not have a response or class label that we are trying to model relationships on. These methods are interested in finding groups of subjects or variables within a dataset that are similar in some sense within groups and dissimilar between groups. Recently, a body of research has been developed to attempt so called "supervised clustering", where effort is put into finding groups of variables that are similar within and dissimilar between as before, but also have a relationship with a response of interest. I will briefly discuss an overview of one such method, namely the averaged gene expression method of Park et al. (2007) and present an application of the method on CSF protein data that is used to predict disease severity in multiple sclerosis patients as well as levels of CNS tissue destruction.

Laura Brutscher: Microbiology & Immunology
Mentor: Michelle Flenniken -- Plant Sciences & Plant Pathology
Honey Bee Transcriptional Response to Virus Infection

Honey bees are significant plant pollinators in agricultural and non-agricultural landscapes. Since 2006, annual losses of managed honey bee colonies in parts of North America and Europe have been high (e.g., US 33% loss). Colony losses are influenced by biotic and abiotic factors, including (+) ssRNA virus infections. Honey bees have evolved antiviral defense mechanisms, including RNAi and additional immune pathways. However, their relative roles in antiviral defense are not well understood. To better understand honey bee dsRNA-triggered immune responses, bees were infected with a model virus (Sindbis-GFP) with or without dsRNA. In our experiments, dsRNA, regardless of sequence specificity, reduced virus production. To investigate the mechanisms of dsRNA-mediated immune responses in honey bees, we utilized RNAseq to examine transcriptional responses triggered by virus +/- dsRNA. We identified more than 200 differentially expressed genes in bees coinjected with dsRNA and virus. Virus-infected bees had greater expression of genes involved in RNAi, Toll, and JAK-STAT pathways, but the majority of genes with increased expression are not well characterized. Further investigation of these genes will yield a better understanding of dsRNA on bee physiology and antiviral defense and may lead to identification of evolutionarily conserved sequence-independent dsRNA-mediated immune pathways in other organisms.

Acknowledgements: Katie Daughenbaugh (Research Associate) - Plant Sciences & Plant Pathology

Julie Gameon: Psychology
Mentor: Monica Skewes -- Psychology
Attitude Change and Bystander Intervention in Sexual Assault Prevention Programs

Sexual assault is a common problem on college campuses across the nation, and female college students are at the highest risk of experiencing a sexual assault. Prevention programs targeted at changing attitudes and teaching bystander intervention demonstrate success in prevention education when presented together. This study examined college students' awareness about sexual assault and self-efficacy to intervene using bystander intervention as part of a prevention program developed and implemented by a university advocacy center. Participants included 475 college students age ranged from 17 and 43 years (M= 20.09, SD= 2.68) and included both female (49.7%, n= 236) and male (50.3%, n= 239) students. The measure used for this study was developed specifically for the program and had strong internal consistency (α =. 78). The measure consisted of 9 questions assessing awareness about sexual assault and 4 questions assessing self- efficacy to intervene as a bystander. We compared mean scores on the pretest and posttest evaluations using an independent sample t-test. Posttest evaluations scored higher than pretest on the attitude subscale $t(677)= -6.77$, $p<.05$. There was not a significant change on the self-efficacy subscale. Attitude change is an important and necessary part of sexual assault

prevention, but is not sufficient. Since the bystander interventions have the best evidence, low self-efficacy is a notable barrier to prevention programs.

Acknowledgements: Joe Schumacher, Hannah Stark, Alanna Sherstad (MSU Voice Center)

Russell Hoeldtke: Psychology
Mentor: Matthew Vess -- Psychology
Finding Meaning In Fantasy: Fantasy Proneness Attenuates the Relationship between True Self-Knowledge and Meaning in Life.

Theory and research suggest that people's subjective feeling of knowing who they truly are (i.e., perceived true self-knowledge; PTSK) positively contributes to meaning in life. This suggests that people low in PTSK are vulnerable to deficits in meaning. In the current research, we aimed to identify a factor that might attenuate the effect of being low in PTSK on meaning in life. We hypothesized that people low in PTSK may attain meaning from fantasy. Participants in two online studies (N = 401) completed measures of PTSK, fantasy proneness, and meaning in life. Both studies supported our hypothesis by demonstrating that the relationship between PTSK and meaning in life was weakened for people high in the tendency to engage in fantasy based experiences (i.e., fantasy proneness). Looked at differently, fantasy proneness positively predicted meaning for people low in PTSK. These findings suggest that engagement with fantasy serves a meaning providing function for people who may otherwise have difficulty constructing meaning in life (i.e., those low in PTSK).

Mary Levandowski: Mathematical Sciences
Mentor: John Borkowski, Andrew Ray -- Mathematical Sciences, Montana Institute on Ecosystems
River Discharge for the Lamar, Madison, and Yellowstone Rivers for Calendar Year 2015

Discharge data for the Lamar River, Madison River, and Yellowstone River for calendar year 2015 were examined and summarized with hydrographs. Hydrographs for the Lamar River near Tower Ranger Station (LMR), Madison River near West Yellowstone (MDR), and Yellowstone River at Corwin Springs (YRCS) exhibit a general pattern of high early summer flows and lower baseflows occurring in late summer and extending into fall. The hydrographs for YRCS and LMR are indicative of snow-melt driven systems while the hydrograph for MDR suggests greater contributions from groundwater. In 2015, flows were near or below the historic mean at each station. Daily flows at MDR were similar to the 25th percentile of flow from 1913-2015 with peak flows below 30-year median flows. The daily flows at YRCS and LMR were above the 25th percentile of long-term flows with peak flows occurring earlier in the year than the historic mean.

Jeffrey Richards, Cody Tyler: Chemistry & Biochemistry
Mentor: Robert Szilagyi -- Chemistry & Biochemistry
Investigation of C-H bond Substrate Activation in Nickel(0)-Phosphine-Olefin Complexes using DFT Based Electronic Structure Methods

Central to the formation of organic compounds is the desire to create regio- and chemoselective C-C bonds between complex molecules. The utilization of a nickel-containing homogenous catalyst has been reported to give C-C bound biaryl products with the aid of a unique bisphosphine ligand. Furthermore, a heterogeneous catalyst employing immobilized phosphine ligands and a palladium metal center have been reported to play a crucial role in the coupling between two aryl moieties. By mapping the potential energy surface of a corresponding model system via DFT based computational methods, we are able to ascertain transition state geometries critical to the original reaction's mechanism. Starting with a neutral $[Ni(PPh_3)_4]$ complex, preliminary results suggest the reaction begins with a rearrangement of the ligand environment, allowing for the coordination of the substrate as a ligand preceding an oxidative addition step. Thus, we first evaluated the speciation of a Ni-PPh_3-olefin system and identified the most likely catalytically active species capable of oxidative addition. Before further investigation towards elucidating the role of the various available ligands present in the reaction, such as substrate oxazole and benzimidazole, we carried out a detailed analysis to address the appropriate level of theory by charting out the basis set saturation limit. This allowed us to use the most experimentally sound electronic structure method with

the highest predictive power. Through examining the thermodynamic traits of relevant starting materials, intermediates, and products, we are provided with crucial information relevant to reaction dynamics such as kinetics and energetics.

Woodcock-Medicine Horse: American Studies
Mentor: Robert Rydell -- History & Philosophy
Traditional Ecological Knowledge: Fertile Ground for Contemporary Museums

Mainstream and tribal museums are ideal venues to educate the public about climate change and the anthropocene, inspiring youth visitors to craft the imaginative solutions needed for our future. My research examines how large museums are tackling these issues and how their knowledge can benefit smaller museums. Most Indigenous cultures share sophisticated knowledge and moral lessons through parables and symbolism communicated through stories. Enduring Indigenous ideas such as "we are all related", "seventh generation", and the "honorable harvest", are concepts that have functioned for millennia, ensuring survival through changing times. Indigenous methodologists teach us that storytelling and relationship building are key methods of conveying cultural knowledge. The Smithsonian's National Museum of the American Indian's annual Living Earth Festival adeptly addresses social and environmental injustice without alienating their visitors and donors. In many tribal museums cultural sustainability often trumps environmental sustainability as even more urgent, leading to an interesting dichotomy between academia and the museum community. Traditional Ecological Knowledge/ Native Science is a focus of the Indigenous Education Institute and partners, funded by the National Science Foundation. IEI created two ground breaking research projects, The Cosmic Serpent, and Native Universe, exploring the cultural disconnect between Native and Western scientists and educators, and working on bridging Native Science into mainstream museums. The exemplary exhibit "Roots of Wisdom" was created through Native Universe, by The Oregon Museum of Science and Industry in collaboration with tribal partners, providing a model for working collaboratively with tribes to create stories of inclusive, proactive environmentalism.

Acknowledgements: Henrietta Mann (Emeritus, Montana State University), William Wyckoff (Montana State University), Leah Schmalzbauer (Amherst University)

2016 STUDENT RESEARCH CELEBRATION

UNDERGRADUATE ABSTRACTS

Sorted by Student Major

COLLEGE OF AGRICULTURE

Colburn Field: Agricultural Economics & Economics
Mentor: Anton Bekkerman -- Agricultural Economics & Economics
Supply Chain Responses to Pulse Crop Cost Dynamics

The recent oil extraction and development boom in the Bakken formation has affected rail services throughout Montana and North Dakota. This change in rail availability coupled with the increased implementation of pulse crops into Montana crop rotation could have had an effect on grain elevator's service decisions throughout the areas of the state where these two influences overlap. The purpose of this investigation is to examine how these changing forces in the supply chain have resulted in changes in costs, and subsequently profits, for the elevators in the Northeast counties of Montana, where pulse crops have the largest foothold. The primary effect for elevator costs will be in regards to capacity for crop storage versus the availability of rail car service for moving commodities. A large backlog due to scarcity of rail cars and the influence of more crops being produced in the area per growing season can cause an elevator to need to invest in larger storage capacity, or in producers self-selecting to larger more streamlined elevators in other locations, which can affect revenues for local elevators. Data will be gathered using phone surveys, and the subsequent recordings will be transcribed and analyzed to determine elevator responses to changing constraints. The qualitative data will be compared to quantitative data on pulse production and elevator transport reports, in order to grasp the scale of the increase of crop production in these areas. The resulting findings will be synthesized into a visual infographic, for presentation and distribution to interested parties.

Kendra Hertweck: Plant Sciences & Plant Pathology
Mentor: Michael Giroux -- Plant Sciences & Plant Pathology
Transcriptisome Analysis of Bread Wheat Rht Mutants using RNAseq

Plant height is an important characteristic in wheat since modern semi-dwarfing varieties yield more than tall varieties. A key gene involved in this process in wheat is called Reduced Height (*Rht*), named for the phenotypic effects of *Rht* mutants. The most commonly used alleles currently are *Rht-B1b* and *Rht-D1b*. The application of *Rht-B1b* and *Rht-D1b* in hexaploid wheat varieties resulted in plants that are 10-20% shorter, have reduced lodging and significant yield increases. These mutant *Rht* genes reduce plant height by encoding DELLA proteins that cause a decreased sensitivity to Gibberellic Acid (GA), and therefore reduced stem elongation. The goal of this experiment was to examine the impact of the *Rht-B1b* and *Rht-D1b* alleles upon the expression of genes involved in GA biosynthesis and perception and overall plant growth. This was accomplished by extracting RNA from leaf and stem tissue from isogenic wheat lines that were either tall (wild type *Rht*) or semi-dwarf (*Rht-B1b* or *Rht-D1b*). RNA sequencing was then used to quantify and compare expression values on groups of genes involved in various plant metabolic processes. The results indicate that *Rht-B1b* and *Rht-D1b* mutations impact photosynthetic pathways and gibberellic acid biosynthesis. Differences in these pathways can result in changes in height and yields of affected plants. Leaf and stem tissues were also compared between mutant and wildtype lines. The stem tissues had more significant affects, these differences can be explained by *Rht* having a greater affect in elongating tissues, such as stems, therefore conferring tall or dwarfed phenotypes.

Acknowledgements: Emma Jobson (MSU Graduate Student) - Plant Sciences & Plant Pathology, Andy Hogg (MSU Postdoc/Research Scientist) - Plant Sciences & Plant Pathology

Kory Kirby: Land Resources & Environmental Sciences
Mentor: Tony Hartshorn -- Land Resources & Environmental Sciences
Toward Optimizing Wetland Restoration Outcomes

Population growth and urbanization have resulted in increased levels of nitrogen and phosphorus in the waterways that nourish Bozeman Montana. Story Mill wetland may represent a cost-effective approach to cleaning Bozeman's waterways. The wetland is located between Bozeman Creek and East Gallatin where it historically functioned as a "landscape kidney," removing harmful contaminants like nitrate from the two waterways. In the South Parcel at Story Mill, Bozeman Creek Backwater Slough (BCBS) was constructed by removing soil to allow Bozeman Creek to spread over a much greater area during flood events. This study looks to quantify carbon losses from the excavated soils and then answer whether the removal of soil to create this slough might have reduced the future ability of these wetland soils to sequester CO_2 from the atmosphere. 33 kg carbon/m^2 of soil was found just outside the BCBS. By estimating that the top two horizons from this location were removed (0.55 m), the restored soil should only contain 7 kg carbon/m^2. By estimating carbon turnover rates, it might take 369 years to return to the original carbon inventory. My null hypothesis is that any profile in the area of interest will result in a carbon inventory of 33 kg carbon/m^2. My second hypothesis addresses any profile where a ~33 kg carbon/m^2 inventory is not met; soil excavated for the BCBS will take 369 years to return to the original carbon inventory. Preliminary modeling work was based off of estimates, a thorough characterization of soils in the area around the backwater slough will be completed and result in a more representative model for the specific area of interest.

Kelly Kjorlien: Land Resources & Environmental Sciences
Mentor: Macdonald Burgess -- Plant Sciences & Plant Pathology
The use of mixed cover crops in Organic vegetable farming systems in Montana

High intensity cropping systems with high harvest index crops such as organic vegetables do little to improve the soil health due to low carbon to nitrogen ratio (C:N) and minimal quantity of crop residue. Cover crops tilled into the soil as green manures provide a recalcitrant form of carbon that increases soil organic matter (SOM) (Brennan and Boyd, 2012a). Legume cover crops fix atmospheric nitrogen (N), which can reduce the amount of nitrogen fertilizer required (USDA-NRCS, 1996). While N fixing legumes seem to be the simple answer to the cover-cropping question, other species such as cereals, can create other soil benefits (Brennan and Boyd, 2012b). Too high of a residue C:N ratio can result in microbial immobilization of soil N, negatively impacting crop production in the short term. To determine the best practices for winter cover cropping, planted in the fall and tilled into the soil in the spring, the study compared a winter pea cover crop (P) to a mixed cover crop including winter pea and winter wheat (PW). Cover crops were terminated by mowing, May 19, 2015, and incorporated with multiple tillage implements before preparing a seedbed for fall spinach. The C:N of winter wheat biomass, 32:1, was higher than the ratio at which N immobilization can occur, around 30:1 (Cabrera et al. 2005). Winter pea residue had a C:N of 13:1, and the mixed PW treatment had a combined C:N of 23:1. With the incorporation of winter peas into a winter wheat cover crop, immobilization of necessary N can be avoided. The P cover crop resulted in average soil nitrate N levels of 30 ppm, while PW resulted in soil nitrate N levels of 22 ppm. Soil nitrate N tests above 20 ppm are adequate for growth of spinach without additional fertilization (Heinrich et al. 2013).

Amanda Leckband: Animal & Range Sciences
Mentor: David Sands -- Plant Sciences & Plant Pathology
Feeding a Virus-Resistant Barley to Ewes May Prevent Scours in Lambs: A Study on the Potential Therapy of Scours With The Natural Plasmid Curing Agents in an Ethiopian Barley

Centuries of selection of three diverse crop species has resulted in a sustainable strategy to neutralize hypervirulent microbes via plasmid neutralization. By reducing the multiplication of genetic elements in the microbe, rendering it less capable of causing disease, this strategy presents a new, easily incorporated application for animal feeds in developing countries and in first world feedlots, with the additional potential for fighting human disease where traditional antibiotics are increasingly ineffective.

Jessica Monte: Plant Sciences & Plant Pathology
Mentor: Casey Delphia -- Ecology
VARIATION IN THE QUALITY OF FLORAL RESOURCES USED BY BUMBLE BEES

Recent declines in managed and wild bees have highlighted the importance of native bee conservation. Farming practices that support native bees and their pollination services are greatly needed. To address this issue we examined variation in the quality of floral resources in wildflower strips implemented for native bee conservation on farms. We measured pollen quality (i.e. protein concentration) of the nine native perennials planted in the strips. We also captured bumble bees foraging on flower strips and removed their pollen loads to 1) determine the protein content of the pollen loads and to 2) identify the pollen types being collected. Interestingly, all of the bumble bees captured in this study were foraging on flowers with some of the highest pollen protein concentrations. However, preliminary pollen identification revealed that the proportions of pollen collected by bumble bees are not directly correlated with the plant on which they were caught foraging. Further research is needed to better understand the relationships between floral resource quality and bumble bee foraging behavior in order to better inform bumble bee conservation strategies.

Chance Noffsinger: Land Resources & Environmental Sciences
Mentor: Cathy Cripps -- Plant Sciences & Plant Pathology
An assessment of the diversity of endophytic fungi from red and green needles of whitebark pine (Pinus albicaulis) in Montana

Endophytic fungi can be defined as living within a plant for at least part of their life cycle without causing apparent disease, and some are considered mutualistic. It has been postulated that fungal endophytes might induce resistance to white pine blister rust (*Cronartium ribicola*), a pathogen responsible for the massive destruction of these 5-needle pines in North America. Our preliminary study revealed a diversity of endophytic fungi (33 isolates) in the needles of whitebark pine with limited sampling. The current project is assessing this diversity of endophytes in needles of whitebark pine by sampling twenty mature whitebark pine trees across four high elevation treeline sites in southwestern Montana. Needles are surface sterilized either with an alcohol-flame method or an alcohol soak method and plated onto PDA agar media. Endophytes are being isolated as they grow out from the needles. Endophyte diversity will be compared between sites, trees, methods, and between green and red needles to see if the endophyte community changes on senescence. Results will be presented in terms of morphotypes per treatment, and if possible molecular identification using NCBI blast to determine the best species match for ITS region sequences. This research will provide insight into the diversity of endophytes in whitebark pine and results could lead towards application of endophytes to nursery seedlings as a possible defense against rust or the mountain pine beetle.

Sarah Spear: Land Resources & Environmental Sciences
Mentor: Whit Stewart -- Animal & Range Sciences
Validation of the FibreLux Micron Meter against the OFDA 2000

The FibreLux Micron Meter presents an opportunity as a cost effective analytical tool that can be utilized chute side and on the shearing floor to make selection decisions based on wool fiber diameter. Validation of this emerging instrument, specifically sample size and preparation, has been minimally researched. The objective of this research is to determine the suitability of the FibreLux instrument as an accurate analytical tool in relation to currently accepted laboratory instrumentation. Over 1000 wool samples from 20 different sheep producers will be analyzed on the FibreLux Micron Meter followed by the same sample being analyzed on the OFDA 2000. Sample preparation will be conducted by separating the individual fibers of a pencil size sample and analyzing the sample on the FibreLux followed by the OFDA 2000. A statistical analysis will be conducted using the statistic software SAS 9.4. Projected results include the FibreLux having an accuracy of 0.8 um and a correlation coefficient between the two instruments being greater than $r \geq 0.85$. Therefore, the FibreLux can be determined as an accurate and affordable tool for woolgrowers to utilize in order to improve the quality of their wool clip and ultimately result in the wool producer receiving a higher economic return per pound of wool.

Alexandra Thornton: Land Resources & Environmental Sciences
Mentor: Fabian Menalled -- Land Resources & Environmental Sciences
Does temperature affect Bromus tectorum mortality caused by the biocontrol fungus Pyrenophora semeniperda?

Bromus tectorum is an invasive winter annual grass that has spread across the Intermountain West, reducing rangeland productivity and crop yields. *Bromus tectorum* seeds can remain dormant in the soil up to five years and seedbank densities can range from 10,000 to 30,000 seeds m^{-2}. Multiple herbicide applications are commonly used for *B. tectorum* control; however, this fails to target the seedbank. *Pyrenophora semeniperda*, a potential biological control agent, is a soil-borne fungal pathogen that attacks *B. tectorum* seeds, thereby reducing propagule pressure. However, *P. semeniperda* use is currently limited because little is known about how environmental and biological variables impact its efficacy. The goals of this study were to a) assess the impact of temperature on *B. tectorum* seed mortality caused by *P. semeniperda* and b) determine if *B. tectorum* susceptibility to *P. semeniperda* varies among *B. tectorum* ecotypes. Results indicated that fungal-caused seed mortality varied among temperature, ecotype and inoculation status. While there was no difference among *B. tectorum* susceptibility at 32.03°C, 17.19°C, and 13.03°C for all ecotypes, we found that *B. tectorum* susceptibility varied among ecotypes at 24.60°C and 20.86°C. In particular, at 24.60°C, the ranch ecotype was less susceptible to infection when compared to the subalpine creek ecotype. The susceptibility of *B. tectorum* from the ranch ecotype was 60% ± 11.5%, compared with 93.3% ± 6.7% from the subalpine creek ecotype. At 20.86°C, the susceptibility of the ranch and farming ecotypes was lower than that from the subalpine creek ecotype. The susceptibility of the farm and ranch ecotypes were 33.3% ± 6.7 and 60% ± 11.5% respectively compared with 93.3% ± 6.7% from the subalpine creek ecotype.

Acknowledgements: Krista Ehlert (MSU Graduate Student) - Land Resources & Environmental Sciences

Amanda Williams: Animal & Range Sciences
Mentor: Emily Glunk, Rachel Endecott -- Animal & Range Sciences
Evaluating the use of BMR (Brown Midrib) Corn as an Acceptable Forage Source for Grazing Cattle

Corn can be a valuable forage substitute for many areas, including Montana. Brown Midrib (BMR) corn is a hybrid corn, with reduced lignin and improved digestibility, allowing for greater dry matter and nutrient intake. While BMR corn has been widely used as an ensiled product, little information is available regarding its use as a grazing source. Our objective was to evaluate the utility of three BMR corn varieties as a forage grazing source. Our hypothesis was that the corn varieties would be adequate for grazing livestock. The study was a randomized complete block design, with three blocks and three replications of three BMR varieties within each block. Corn was planted on June 10, 2015 and sampled on August 24, 2015. A 0.3 m x 0.3 m sample was hand-harvested from each plot. Samples were weighed and dried for dry matter and nutrient analysis. Samples were analyzed for nitrates, neutral detergent fiber (NDF) and acid detergent fiber (ADF). Crude protein (CP) and digestibility will follow. NDF values were significantly impacted by both replication (P = 0.0002) and variety (P = 0.0079), with replication 1 having the highest NDF and replication 3 having the lowest. Variety 2 was significantly lower (P < 0.05) than varieties 1 and 3. ADF was significantly impacted by replication (P = 0.0001), with replication 1 having the highest ADF, and replication 3 having the lowest. Nitrate levels were not affected by replication (P = 0.1221) or variety (P = 0.1950), and all were under toxic levels. This information indicates that corn can be a suitable source of forage for grazing livestock in Montana.

Acknowledgements: Richard Waterman (Research Scientist) – USDA-ARS Fort Keogh LARRL

COLLEGE OF ARTS & ARCHITECTURE

Charles Bolte: Film & Photography
Mentor: Ian van Coller -- Film & Photography
BOZEMAN: 1940 - 2015

Bozeman Remembered is a photography exhibition produced by Charles Bolte with the support of the Montana State University Undergraduate Scholars Program. The project seeks to visually document the changing landscape of Bozeman and surrounding Gallatin County as the area deals with rapid population growth. In order to avoid outside bias, the locations investigated by the project were guided by input from a sample of county residents who have lived in the area from roughly 1940 to 2015. In total, 20 participants were interviewed and each was asked to recall a place in the city or county that they would describe as memorable. These locations became the focus of the project's re-photographic content. The juxtaposition of historic photographs and current photographs reveals how each place has changed over time and whether or not it has been affected by the area's population boom. The project culminated in a three week exhibition of 18 framed displays at MSU's Exit Gallery in the fall of 2015. In summary, the project revealed that these long-time residents accepted the region's growth as a positive influence on the community through a strong economy, increased cultural diversity, and greater access to simple conveniences.

Celina Brownotter: Architecture
Mentor: Thomas McaNab -- Architecture
Tipi Tectonics: An Analysis of How Culture, Beliefs, and Traditions Positively Affected Early Lakota Housing

The Great Sioux Nation is well known for their nomadic lifestyle. This way of life would not be known for what it is today if it were not for the tipi. Originally arising from the elaborate indigenous culture, this portable dwelling was known for being extremely efficient, sustainable, and well designed. In today's society there are extreme issues that the aboriginal peoples face within their homes, which could be solved through understanding the beliefs and customs that they are accustomed to. By understanding the beliefs and traditions of the original habitants of the Great Plains and integrating this information with modern design methods, design strategies from the past could help alleviate housing issues faced by the Great Sioux Nation today.

Tember Dykgreve: Art
Mentor: Kevin Wanner -- Plant Sciences & Plant Pathology
Sexual Dimorphism of Click Beetle Antennae Supports their use of Sex Pheromones for Mating

Wireworms, the larval stage of click beetles, are important soil dwelling pests of agricultural crops grown around the world. In Montana wireworms are an increasing threat to the sustainable production of cereal, pulse, and potato crops. The removal of older conventional insecticides from agricultural use has created the need for new tools based on the concepts of integrated pest management (IPM). Some insects use attractive sex pheromones, odors released by the female to attract males for mating. Synthetic pheromone lures are used extensively in IPM as nontoxic alternatives to insecticides. A survey of Montana's cropland determined that *Limonius californicus* was the most common wireworm species causing damage (Morales-Rodriguez, Wanner, & O'Neill, 2014). As a first step towards determining whether this species uses sex pheromones, this study analyzed the morphology of male and female antennae using scanning electron microscopy (SEM). Male antennae can possess olfactory structures dedicated to detecting sex pheromone that are lacking on the female antennae. Three male and female *L. californicus beetles*, collected near Conrad, Montana were examined by SEM to detect sexually dimorphic olfactory sensilla, based on sensilla type, location and number on the antennae.

MUSE 383 Foundations of Assessment - Alethia Heide, Galina Popovich, Brian Rogge, Lily Wright: Music
Mentor: Kristin Harney -- Music

Best practices for private music lessons taught by undergraduates: An exploration of the Arts Without Boundaries music program

All undergraduates at Montana State University are required to generate a scholarly project and participate in a research/creative experience. We participated in a semester-long project designed to introduce us (second year, pre-service music education students) to the tools we will need to successfully design, carry out, and complete research during our senior year. Four students who were enrolled in MUSE 383, Foundations of Assessment, participated in the study. Outside of class, each participant also served as a mentor teacher providing free after school music lessons to fifth through eighth grade students through a local non-profit, Arts Without Boundaries. As a way to explore a variety of research strategies in a safe, supportive environment, students engaged in a collaborative research study exploring the Arts Without Boundaries program. We created research questions, created and administered a survey, coded qualitative data, performed simple statistical analyses of quantitative data, created tables and graphs, and drew conclusions. Individually, each student developed a literature review, made observations, kept a journal, interviewed a student, and transcribed the interview. Products from individual tasks were all brought back to the large group for discussion and analysis. Although the focus of the study was on the rehearsal of research, rather than on the generation of a specific research product, our conclusions point toward increased comfort and preparedness among teachers over the course of a semester. Best practices identified included building trust with students, setting student goals, encouraging outside practicing, and lesson planning before each private lesson.

Anthony Gaglia: Music
Mentor: Gregory Young, Michael Videon -- Music
Impressions of Haiti for Guitar Ensemble

The only Haitian composer whose music is included in the standard repertoire for classical guitar is Franz Casseus. Inspired by my work as a volunteer in Haiti in 2012, I plan to add to the repertoire for classical guitar ensembles within this cultural genre. After investigating the rhythms and harmonies of different Haitian genres I chose specific compositional techniques to capture what Haiti sounds like to me. This project involves composing an original piece for five guitars based on my research findings. The piece includes extended techniques for the guitar, some of which are original, as well as traditional techniques I have been studying during my degree program at MSU. I intend to capture the different parts of Haiti that inspire me including voodoo rituals and the work of Franz Casseus while being true to my compositional voice. The poster will document the research findings and the compositional process. To complement the poster I will provide a recording people can listen to as they study the score. This recording will be done by MSU students.

Kimball Kaiser: Architecture
Mentor: Bradford Watson, Walter Fleming -- Architecture, Native American Studies
American Indian Culture as Design: Absarokee

The American Indian Culture as Design project seeks to take a detailed ethnological/anthropological study of the Crow Tribe's traditional culture and mine it for its benefit in terms of architectural design and planning. The project aims to discover multiple aspects of traditional culture more rooted in the region of Montana that can similarly be beneficially applied and used to generate a more appropriate current context for design in Montana. Goals of the research include introducing more appropriate uses of passive strategies, site planning, community planning, and regional culture significance. The tools being used to accomplish these goals are a series of literature, systematic drawing and analysis, 3d modeling, and schematic design.

Adam Shilling, Kimball Kaiser, Jonathan Chavez: Architecture
Mentor: Christopher Livingston -- Architecture
Small Scale Prefab

The objective of our research project is to research, design, and construct a prefabricated structure meeting the backyard shed requirement of the Bozeman Municipal code. The programming of this prefabricated structure will

be an accessory dwelling space intended to be used as an office or even a studio space. Therefore, the structure will be designed to allow electrical and other utilities to be added depending on how a user decides to occupy the space. One of our goals for this project is to build with a minimum of 50% recycled or reclaimed materials. This is a sustainable practice and will help us cut down on construction cost. It is a method applicable to the local environment of Bozeman in that with all of the construction currently happening here, salvageable material waste is at an all-time high. Other constraints have been identified for the project, such as requiring that all pieces fit in the bed of a pickup truck and making sure the structure can be assembled without heavy machinery using common tools.

Erika Stiff: Architecture
Mentor: Fatih Rifki -- Architecture
Architecture of Authority: Human Perception

This project focuses on symbolism in architecture. More specifically, it investigates the effects that power and authority in architecture have on users, primarily through government buildings, and the common techniques used to convey the declaration of power. The study focuses on architectural works from different time periods developed under different forms of government. Some of the questions addressed are what does a specific work communicate about the governing body that commissioned it? What was trying to be communicated? How do various styles of architecture differently affect a user's perception? In what ways does authority manifested in architecture affect what the user sees and notices about a project? The results will be related by means of 2D graphic representations that will communicate my analysis of each site.

Christian Storch: Architecture
Mentor: Fatih Rifki -- Architecture
Architectural Procession

The project employs both deductive and inductive methods of investigating the significance of architectural procession. Research began with a general inquiry; "How does architectural procession affect individual and group human experience of designed urban places?" Architectural procession is defined as a movement through a series of architectural spaces in a specific order. Working to deduce observations about the relationships between architectural procession and human experience, the investigation positions the researcher in a series of individual and group based processions throughout England, Greece, Italy and France. In order to quantify information the research collects distances, time periods, and photographic data from each procession participated in by the researcher. The project then compiles this information into a two-dimensional graphic that is created by organizing photographs in relation to the time and distance based data collected from each procession, and tracing over the dominant contours of the organized photographs. Further observations are then induced by critically reflecting upon and analyzing the resulting two dimensional graphics separately as well as in comparison to one another.

Keeli Telleen: Music
Mentor: Gregory Young -- Music
Living Those Songs Again: Music for Memory Care

To shed light on the relationship between music, memory, and emotion, particularly in elderly adults with memory deficiencies, I plan to investigate the effects of music on memory care residents. Research by Simmons-Stern, Budson, and Ally (2010) suggests music can enhance memory in Alzheimer's patients. El Haj, Fasotti, and Allain (2012) discuss how listening to preferred music evokes memories that are more specific and have more emotional content than when individuals try to retrieve memories in silence. Further, a large body of research supports music listening as an effective form of therapy for individuals with various forms of dementia. My goal is to build upon these findings using qualitative methods. I will assist in the Music and Memory program at Spring Creek Inn Memory Care Center, where custom playlists are gathered with music from residents' youth to tap into memory, aid in therapy, and improve cognition. Through interactions and observations, I will study the effects of music on their memory and behavior. Following up with individual interviews of family members and caretakers, I intend to generate new insights and disseminate ideas for family involvement with loved ones who suffer memory loss.

COLLEGE OF BUSINESS

David Lowe: Business
Mentor: Loretta Backstrom -- Business
Bridging the GAAP: A comparison of common accounting practices in rural areas of the United States and China

How similar are small businesses in rural areas of the United States and China? Do these small businesses share the same basic operational procedures, or do different cultures create different accounting methods? In an effort to explore the universal trends of small business operation, surveys were conducted into the day-to-day activities of several common small business types: A convenience store, a bar, a restaurant, a barbershop, and a specialty store. Businesses of each type were interviewed in Bozeman, Montana and Lanzhou, China. Broadly, the results show that US business owners are more likely to form corporations, while Chinese business owners operate simply as sole entities or partnerships. US businesses are also more likely to utilize advanced technology, such as inventor-tracking sales registers, electronic bookkeeping methods, and security systems. US businesses were more likely to match revenues and expenses through the use of accrual accounting methods, as well as prepare and utilize financial statement reports. In contrast, Chinese businesses tend to operate on a strict cash basis and utilize informal financial reports less frequently. Similarities include a predominantly January-December fiscal year, the documentation of transactions in ledgers and journals, and a general aversion to sales on credit. While the differences in US and Chinese businesses are numerous, it is likely that the majority of these are the result of differing levels of access to technology and capital rather than any differences in culture. As access to financial and economic resources increases in rural China, these differences may well fade away, eventually bridging the gap between small business practices around the world.

COLLEGE OF EDUCATION, HEALTH & HUMAN DEVELOPMENT

Jenna Blair: Health & Human Development
Mentor: Kalli Decker, Tricia Foster (Eastern Michigan University) -- Health & Human Development
Early Intervention Service Providers' Day-To-Day Practices with Children and Families

Children with delays and disabilities are eligible to receive services as part of the Individuals with Disabilities Education Act (IDEA), and Part C of IDEA relates to early intervention services for infants and toddlers. The Division for Early Childhood recommends early intervention services should follow family-centered practices, which empowers parents, since they are the most important individuals in children's lives. According to previous research, early intervention service providers struggle with providing family-centered intervention services, but little is known about the barriers that these professionals face in regards to providing services that align with recommended practices. Therefore, the purpose of this research is to provide insight to the barriers service providers face when collaborating with families, and the ways in which these professionals could be better supported in order to provide family-centered services. Data was collected via surveys (N=204) from a variety of early intervention service providers attending an early intervention/Part C conference. The survey included quantitative and qualitative data of service providers' beliefs, everyday practices, and the barriers they face to providing services that align with recommendations. We reviewed the data for themes in the participants' responses regarding their strengths and barriers to providing family-centered services. The results from this research provide insight as to the ways in which service providers interact with families, and the extent to which this aligns with recommended practices. Furthermore, this research identifies potential barriers that exist, and this identification may be useful in further progression of early intervention programs and policies that are intended to reflect these recommended practices.

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Danielle Braget: Health & Human Development
Mentor: William Stadwiser -- INBRE
HOW CAN GALLATIN COUNTY WIC BETTER ENGAGE MONTANA STATE UNIVERSITY STUDENTS TO INCREASE PARTICIPATION IN THE PROGRAM?

Women, Infants, and Children (WIC) is a federally funded organization that provides resources for expecting mothers, single mothers, single fathers, and families with children up to 5 years of age. Access to nutrient rich foods, breastfeeding support, free health screenings, and nutritional advice is available through WIC. These resources encourage healthy growth and development for the entire family. There are 1,900 WIC agencies located around the United States. To qualify for WIC benefits, an applicant's household income must not exceed 185% of federally established poverty guidelines for the given region. Many expecting mothers and students with families who attend higher level educational institutions across the United States do not have the ability to maintain a full-time job while enrolled as a full-time student. This often lowers their income potential and increases their chances of meeting the income criteria for WIC, noting scholarships and financial aid are not factored into income. A baseline of non-member eligible families and parents at Montana State University will be established by a survey distributed throughout family and graduate housing. The data from this survey will be used to create a program to better WIC outreach on the Montana State University campus. This outreach program will potentially increase student participation in WIC, leading to increased opportunity for expecting mothers and children in the Gallatin County. WIC can change people's lives by providing them with the extra nutrition they need not only to thrive, but in some cases simply get by. Increasing awareness of WIC services by targeting expecting mothers and families with children living on campus can lead to children having better access to well-balanced nutrition.

Dani Hess: Health & Human Development
Mentor: Selena Ahmed, Carmen Byker-Shanks -- Health & Human Development
Dietary quality on the Flathead Reservation: understanding the relationship between dietary diversity and nutrient intake

Diet-related chronic diseases are major health concerns among American Indian populations in Montana. As a part of an ongoing project that seeks to further understand the food environment and nutrition on Montana's Flathead Reservation, this study examines the relationship between dietary diversity and nutrient intake. Using the Food and Agriculture Organization's (FAO) Dietary Diversity Tool and dietary intake data collected by the MSU Food and Health Lab and Salish Kootenai College researchers, dietary diversity score (DDS) was calculated. Scores were assigned into a high, medium, or low diversity groups and compared to assess fulfillment of 12 nutrient recommendations outlined in the 2010 Dietary Guidelines for Americans. Mean DDS (n=80) was 4.6 (± 1.365) on a scale of 0-9. High diversity diets indicated significantly higher intake ($p<0.01$) of 3 nutrients compared to low diversity diets: dietary fiber ($p<0.0003$), potassium (0.0024), and cholesterol ($p<0.0048$). Analysis of DDS showed cereals to be most the frequently consumed food group across all levels of dietary diversity (included in 100% of high diversity diets, 97.8% of medium diversity diets, 87.5% of low diversity diets). Vitamin A rich food groups (fruits, vegetables) showed the greatest disparity in consumption across high (15%, 73%), medium (11%, 20%) and low (0%, 0%) diversity diets. A significant difference was found between nutrient intake of several nutrients and diets of high and low DDS. The relationship however was not always indicative of a higher dietary quality since cholesterol consumption was higher in those with high DDS. Trends showed slightly higher total fat and calorie consumption suggesting that high cholesterol intake among high DDS subjects may be a result of higher consumption of fatty or energy-dense foods. To further characterize the relationship between dietary diversity and nutrient intake, the constant influences of the food environment on quality, quantity and food choices must be considered.

Debra Kraner: Health & Human Development
Mentor: Selena Ahmed -- Health & Human Development
Impacts of Environmental and Management Factors on the Functional Quality of a Traditional Chinese Medicinal Plant: Case Study of Jobs Tears Coix lacryma-jobi

As Traditional Chinese Medicine (TCM) becomes more popular, the need for high-quality herbal products also increases. A major problem facing the TCM system is the need for a balance between cultivation methods in a large-scale setting to keep natural environments in tact and a high quality herbal product. Quality is dependent on the amount of secondary metabolite chemicals that vary with agroecological management. I am working with Dr. Selena Ahmed of the MSU Food and Health Lab to examine how changes in environmental and agroecological management impact the functional quality of TCM herbs. Speifically, I am carrying out a manipuative greenhouse experiment of growing *Ocimum tenuiflorum* and *Scutellaria barbata* under varying soil moisture content and food waste compost treatments to modify soil quality in the Plant Growth Center on the MSU campus. My hypothesis for this study is that plant samples which are put under higher levels of ecological stress will have higher levels of secondary metabolite concentrations. I am measuring various parameters of botanical quality including plant vitality, biomass, and secondary metabolite concentrations. Statistical analysis will involve determining if there are significant differences between levels of antioxidants, total phenolic concentrations, biomass, and plant vitality measures between treatment groups. Data will be interpreted to make an assessment of best ways to cultivate high quality Tulsi Basil and Barbat Skullcap product on the basis of water and soil quality.

Sarah Phillips: Health & Human Development
Mentor: Selena Ahmed -- Health & Human Development
Examining the Biosafety of Fruits and Vegetables in Supermarkets in Montana along an Rural-Urban Continuum

Food safety and food contamination is a prevalent problem worldwide. The prevalence of food safety may vary along multiple factors including rurality which can lead to health disparities in rural population. This research examines the food safety of fruits and vegetables procured from supermarkets in Montana along a rural to urban continuum under the mentorship of Dr. Selena Ahmed and Dr. Carmen Byker-Shanks who lead the Food and

Health Lab at MSU. The proposed research builds on the existing INBRE-funded work of the Food and Health Lab at MSU on the quality of fruits and vegetables from supermarkets throughout Montana through the lens of food safety. The objective was to analyze the quality of fruits and vegetables from supermarkets in Montana for microbiological safety towards better characterizing the food environment and highlighting possible drivers of food disparities in rural communities. Food safety was determined using Bacteriological Analytical Methods for the Enumeration of Escherichia coli and the Coliform Bacteria. The importance of this research links fundamental biosafety to human nutrition while addressing a need for further investigation of microbial contamination.

Katie Sutton: Health & Human Development
Mentor: Florence Dunkel, Selena Ahmed -- Plant Sciences & Plant Pathology, Health & Human Development
Building Resilient Community Members: A Survey that Examines Self-efficacy via Perceptions of Resources Available, Job Opportunities and Barriers to Future Aspirations in Small Montana Communities

While all people are entitled to a quality of life without extreme poverty, inequality or injustice (FAO 2015), we still see these issues across the world, even within our own nation. Access to affordable healthy food remains an issue in Native American communities (Sarche & Spicer 2008). Food insecurity has been correlated to poverty, unemployment (Satia 2009), and ultimately lower levels of self-efficacy, which can hold individuals back (Bandura 1986). I am working with Drs. Ahmed and Dunkel to test the hypothesis that individuals are interested in skill-building resources and perceive greater access to career opportunities and quality of life with skill-building resources. To address my research objective, I am administering a qualitative and quantitative semi-structured survey evaluating and comparing perceptions of self-efficacy in two rural communities in Montana which also identifies barriers and opportunities for skill building and career development. The surveyed communities include a tribal and a non-tribal community to compare variation in perceived self-efficacy, desired skills, and current individual skills. The skills being identified include: growing, preparing, and processing food; creating value-added products; wind, solar and geothermal energy production along with desires for trade skills. Multiple choice questions will be tabulated for frequency and open-ended questions will be coded to identify themes. Findings will be presented back to the communities through a brochure. This work could potentially help identify skills to help improve self-efficacy at the study sites, fostering self-reliance and resilience through improved personal food production, becoming entrepreneurial through cottage industry goods, or through improved access to trade skills.

Sean Van Horssen: Health & Human Development
Mentor: Lynn Owens -- Health & Human Development
Return to Play in a Contact vs a Non-Contact Injury

The purpose of this research was to understand how long it takes for an athlete to feel 100% play ready after experiencing a contact vs. a non-contact injury. The specific research questions were "What is the difference in readiness to play of athlete experiencing a non-contact injury vs. a contact injury of the same type and severity?" and "What is the difference of time between when a player is able to play, and when a player is ready to play?" Data was collected using a survey put out through survey monkey, and there were 20 participants. The data was analyzed by using text analysis and constant comparison. The results suggested that three common themes arose from the data. These included mental pressures, gender differences, and internal pressures. Mental pressures were what an athlete feels after an injury, gender differences were the differences between male and female participants, and internal pressures were the pressures the athletes perceived they were experiencing. The data did not reveal any difference in readiness to play, but it did suggest a relationship between when a player is ready to play, and when a player returns to play.

COLLEGE OF ENGINEERING

Leyla Avci: Chemical & Biological Engineering
Mentor: Stephanie Wettstein -- Chemical & Biological Engineering
Small pore zeolite catalysts for furfural synthesis from xylose and switchgrass in a γ-valerolactone/water solvent

Small pore zeolites were evaluated as catalysts in the dehydration of xylose and biomass to furfural in a monophasic system of 90/10 γ-valerolactone (GVL)/water. Although the pore sizes were significantly smaller than the kinetic diameter of the sugars, furfural yields on the commercial SAPO-34 catalyst were 40% from xylose and 31% from switchgrass (considering total glucose and xylose moles). Furfural degradation with time was minimal. The SAPO-34 catalyst was recycled multiple times with only a 5% drop in furfural yield and no significant leaching of acid sites occurred. To our knowledge, this is the first time that real biomass has been reported to be converted with moderate yields to furfural using small pore zeolites.

David Bell: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Battlecode: Navigation in MIT's Longest-Running Artificial Intelligence Competition

The purpose of this project was to research, design, and implement a navigation system for a submission to Battlecode 2016, an artificial intelligence programming competition directed by MIT. A new variant of Jump Point Search, one of the best algorithms for two-dimensional path finding optimization, was developed to address Battlecode's tight restrictions on computation. The variant, called Bit String Jump Point Search, was motivated by the concept of searching lines or distances instead of points on a two-dimensional grid. Bit String Jump Point Search outperformed several other Best First Search algorithms and was integrated into the submission for Battlecode 2016, which was a finalist in the competition and won awards for Most Creative Strategy and Most Adaptive Strategy. While limited to a specific case where nodes on a two-dimensional grid can be represented as bits, Bit String Jump Point Search was the best search algorithm for that case found by this research.

Brianna Bos: Mechanical & Industrial Engineering
Mentor: William Schell -- Mechanical & Industrial Engineering
Writing and Communication in Engineering Courses at Montana State University

Writing and communication are important aspects of all professions, including engineering. Despite this importance, previous research indicates that MSU does not have a strong focus on writing in engineering, while other engineering institutions have implemented specific classes to address writing and communication for engineering students. This research seeks to better understand how writing is emphasized within a single MSU engineering major by observing and analyzing the approaches to writing and communication education in Industrial and Management Systems Engineering (IMSE) courses. Observing courses, reviewing student writing assignments and scoring them on a standard rubric created through this research will provide information on how engineering courses are addressing writing and communication. The project strives to see how well prepared MSU engineering students, in IMSE courses, are for the professional world of engineering where writing and communication is a crucial skill. This project focuses directly on what MSU offers for writing in engineering courses and looks for progress in students and the writing/communication abilities they gain while in the curriculum. The purpose is to understand how writing and communication is addressed in MSU IMSE courses, so that information can be drawn on MSU's engagement in writing and communication education in engineering courses. Throughout the course of the project, possible areas for improvement will be analyzed to see how MSU could develop its approach to writing in engineering.

Chad Bowman, Ross Wendt: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Rocket Evolution

Rocket Evolution is a game for Android devices that explores a unique game type; one that combines rocket-launching simulation with evolutionary algorithms. Instead of explicitly designing rockets, the user utilizes an evolutionary algorithm as a tool, gradually improving the design of the rocket in an effort to achieve an array of different goals and mission profiles. This is accomplished by having the user pick a particular attribute, such as accuracy to a target or average speed, for the evolutionary algorithm to optimize. In time, the user will have generations of different rockets available and the option to manually reintroduce a small number of rockets into the population for more control. Our hope is to find a way to successfully join enjoyable gameplay with fairly accurate simulation so users can develop real, physical intuitions about how certain design attributes affect the performance of the launch-vehicle.

Joe Brindle: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
Modelling Locallized heat transfer in porous media using computational fluid modelling

The purpose of this project is to determine localized transient heat transfer in a packed bed apparatus. This involved using computational fluid dynamics modelling with Star CCM+ to establish a packed bed geometry with a distribution of alumina particle sizes. The resulting geometry can be used to simulate flow of hexafluoroethane through the packed bed and then a transient heat transfer. The method to establishing a packed bed is via gravity filled Discrete Element Modelling with the Lagrangian phase tool in Star-CCM+. Fluid flow is modelled in the laminar regime to determine the flow characteristics locally through porous media. Transient heat transfer is modelled with inlet temperatures ranging from 40°C and 60°C with various wall loss characteristics such as isothermal, adiabatic, and convective heat transfer. These results will later be compared with experimental data from Nuclear Magnetic Resonance experiments to correlate a temperature profile to a velocity profile in a packed bed media. This lays the modelling foundation for a graduate project to continue on this novel method to provide insight on transport phenomena in non-isothermal packed beds.

Murat Buyukyoruk: Chemical & Biological Engineering
Mentor: Mensur Dlakic -- Microbiology & Immunology
Optimizing In vitro Selection of RNA Aptamers for New Fluorescent Dyes

Imaging macromolecules such as DNA, RNA or protein can be done by specific techniques: using probes that bind to a specific part of DNA strands or using fluorescent proteins that can trace the activity of proteins. On the contrary, imaging small metabolic molecules - also known as metabolites - is more difficult because they are not coded genetically like proteins. However, they are also the products of cell activities determined by genetically encoded macromolecules. New methods are in development that enable us to trace cellular metabolites, as well as allow us to determine the ratios of present metabolites in cells. In this project we explore the properties of new, conditionally fluorescent dyes - ATI-2 dye and other possible dyes - by finding the most suitable *in vitro*-selected RNA aptamer that can induce fluorescence in these dyes. During this research, many *in vitro* selection trials were performed from a large pool of random RNA sequences in order to obtain the best RNA aptamer molecules. Multiple selection rounds were done with the ATI-2 dye by gathering initial RNA aptamers and amplifying them by PCR. The sequences of obtained RNA aptamer molecules will be determined and they will be compared to see if they have any common sequences that are responsible for specific binding to ATI-2.

Stephanie Conrad: Chemical & Biological Engineering
Mentor: Ellen Lauchnor -- Civil Engineering
Cultivation and Kinetic Analysis of Anammox Bacteria Grown in a Sequencing Batch Reactor

As westernized culture expands, so does the need for innovative waste water remediation, but current nitrogen removal techniques are cost and energy intensive. Anammox, or anaerobic ammonium oxidizing, bacteria offer a potentially more cost effect alternative to traditional nitrogen removal by decreasing oxygen requirements and sludge production. While these properties are beneficial to saving money, they can also lead to optimization problems within the treatment system. An increase in oxygen or decrease in substrate availability leads to

dormancy within the bacteria as well as the production of other, more competitive bacteria. In this research, Anammox removal of nitrogen was studied in a Sequencing Batch Reactor (SBR) kept at 30° C with a media recipe created to both facilitate growth and simulate an artificial clarified waste water. During the cultivation time studied, noticeable dormancy due to reduced substrate addition occurred twice. The implementation of additional nitrogen sparging was added in order to reduce oxygen re-dissolving into the system. Removal efficacy was evaluated by determining substrate concentrations both before and after batch testing. The ratio of nitrite reduction to ammonium reduction proves anammox activity. Future work for this project will include determining rate kinetics and generating sufficient biomass concentrations to remove cultures from the system and test micropollutant inhibition.

James Crawford: Chemical & Biological Engineering
Mentor: Brent Peyton -- Chemical & Biological Engineering
Culturing High Value Astaxanthin as a Biofuel Co-product of Haematococcus Pluvialis

The green microalgae *Haematococcus pluvialis* is capable of forming up to 3% cell dry weight of keto-carotenoid astaxanthin while simultaneously forming fatty acid methyl ester (FAME) biofuel precursors. Astaxanthin is used as a dietary supplement in pisciculture and as a nutraceutical supplement for human consumption. Sold at up to $2,500 per kilogram with a global market of $200 million annually, astaxanthin holds great promise as a high value algal biofuel co-product. Previous research conducted on other chlorophyte strains indicated that bicarbonate amendments can cause a cessation of cell growth and stimulate the production of lipids, primarily in the form of FAMEs. In the case of *H. pluvialis*, an environmental stressor, such as high light intensity, is required to stimulate the accumulation of astaxanthin. A study was conducted on *H. pluvialis* (UTEX 2505) cultures which were amended with sodium bicarbonate and the resulting change in cell dry weights, FAMEs, and astaxanthin content was monitored. Over the course of the experiment, cell density, pH and optical density were monitored in flask cultures containing 250mL MES-Volvox medium continuously shaken at 120rpm, exposed to a 14:10 hour light dark cycle with light intensity of 250µmol photons·m^{-2}·s^{-1}. Three of the six cultures received bicarbonate while three remained as a controls. Preliminary results of bicarbonate addition showed a 10% higher cell dry weight when compared to the controls. Further experimental trials will be conducted, testing for repeatability and optimization of bicarbonate concentrations.

Spencer Dansereau: Mechanical & Industrial Engineering
Mentor: Roberta Amedola -- Mechanical & Industrial Engineering
Low Temperature Hot Corrosion (LTHC) of Silicon Carbide

New silicon carbide SiC based materials components offer lighter weight and higher temperature oxidation resistance in clean air than their Ni super alloys counterparts in hot section gas turbine components. I will monitor the weight change of silicon carbide samples over a period of 100 hours at specific time increments that will be discussed during the research kick-off meeting. The purpose of the weighting is to evaluate the development of the surface oxide layer to quantify the entity of the corrosion process. The higher the sample weight gain, the more severe the corrosion process is. Results will then be compared with those collected for samples exposed to oxidation conditions (air only). After 100 hours exposure to simulated combustion environment, specific analyses will be conducted in order to assess the effect of the corrosive process on the samples surface and cross-sections. This stage will consist of Field Emission Scanning Electron Microscopy (FE-SEM) to characterize morphologies and Energy Dispersive X-ray spectroscopy EDX to assess the chemical composition.

James Dilts: Electrical & Computer Engineering
Mentor: Wataru Nakagawa -- Electrical & Computer Engineering
Fabrication Optimization for a Polarizer Array Device

Silicon nanostructures can be optimized for optical applications such as implementing polarization filters. To meet the long term project goals, many different types of devices will need to be placed on the same silicon chip. To achieve this, it must be possible to consistently produce repeated optical structures with a small period, in this case 300 nm. In the first project stage, the device fabrication process was optimized by developing a thinner e-

beam resist layer and changing the lithography exposure dose and development time. It was found that the chips made with the thinner resist layer had a more consistent dosing than the chips with the thicker resist. A thinner aluminum etch mask layer was developed for the thinner resist layer which will give a higher etch resolution. Further plans are to determine the best performing fill factor and optimize the device design for the fabrication process. Eventually, the sizes and types of devices able to be fabricated on a single chip will be expanded. This should allow for the consistent creation of diverse nanostructures in silicon for polarimetric imaging applications such as atmospheric science or medical imaging.

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Erica Eggleton, Logan Battrell: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
PEM Fuel Cell Water Saturation Modelling And Imaging

A major challenge the world currently faces is finding sustainable energy sources to meet the growing energy demand. One possible source is proton exchange membrane (PEM) fuel cells, which convert hydrogen and oxygen into electricity. In order to make these cells the most efficient, the water management within the cell needs to be better understood. This work studies water saturation through two methods: numerical modeling and Synchrotron X-ray radiography. The baseline model construction was influenced by the reduced model by Grötsch and Mangold. It includes a system of three ordinary differential equations, which define the change in saturation, density of water vapor, and density of oxygen over time, along with 23 explicit equations. Collaborators at the University of Saskatchewan created a solver for the model in Radau5 and MATLAB. Now the focus has shifted to analyzing outputs of a fuel cell under different conditions. Outputs of interest include saturation, voltage, and electrical current of the cell. Initial results show that lowering the temperature increases the initial saturation, whereas increasing the temperature lowers the initial saturation. Also, decreasing the pressure by only 0.5 atm increases saturation significantly. The research team traveled to the Canadian Light Source facility in Saskatchewan to use the beamline in January. Baseline values and procedures were collected for forthcoming data collection trips. An image showing a water droplet in the system was collected, and it was determined that the best conditions to gather images were at a distance of 50 cm and a beam energy of 25 keV. For future work, the results of the model and radiographs will complement experimental data gathered using a TP50 research cell and a G20 PEM fuel cell test station.

Thayne Ekness: Chemical & Biological Engineering
Mentor: Seth Walk -- Microbiology & Immunology
Identification of nosocomial outbreaks of Clostridium difficile by isolate genotyping and antibiotic resistance profiling

C. difficile is the most common cause of nosocomial (hospital-acquired) infections in the United States. Although *C. difficile* can pass through the human gut without symptoms, it commonly causes disease in patients with a perturbed microbiome due to antibiotic therapy. My project has two-parts: genotyping of *C. difficile* from US hospitals around the country and determination of resistance to a panel of antibiotics. A common method for genotyping *C. difficile* is with PCR ribotyping. This is a cost effective way to classify isolates into groups, but it cannot differentiate between closely-related isolates, or clones, that are transmitted during outbreaks. To identify and differentiate between clones of *C. difficile*, a more discriminant tool like multiple locus variable number tandem repeat analysis (MLVA) can be used. Furthermore, antibiotic resistance profiles can be used to compare the relatedness between clones based on their ability to grow in the presence of different drugs. I will use PCR ribotyping, MLVA, and antibiotic resistance profiling to address the following three hypotheses: 1) There is an ongoing outbreak of *C. difficile* infection at the Bozeman Deaconess Hospital.; 2) There is an ongoing outbreak of *C. difficile* infection at the University of Michigan Hospital.; and 3) The number of *C. difficile* MLVA types and diversity of antibiotic resistance profiles depends on the hospital where the isolates were collected. This study will increase

our understanding of the epidemiology and diversity of *C. difficile* pathogens within and between hospitals, which will lead to more effective preventative measures and patient care.

Brooke Filanoski: Chemical & Biological Engineering
Mentor: Adrienne Phillips -- Civil Engineering
Microbial Induced Calcium Carbonate Precipitation of Coal Combustion Residuals

Coal Combustion Residuals (CCRs) are a toxic ash byproduct created when power plants burn coal to produce electricity. Impoundments that contain CCRs possess the risk of leaking or even breaking, resulting in a devastating exposure of heavy metals to the air and ground water. Microbial induced calcium carbonate precipitation (MICP) is the process by which microorganisms induce mineral precipitation, hydrolyzing urea into ammonium and carbonate. MICP can cement porous media by filling in the gaps between grains. For this research, the bacterium *Sporosarcina pasteurii* was used to biocement CCRs. With the ability to precipitate calcite when supplied with a calcium and urea source, *S. pasterurii* could retrofit a reduced permeability liner. Impoundments that contain CCRs could greatly benefit from biocementation. An XRD (X-Ray Diffraction) ran on a sample of Bowen Fly Ash injected with microbes showed definitive calcite peaks that indicated biomineralization did occur. The EDX (energy-dispersive X-ray microanalysis) ran on Bowen Fly Ash calculated large percentages of calcium, the largest percentage being found in Bowen Fly Ash injected with microbes. This calcium source creates an ideal environment for calcite precipitation, proving as a possible method to fix the containment of CCRs. In a batch study, higher urease activity was seen in samples of Bowen and Scherer Fly Ash injected with microbes compared to their control counterpart without microbes. Both the pH and O.D. measurements taken during this batch test indicate the potential of microbes fortifying CCRs ponds through MICP.

Amy Fox: Chemical & Biological Engineering
Mentor: Connie Chang, Phillip Himmer -- Chemical & Biological Engineering, Electrical & Computer Engineering
Investigation of Microfluidic Temperature Control for Organoid Growth

Microfluidics and microelectronics are two rapidly expanding fields of research that have advanced together to form a new field of research known as Bio-MEMS. Bio-MEMS uses the concepts of microelectromechanical systems (MEMS) to provide process control to microfluidic devices. This project's objective was to use MEMS fabrication technology to develop a heater and thermocouple for use in microfluidic devices. The main application of this project will be to regulate and monitor temperature in a microfluidic device used to grow human intestinal organoids (HIOs). HIOs are stem cells that have been strategically influenced to form small 3D organ buds. Future expansion research related to this project could include applying microfluidic temperature monitoring to other research areas in the Center for Biofilm Engineering, a temperature variation study of organoid growth using the device developed in this project, and development of more complex MEMS control devices for use in microfluidics.

Emma Garcia: Chemical & Biological Engineering
Mentor: Michelle Flenniken -- Plant Sciences & Plant Pathology
Investigation into Sub-Lethal Impacts of Agrochemical Exposure and Virus Infection on Honey Bee Health

Honey bees are significant plant pollinators in non-agricultural and agricultural landscapes, including crops in the US valued at $15 billion annually. Therefore, high annual losses of honey bee colonies (averaging 33% since 2006) are alarming. These losses have been associated with increased pathogen (e.g., viruses, bacteria, microsporidia, trypanosomatids, and mites) incidence and abundance, though no specific pathogen(s) are consistently associated with colony deaths. Multiple biotic and abiotic factors influence honey bee health, such as agrochemical exposure and viral infection. To examine the effects of these honey bee-affecting stressors concomitantly, bees were infected with a model virus (SINV-GFP) and orally exposed to five different agrochemicals. After three days, virus abundance in individual bees was assessed at the protein level, via Western blot, and at the genomic level, via qPCR. Overall, there was large variability in viral abundance, and bees exposed to agrochemicals had reduced virus abundances as compared to unexposed controls. Similarly, bees given a lower dose of clothianidin had greater viral abundances as compared to those given the higher dose, a trend not seen in bees treated with other agrochemicals. In parallel, we utilized liquid chromatography/mass spectroscopy (LC/MS) to investigate the

metabolomic responses to these stressors. Analyses of these data revealed the similarities and differences in the metabolic profiles of agrochemical exposed bees (e.g., neonicotinoid insecticide clothianidin) and/or virus infected bees. Additional analyses of this data may lead to the identification of stress specific biomarkers, which could be useful for diagnosis or investigating detoxification and/or immune mechanisms.

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Hendrick Haataja, David Kelley: Electrical & Computer Engineering
Mentor: Brock LaMeres -- Electrical & Computer Engineering
Reliability Analysis of a Reconfigurable Space Computer

This project was focused on performing a reliability analysis for the Reconfigurable Space Computer that a top MSU research team led by Professor Brock LaMeres is designing. The computer system is scheduled to go on three missions in the next year, one sounding rocket flight, a six-month rotation on the International Space Station (ISS), and a satellite launch. Previous iterations of the system were modeled, but a new model was needed to reflect all of the changes in the device that will be flown. This model provides critical data on the expected performance of the system. This has enabled the design to be characterized before sending the computer on a mission. This project was a joint effort with my fellow student David Kelly. David and I have worked collaboratively to understand what reliability modeling means, the theory behind how to perform an analysis on a computer system, and how to use the tools necessary to come up with an accurate model. We focused on using these skills during the second part of the project to model the expected performance of the MSU computer system under radiation bombardment. For the sake of comparison, we have created models for four different levels of radiation fault mitigation. The first is a simple system with no radiation mitigation strategy, and the next three add a level of protection one by one so the advantage of each protective stage that the final design employs can be shown clearly. This project provides crucial information on the advantages of the MSU system, and validates that the fault mitigation strategies are statistically an improvement.

Keara Haley: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Restaurant Management

There are many opportunities for the field of computer science to improve business practices. Restaurant management is one of the fields that can be greatly assisted by a well written piece of software. Restaurants often use measures of success that look at how many groups of people the restaurant can move through in a period of time. Obviously that number is somewhat dependent on how fast people eat, how long they stay after they are done eating, etc, but the goal of effective restaurant management is to minimize the time that the customers are waiting on any of the restaurant workers. One of the most common issues with restaurant management that affects wait time is the often present communication breakdown between the 3 main work stations (host, server, kitchen). This software remedies that breakdown by remotely connecting the three work stations and providing insights in an efficient way that saves time and ultimately money.

Dustin Hays: Mechanical & Industrial Engineering
Mentor: Ron June -- Mechanical & Industrial Engineering
Mechanobiological Characterization of In Vitro Pericellular Matrix for Human Articular Chondrocytes in High-Stiffness Agarose

This project focuses on the study of cells found in human articular cartilage, chondrocytes. Confocal microscopy is proposed for use in examining the microstructure of the cell and the peri-cellular matrix (PCM) surrounding the cell. Chondrocytes are harvested from cartilage found on donated hip surgeries. These are then cultured in a physiologically stiff agarose hydrogel and conversely, a more compliant hydrogel. It is hypothesized that by

comparison through imaging, differences in PCM development in the two separate hydrogels will be present. This will be completed by the use of confocal fluorescence microscopy by the targeting of collagen type VI, a protein found exclusively in the PCM. Confocal reflectance microscopy will be combined with this for further cellular context. A control study will be conducted, simply imaging the development of the PCM. Primary and secondary staining protocols have been verified by the use of epifluorescence. Further experimentation is required to develop an imaging protocol for the use of a confocal microscope Other studies will then apply mechanical compressive and shear loads to the chondrocyte-seeded agarose constructs throughout culturing. Comparison of the control and mechanically loaded cells is hypothesized to show further information in PCM irregularities found in osteoarthritic cells of cartilage. This is important because it is thought the PCM plays an important role by isolating the cell from direct mechanical loads. The results of this project could provide valuable information in understanding the inefficiencies of chondrocytes in regulating cartilage health, of which impact leads to osteoarthritis.

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Reece Hoskins: Civil Engineering
Mentor: Ellen Lauchnor, Christopher Allen -- Civil Engineering
Ennis Treatment Wetlands: A Baseline Study of Organic Pollution in the Blaine Spring Creek Ecosystem

The purpose of this research is to quantify the level of pollution introduced into the Blaine Spring Creek ecosystem by the wastewater from the Ennis National Fish Hatchery. We postulate that we will successfully measure a difference in water turbidity above and below the wastewater outlet of hatchery and that we will be able to develop a relationship between increases in turbidity and increases in organic pollution. This research will serve as a foundation for future research into wetland design, efficiency and effectiveness as well as a comparison tool for the U.S. Fish and Wildlife service to document the reduction in environmental impact due to the wetland treatment system. We will use records collected from the hatchery to determine the natural variance of the creek. Then we will collect turbidity measurements from the creek above and below the outlet for hatchery wastewater. Simultaneously, I will be collecting water samples from the creek for testing in the lab. I will use standard BOC and HACH COD tests to determine the concentration of organic pollution of the previously collected samples. At the same time I will use a standard TSS test to get an accurate measurement of the suspended solids in the sample. Using these two measurements I will create a relationship between the turbidity of the water samples and the organic pollution. This relationship will be applied to the turbidity data collected from the creek over time to determine the mass loading of organic pollutants in the creek.

Jayesha Jayaratne: Chemical & Biological Engineering
Mentor: Jennifer Brown -- Chemical & Biological Engineering
Rheology and Rheo-NMR characterization of wormlike micelle solutions at transient states

The study focused on characterizing worm-like micelle solutions using rheology and testing new Rheo-NMR (nuclear magnetic resonance) techniques and equipment at shear start-up. Surfactants at certain temperatures and concentrations can self-assemble into cylindrical forms called wormlike micelles, of interest in biomedical fields and the petroleum industry. Under steady shear, wormlike micelle solutions can exhibit a non-homogeneous flow, called shear banding, that occurs at a specific range of shear rates where the shear stress plateaus. It is also known that during a shear start-up, a stress overshoot occurs that can cause transient shear banding even in fluids that do not exhibit non-homogeneity at steady state flow. Rheo-NMR techniques are complimentary to bulk rheological stress measurements as it can measure the full velocity field. In this study, new Rheo-NMR equipment that can simultaneously measure the rheological response, a new capability for Rheo-NMR, was tested. The surfactant used was cetylpyridinium chloride (CPCl) with a counter-ion of sodium salicylate (NaSal), widely used in mouthwashes, toothpaste and other antiseptic products. Rheology was employed to identify the concentrations with shear banding shear rate ranges appropriate for more detailed Rheo-NMR measurements of the velocity field. Out of nine different concentrations, 6% wt and 10%wt CPCl/NaSal solutions were selected and were subject to rheology and Rheo-NMR shear start-up tests. For the 6% wt CPCl/NaSal solution, stress overshoot under shear

start-up conditions was observed for approximately a 2.5 s at shear rates between 6.5 s^{-1} and 10 s^{-1}. Rheo-NMR 1D velocity images and torque responses were then simultaneously acquired at shear rates of 7- 9 s^{-1}. In order to capture the transient velocity during stress overshoot, the time of acquisition for the Rheo-NMR velocity images was shortened to 2 s by optimizing experimental parameters.

Acknowledgements: Rehab Al Kaby (MSU Graduate Student) - Chemical & Biological Engineering

Emily Jones: Mechanical & Industrial Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
Investigation of Co-Sputtered Mg-Cr Alloy Thin Films

Owing to their light-weight and tunable electrochemical characteristics, magnesium (Mg) alloys have attracted increasing interest for diverse technological applications ranging from structures, e.g., aviation/transportation to functions, e.g., biocompatible materials. To realize performance in these applications, improved understanding of the basic relationships among Mg-alloy processing, structure and properties is needed. In this study, thin film (<5 μm) magnesium- chromium (Mg-Cr) alloys were deposited on quartz substrates by RF magnetron co-sputtering, yielding elemental compositions ranging from approximately 1 to 55 at% Cr. The films' surface morphologies, crystalline structures and electrochemical behaviors were characterized using field emission scanning electron microscope FE-SEM, energy-dispersive X-ray spectroscopy EDS, X-ray diffraction XRD, and potentiodynamic polarization measurements. As the concentration of Cr in the films increased the grain size reduced, surface roughness decreased, and anodic polarization current densities all decreased. XRD patterns show a shift to an increased value of 2Θ for the Mg peak as Cr concentration increased. Observed relationships among alloy physical vapor deposition PVD processes and structure, as well as alloy structure and properties are presented and discussed.

Kayla Keepseagle: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering
Spatiotemporal Distribution of Oxygen in Biofilms Measured by MR

Biofilms are single celled bacteria microorganisms that form colonies on a solid surface. The microorganisms are protected in the colonies by forming a biopolymer matrix made up of polysaccharides, proteins and DNA. All of which come from their own secretion. A mature biofilm is resistance to antibiotics due the active and dormant layer foundation. *Staphylococcus aureus*, a bacterium normally found on the skin, is the most common cause of hospital-acquired infections worldwide. Oxygen supply is a primary factor in healthy tissue. Delivery of oxygen can become impaired due to biofilms. Magnetic resonance imaging is a suitable technique to measure oxygen concentration within biofilms because it is non-invasive and gives spatially resolved images. It has been demonstrated that there is a linear relationship between spin-lattice relaxation rate of ^{19}F nuclei in fluorinated compounds and local oxygen concentration. But what has not been considered is the effect of droplet size due to the immiscibility of hexafluorobenzene and water. For the first bacterial sample, agrose gel was used as a tissue proxy. *S. aureus* and HFB was added to the sample prior to setting. A sterilized shear mixer was used to at the desired RPM to distribute droplets within the sample. A graph of pO_2 over time was obtained and the data concluded that there was biofilm growing at the top and the bottom of the sample, which illustrated a parabola shape of oxygen concentration with respect to position. The desired plot would have been for biofilm to be only growing at the top of the sample. Had this been true, the plot would have shown an exponential decay in oxygen concentration as a function of depth.

Acknowledgements: Jeffrey Simkins (MSU Graduate Student) - Chemical & Biological Engineering

Katherine Kent: Chemical & Biological Engineering
Mentor: Jennifer Brown -- Chemical & Biological Engineering
Rheo-NMR Studies of Locust Bean Gum, Xanthan Gum, and Mixed Biopolymer Gel with Silicon Dioxide Nanoparticles

Locust bean gum (LBG) and xanthan gum (XG) are biopolymers with many applications in food, biomedical, and pharmaceutical industries due to their low toxicity, availability, and affordability. The ability to modify the material properties of these polymers with additional components (i.e. polymers or particles) makes them particularly suited to a number of biomedical applications. When combining LBG and XG at 1% weight, a synergistic gel (LX) can be created that has remarkably different properties than each individual polymer. In the pharmaceutical industry, the LX polymer solution has been of interest to drug-delivery and slow release applications. Likewise, the addition of varying weight percentages of silicon dioxide nanoparticles (SiO_2) to 1% weight LBG, XG, and LX solutions can also substantially affect the material properties of these polymer solutions. Previous investigations have been concerned with characterizing these novel polymer-particle solutions on a macroscopic level through bulk measurements completed with a rotational rheometer. However, more information is needed to understand how these solutions are affected by SiO_2 concentration at a smaller scale when subjected to shear forces. Rheo-NMR, a combination of rheology and nuclear magnetic resonance, was used to gain insight on how these polymer-particle dispersions spatially behave under shearing forces. Velocity imaging, T2, and diffusion experiments were performed to help elucidate how the addition of SiO_2 nanoparticles affected the material behavior of each polymer solution.

Bridget Kilcrease: Mechanical & Industrial Engineering
Mentor: David Dickensheets -- Electrical & Computer Engineering
Focus Control Mirror Device for a Confocal Laser Scanning Microscope

Deformable mirror membranes use electrostatic forces to change the concavity of the mirror and therefore vary the focal length. This technology has been around for years and has many applications. Montana State University has been fabricating fast focus control deformable mirrors for use in laser-scanning instruments, including bar code scanners, 3D scanners, laser displays, laser cutting and engraving tools, and miniature confocal microscopes, since 2002. Typically these mirrors use aluminum as the reflective surface, but for this particular project the mirror surface will be silver, optimizing reflectance in the visible and infrared. Silver mirrors require a protective coating to prevent damage and tarnishing. This research is focused on developing a protective coating for the silver mirrors which will have to survive mirror fabrication, protect the silver, and not impair mirror function. So far it has been concluded that a thin layer of aluminum oxide, Al2O3, performs well in this regard. The next steps are to fabricate functioning mirror devices, characterize them and ensure functionality. Attempts to optimize the fabrication process and layer thicknesses are integral to this research as well. Once complete, mirror devices of this nature will be utilized in a functional confocal laser scanning microscope.

Nell Kirchhoff: Mechanical & Industrial Engineering
Mentor: Roberta Amendola -- Mechanical & Industrial Engineering
Optimization of the heat treatment parameters of Al, Cr and C coatings for nickel protection in Low Temperature Hot Corrosion (LTHC) environments

Propulsion systems, such as turbine engines, rely upon oxide surface layers to defend the bulk material from negative environmental effects. Systems that exist in environments that contain a high concentration of particulate matter or function under water, namely airplanes and submarines, suffer from corrosion in the combustion zone. The corrosion is a result of the combination of salts with sulfur compounds and water vapor all of which can be found in the fuel or the air. As a result of hot temperatures in the combustion zone and the low melting points of many salts, liquid deposits from the salts form on the bulk material and start to dissolve the oxide surface layers. This process is known as "hot corrosion." The development and optimization of coatings that are resistant to hot corrosion would increase the durability and efficiency of the components of propulsion systems. In this way, the propulsion systems would become more economical and improve the performance of aerospace and marine missions. For this investigation, thin (1 micron) coatings made out of combinations of aluminum, carbon, and chromium were deposited on nickel samples and the samples were heat treated to improve the coatings. A set of heat treatment parameters were used that varied the length of the heat treatment (1-2 hours) and the temperature at which the samples were heat treated (500-600 F). The surfaces were analyzed using a field emission scanning electron microscope (FE-SEM) and an x-ray diffraction system (XRD). Further analysis of the samples will determine which heat treatment parameters produce the most protective coating.

Acknowledgements: Lik Ming Aw (MSU Graduate Student) - Mechanical & Industrial Engineering

Thomas Lund: Chemical & Biological Engineering
Mentor: Jennifer Brown -- Chemical & Biological Engineering
Rheological Characterization of Suspensions of Inorganic Nanoparticles in Carboxymethyl Cellulose Solutions

Through the application of well-understood rheological techniques, this research aimed to investigate the ability to tailor the properties of aqueous sodium carboxymethyl cellulose (NaCMC) and nanoparticle solutions. Knowledge about how to control solution properties will enable the ability to impact the final characteristics of tape-cast nanoparticle and NaCMC films. Nanocomposite films are a growing area of research due to the wide range of potential applications. To accomplish this investigation, graphene, graphene oxide and hexagonal-boron nitride nanoparticles were suspended in 10 mg/ml NaCMC solutions and studied using a TA Instruments AR-G2 rheometer. These nanoparticles all have a similar 2 dimensional hexagonal structure. Due to this unique shape and the molecular structure of these particles, they had strong effects on the viscoelastic properties of the solutions. In particular, the -O and -OH functional groups on the graphene and the graphene oxide particles are hypothesized to interact with the NaCMC polymer chains. Graphene and graphene oxide both increased the viscosity of the solution by an order of magnitude and the hexagonal-boron nitride doubled the viscosity of the solution. Oscillatory experiments indicate that the graphene and graphene oxide solutions have a characteristic relaxation time of 0.063 seconds. Results for the less viscous samples were inconclusive. Work is ongoing to study the effect of varying the pH of the solutions which will provide additional information about the secondary bonding occurring between the polymer chains and the nanoparticle surfaces.

Acknowledgements: Julie Muretta (MSU Graduate Student) - Mechanical & Industrial Engineering

Ryan Mason: Chemical & Biological Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
Making Solar Cheaper with X-Ray Diffraction

Chlorosilane gas streams are used at high temperatures (>500C) to deposit ultrapure silicon required to make a product with semi conductive properties needed by the solar industry. This unique combination of high temperature and chlorosilane results in highly corrosive environments. By researching how to reduce this corrosion, the cost of silicon production and the cost of manufacturing solar panels will subsequently decrease, accelerating the adoption of this form of renewable energy around the globe. To reduce corrosion within reactor vessels, the corrosive environment within reactors was replicated in a corrosion testing apparatus found at the MSU High Temperature Materials Laboratory. Samples of iron and its alloys were exposed to chlorosilane gas streams of varying composition, temperature, and exposure times. In previous experiments, these samples were only subjected to gravimetric and FEM-EDS (Field Emission Scanning Electron Microscopy - Energy Dispersive X-Ray Spectroscopy) analysis, which allowed corrosion layers to be both identified and quantified. Upon the addition of XRD (X-Ray Diffraction) analysis, the structural composition of materials found in and around the corrosion layers of samples could be confirmed. The addition of XRD analysis furthered our understanding of iron corrosion in chlorosilane environments in several ways. XRD confirmed the existence of FeSi and Fe_3Si compounds in corrosion layers, something that previous analysis methods had predicted yet never confirmed. XRD has also indicated changes in FeSi compounds at different temperature and exposure ranges, a trend which is currently being investigated. Using these forms of analysis, trends can be quantified and utilized in silicon manufacturing to lower the cost of solar adoption.

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Michelle Meagher: Chemical & Biological Engineering
Mentor: Brent Peyton -- Chemical & Biological Engineering
Cultivation and Isolation of Novel Thermophilic Archaea from Alkaline Springs in Yellowstone National Park

A plethora of novel archaeal phyla have been proposed in recent years, significantly expanding the tree of life within this domain. Currently, few archaeal isolates have been successfully cultured and grown in the laboratory, such that little is known about the metabolic capabilities, nutrient cycling and basic physiological role of these unique and novel organisms in their environment. The goal of this research is to cultivate and isolate species of Archaea inhabiting alkaline hot springs in Yellowstone National Park (YNP), so as to develop a greater understanding of the prokaryotic life present in such novel environments. Sediment slurries collected from several thermoalkaline springs in the Heart Lake Geyser Basin were used to inoculate a matrix of Hungate tubes containing a common geothermal culturing medium, prepared either anaerobically with added nitrate or under microaerophilic conditions with either oxygen or nitrous oxide in the headspace. Oxygen containing tubes displayed a low concentration of apparent growth when observed via fluorescence microscopy, and images of this growth were captured. Due to this low concentration of cells, DNA extraction yielded insufficient genetic material for sequencing. It is thought that metabolite exchange is an important factor in the growth of these organisms. Continuing research will explore the possibility of establishing a co-culture with hyperthermophilic bacteria *Thermocrinis*.

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Addison Melvin: Chemical & Biological Engineering
Mentor: Joe Shaw -- Electrical & Computer Engineering
Studying the Characteristics of Aerosols Under Varying Atmospheric Conditions

During the 2015-2016 academic year, I will study aerosol effects on air quality with a focus on the size distribution and scattering properties of aerosols under varying atmospheric conditions. The amount and type of aerosols in the air are expected to change greatly between clean air months in the spring, wildfire smoke in the summer, and inversion haze in the winter. Parameters such as particle size distributions, optical depth, and Angstom coefficients describe the aerosols and provide a comprehensive description of the air quality. I will use instruments in Dr. Shaw's lab, such as the nephelometer and solar radiometer to measure these parameters during past and present time periods. Examining the different parameters of the atmosphere will allow me to depict the differences in air composition for clean and polluted air. I will discuss what the results mean in terms of the effect they have on public health and the cleanliness of the air in the Gallatin Valley.

Megan Miller: Chemical & Biological Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
PVD Thin Film Alloy Analysis

Physical vapor deposition (PVD) of thin film alloys has many different technological applications. For example, PVD coatings can be used to enhance the durability and wear resistance of metals, as well as accommodate non-equilibrium alloying to improve the corrosion resistance of the material. To increase the performance of thin film alloys, understanding the relationships among processing, the structure, and properties of these alloys is critical. Thin film alloys were deposited on quartz substrates by RF magnetron co-sputtering within the Montana Microfabrication Facility (MMF). Quartz substrates were used because of their chemical stability at high temperatures, relative inertness, and low-cost. The surface morphologies of the deposited thin film alloys were characterized using the field emission scanning electron microscope (FE-SEM) and elemental compositions were determined using energy-dispersive x-ray spectroscopy (EDS). X-ray powder diffraction (XRD) was used to identify the crystalline structure of each sample and small-spot x-ray photoelectron spectroscopy (XPS) was used to determine the chemical composition of the samples as a function of depth. The relationships between PVD parameters and resulting alloy characteristics are presented and discussed.

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Daniel Mills: Electrical & Computer Engineering
Mentor: Brock LaMeres -- Electrical & Computer Engineering
Vertically Integrating a Robotics Thread Through the Undergraduate ECE Curriculum

The objective of this research project is to evaluate whether using robotics throughout the electrical and computer engineering (ECE) curriculum can increase student understanding of theoretical concepts. This overarching research question is part of a project that Dr. Brock LaMeres is conducting through funding from the Montana Space Grant Consortium. Dr. LaMeres' team has deployed robotics in the freshman level courses in the ECE department with promising results. In my project, I assisted Dr. LaMeres in implementing robotics in a junior level course. Specifically, I worked with Dr. LaMeres to deploy robotics-based learning modules in EELE 371, Introduction to Microprocessors Systems. I also worked with Dr. LaMeres on creating the assessment plan to measure the impact of using robotics as the target application.

Joshua Moellenkamp, Gunnar Holwerda, Angelica Davis, Emily Rohrbough: Computer Science
Mentor: Clemente Izurieta -- Computer Science
The Software Factory Model: Refactoring S2 Corporation's EBAC System

The Extreme Bandwidth Analyzer and Correlator (EBAC) is a software product developed by S2 Corporation to process and display radio frequency signals received from their proprietary sensor system. In order to accommodate for future technical requirements, our team, working under the Software Factory model in the Software Engineering Laboratory, is redesigning its core architecture through a series of refactoring activities. These activities include (1) maximizing extensibility through the decoupling of system and graphical user interface logic, (2) increasing cohesion within and introducing encapsulation to subsystems, and (3) creating industry-standard documentation. To exemplify the new architecture, a fully-featured logging system will be developed atop the new design. By addressing current code faults in the EBAC software system through the methods described above, the functionality, maintainability, and reusability health factors of the system will be improved drastically, extending the software's expected lifetime. In leveraging strong software engineering principles, the Software Factory fully expects the refactored code to uphold and exceed requirements today and in the future.

Jake Morison: Computer Science
Mentor: Clemente Izurieta -- Computer Science
A Foreign Language Conversation Mobile Application

We develop an Android application for learning a foreign language, with a focus on conversational skills for intermediate and advanced learners. This app connects users via video chat to native speakers of the language they are learning. In turn, users spend an equal amount of time chatting in their own language to other users. This application is useful to developing the conversational skills, vocabulary, and inherent linguistic nuances that are so crucial to foreign language learning. This application exposes users to a wide variety of speaking styles, idiomatic expressions, and higher-level vocabulary. The app allows users to progress from beginner to intermediate speakers, and to advanced speakers with a firm grasp on conversational skills. Amongst notable functionality, the app allows a user to toggle between learner mode (foreign language) and teacher mode (native language), launch a search for other users currently online, and allow for the possible selection of conversation partners. Video chatting will be implemented using the VoIP protocol. This app allows users the opportunity to connect with other people around the world, gaining an insight into the nuance of foreign language and an appreciation of foreign culture.

Andrew Mueller, Jenna Lipscomb, Joshua Behm, Clint Cooper, Clayton Walker: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Truly Intelligent Gifting

PrintingForLess.com (PFL) is a Livingston based company that is currently developing a product, SwagIQ, which allows sales representatives to send gifts – food, branded apparel, desk toys, and other 'swag' to business contacts in order to initiate or deepen a business-to-business (B2B) relationship. This project is being developed through the Software Factory at Montana State University; which allows undergraduate students to work on real projects, with real stakeholders, in a simulation of a real-world work environment. The foremost requirement of this project was to take the existing SwagIQ concept, and automate it; that is, we want to send the right gift to the right person, at

the right time, automatically. We developed a stateless, web-based interface, using a natural language processing tool to parse text and help generate associations for words from a given corpus. We source this information through various means, including Facebook (where we can), Twitter, LinkedIn, and other social networking and Internet marketing sources. The basic algorithm works by retrieving information about an individual targeted for gifting, and determining, based on a weighted scale, what the best gift would be from a set of possible options from a given SwagIQ store.

Heather Nold: Civil Engineering
Mentor: Tony Hartshorn -- Land Resources & Environmental Sciences
Green Roofs: A Shelter from the Storm

Living roofs have potential to increase building energy efficiency, filter pollutants, provide lost habitat, and increase livability of urban environments. However these benefits require additional costs, bloating construction bids 4%-100% more than a conventional roof, making the economic practicality of green roofs questionable. One facet of research is quantifying the ability of a green roof to mitigate the impact of storm water runoff for city municipalities. To analyze the hydrology benefits of green roofs, regional characteristic runoff is simulated over green and conventional roof types in order to model roof discharge per unit time at various characteristic regional storm intensities and durations. If a trend in maximum sustained soil retention can be determined it can be equated to a maximum equivalent weight per unit area, allowing a structural designer to account for increased dynamic loading of a structure. This maximum value, equated with appropriate factors of safety will allow additional load to be quantified for the tested system. However due to the variety of engineered soils that exist in the green roof industry, there are large limitations on the universal validity of this project to the industry as a whole. Despite these limitations, the initiation of these studies is imperative to explore innovative environmental and communal solutions such as living roofs to investigate their progressive benefits and economic feasibility.

MacKenzie O'Bleness, Mike Trenk: Computer Science
Mentor: Clemente Izurieta -- Computer Science
The Effectiveness of Software Development Instruction Through the Software Factory Method for High School Students

Teaching software development in environments that mimic industry practices is essential for teaching applicable real-word development skills. In addition, these delivery based projects engage students in meaningful design work that encourages clear, sustainable code. The Software Factory has provided such projects and environment to students at MSU for the past year. This project aimed to explore the effectiveness of such instruction for high school students with limited programming experience. Three students from Bozeman High School were selected to work in a team with two undergraduates with the goal of creating an Android application over the course of a summer. In the process, these students were exposed to Java, sorting algorithms, version control, and software development practices in an industry setting. The experiences of the team will be described, as well as the challenges and rewards of using this teaching method, and the Software Factory, for students so early in their computing education.

Christopher ODonnell: Mechanical & Industrial Engineering
Mentor: Daniel Miller -- Mechanical & Industrial Engineering
How Variable Snow Microstructure Affects Gas Diffusion Rates

Our project focuses on both the causes and effects of gas flux through winter snowpack. Initial soil conditions, along with atmospheric influences, can affect gas flux, while this in turn can affect the snowpack's microstructure. In order to measure this gas flux, we have created a gas-tight sampling mechanism that can operate at low temperatures, unlike similar devices that are currently available. This sampling procedure has not only allowed us to further our research, but will also provide for unique collaboration and research projects with the department of environmental and land resource sciences. Furthermore, the results of our research will be beneficial in three key ways. First, our research will potentially reveal how changing gas flux through the snowpack can affect the snow's microstructure, such as through the amplification of temperature-gradient-driven depth hoar. Second, the

results will allow for better avalanche management, both through increased knowledge for snow patrollers about the amount of time they have to find buried individuals (based on remaining O_2 and the buildup of CO_2), as well as through allowing for more precise and location-specific predictions of avalanche occurrences through a focus on pre-snowfall soil conditions. Finally, with a better working understanding of the gas flux in the winter snowpack, environmental scientists will be able to better track and predict how snow conditions will affect the subnivean climate (the zone in and underneath the snowpack) and the vegetation and animals that inhabit it throughout the year.

Acknowledgements: Jeremiah Johnson (MSU Graduate Student) – Civil Engineering

Esther Oloff: Chemical & Biological Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering
Manipulating the growth of organoids using microfluidic techniques

We aim to use microfluidics, in which small volumes of fluid are precisely manipulated in a lab-on-a-chip device, to observe and manipulate the growth of human gastric organoids and to better understand the physical properties of the organoid structure and the growth process. Organoids are populations of stem cells grown into tissue spheroids which mimic in vivo organs and systems. The focus of our research is on human gastric organoids, which are grown from gastric epithelial cells. We use specialized microfluidic devices to encapsulate these cells within different geometries. The first technique is to make a device with different shaped holes, such as squares, cylinders, or crosses, which is submerged in a solution of gastric cells and liquid Matrigel. Once the Matrigel hardens, the shapes can be removed from the mold and placed in media, and the growth of the cells into organoids can be monitored. The second technique is to use a microfluidic drop maker to form drops of Matrigel that contain cells. The drops are collected and cell growth within each drop is examined. The goal is to learn what effect different forces from different Matrigel geometries have on growth. This project is in collaboration with the Chang and Bimczock groups at Montana State University.

Ticha Padgett-Stewart: Chemical & Biological Engineering
Mentor: Laura Bueter, Eric Boyd – Microbiology & Immunology
Determining ideal growth conditions for anaerobes from the Samail Ophiolite serpentinite system

Serpentinite systems have recently become a topic of increased scientific interest due to their similarity to early earth and extraterrestrial systems. Understanding the biology of serpentinite systems, such as the Samail Ophiolite in Oman, is therefore critical. Many organisms including those from serpentinite systems, metabolize chemicals to gain energy. This experiment focuses on the basic requirements for life; electron donors, electron acceptors, and carbon sources. Thirty-six samples containing one electron acceptor (either ferrihydrite, sulfate ($-SO_4$), or thiosulfate ($-S_2O_3$), at least one electron donor (hydrogen gas (H_2), formate or carbon monoxide (CO)), and at least one carbon source (carbonate ($-CO_3$), formate, or CO) with an H_2 headspace and a pH of 7.53 were grown. Additionally, thirty-six identical samples were cultured with the addition of cysteine as a source of reduced sulfur to allow for the growth of methanogens from the Samail Ophiolite. The reduction of iron and sulfur were measured as a proxy for growth. We found that the anaerobes present in the sample could grow with all tested electron acceptors with H_2/CO_3, formate and CO as electron donors. However no methanogenesis was observed. The next step after successfully culturing these organisms is to isolate them, and extract and sequence their DNA to better characterize the microbial community.

Amanda Parsons: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering
Pressure Driven Flow through Alginate Gels

Alginates are biopolymers extracted from the cell walls of brown algae and some strains of bacteria. In the presence of a divalent cation such as copper or calcium, the alginate forms a gel structure. These gels are useful for many applications such as waste water treatment and tissue engineering [1-3]. Using nuclear magnetic resonance (NMR) imaging however, it is possible to view the structure of the gels in a non-invasive way. With these images

the structural differences between the copper and calcium heterogeneous gels as well as clearly see no real structure in the homogeneous gel. NMR uses radio frequency energy to excite the nuclei of atoms such as hydrogen ^{1}H in order to record the amount of signal obtained from these excited nuclei. The purpose of this research is to learn the process behind creating these gels as well as the technique of imaging them in order to see the structure of the gel formed, and to look at the velocity profiles formed from flow through gel plugs.

Acknowledgements: Elmira Nybo (MSU Graduate Student) - Chemical & Biological Engineering, Sarah Codd (MSU Faculty Member) - Mechanical & Industrial Engineering

Sawyer Payne: Computer Science
Mentor: Brittany Fasy -- Computer Science
TODO: Analysis of Prostate Cancer with Persistent Topology and Homology

Every year in America alone there are 27,500 deaths from prostate cancer which is the the second most prevalent kind of cancer in men. Currently Prostate cancer is classified on the Gleason Grading Scale which ranges on a scale of one to five: one being the least dangerous pattern and five being the most. Doctors must spend valuable time grading each prostate slide. Even after they have graded the individual slide a patient or doctor may wish to find a second opinion on these slides which is very common because the most deadly pattern is misevaluated as a lower pattern 50 percent of the time. Currently in my research I am using the statistics modeling program R to generate a program that takes several numerical inputs and makes fake prostate glands. I will present my fake cancerous glands to a pathologist who will grade them as one of the five gleason patterns. Once this is done and I know the range of values that I can put into my program that generate each of the gleason patterns. The overarching goal of this research I am doing in conjunction with Dr. Fasy is to create a suite of descriptors that could be used to assist pathologists and doctors in identifying the gleason patterns found on slides taken from a patient's prostate using tools from computational algebraic topology. My program to generate fake slides will help expedite this process. Secondly, see if I can find any patterns in this cancer that previously have not been identified by doctors. This suite will save doctors valuable time and patients time and money in finding a second opinion.

Cara Robertus: Chemical & Biological Engineering
Mentor: Stephanie McCalla -- Chemical & Biological Engineering
Optimization of a Two-Stage EXPAR Reaction for Detection of let-7a and miR-208a

A promising new method for disease diagnosis is the detection of small, noncoding RNAs called microRNAs. These sequences serve as biomarkers for a wide variety of disorders. In addition, they are remarkably robust in the presence of adverse environmental conditions. In light of these characteristics, microRNA profiling holds great diagnostic potential. However, traditional methods of nucleic acid amplification are time-consuming, expensive, and impractical for resource-limited settings. The development of an isothermal amplification method for such environments will reduce the need for power and technical expertise when detecting microRNAs. One method for isothermal nucleic acid amplification is the exponential amplification reaction, or EXPAR. This reaction amplifies microRNAs at a single temperature in less than twenty minutes, making it a remarkably efficient, simple detection method. However, numerous studies have revealed that EXPAR promotes a phenomenon known as non-specific background amplification, wherein products are generated in the absence of the target sequence. This project explored an innovative approach to EXPAR designed to limit non-specific background amplification. Several different amplification regimes, including two-step amplification and amplification using a stem-loop sequence, were analyzed in order to characterize the reaction kinetics and to decrease the magnitude of non-specific amplification. In addition, surface plasmon resonance was used to study the kinetic behavior of Bst polymerase. This was done in order to elucidate the mechanism of non-specific amplification and to generate a mathematical model for the association of the enzyme with EXPAR reactants. The results of this study will be of great importance in future experiments.

Nathan Robertus, Karl Ohaus: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Sharelift

The purpose of this project is to design and implement a mobile application for use in the Bozeman community. The app, under the moniker *Sharelift*, will be a platform to facilitate ride-sharing in the Bozeman and Belgrade communities. It will allow skiers and snowboarders to offer and request rides from their peers in the community. The intention of our involvement is to provide design work and an implementation of a beta application for future testing over the upcoming 2016-2017 ski season. We developed our strategy and approach in terms of mapping the city, sorting rides geographically, creating an intuitive user experience flow, and choosing a platform upon which to build the app. After our design was ready, we began our development phase. This consisted of a weekly cycle of implementation changes, reviews, and re-designs when necessary. Once an alpha implementation was ready, we released a trial version to Apple's TestFlight service and the Google Play store. Development and alpha updates continue while alpha testers use the app and report bugs. The scope of our project is local. Our involvement comprises the initial development and testing phase, so the entire community of Bozeman will not be involved with our tests. Apple's TestFlight framework only allows twenty five users, so alpha and beta tests will only include a pool of users roughly this size. New versions and their counterpart requirements are in design stages, and the Sharelift team will continue to increase the user base and improve the application, broadening the scope to potentially include the northwestern United States.

David Schwehr, Dustin Spivey, Garrett Cornwell: Computer Science
Mentor: Clemente Izurieta -- Computer Science
High Altitude Balloon Tracking

With the increase in developing aerospace technology there is also a higher demand for aerospace programs at the academic level. High altitude balloons are an attractive tool to test and help develop these new technologies due to the potential of less cost and complexity of other test vehicles. For high altitude ballooning to be feasible to academia, the projects must fit size and weight constraints to avoid expensive components such as larger balloons, amounts of helium/hydrogen support, and requirements put forth by the FAA which can require the use of a transponder. If a smaller lighter payload can be used without a transponder but still provide air traffic control location information, high altitude ballooning programs would be more attainable by universities while not affecting the safety of air traffic. Our project aims to demonstrate the possibility for a balloon to provide dependable, near real time location information while remaining small, lightweight, and affordable. The balloon payload will utilize GPS, the Iridium Satellite Network, and the internet to make this goal a reality. Observers will have access to balloon location information through a mapping application and web server. The system will be tested and demonstrated during a total solar eclipse taking place in August of 2017. During the eclipse there will be 60+ high altitude balloons implementing our system that will be used by several air traffic control centers across North America. We can make high altitude ballooning a reality for more academic programs.

Jacob Senecal: Mechanical & Industrial Engineering
Mentor: Mark Owkes -- Mechanical & Industrial Engineering
Development of a Computational Fluid Dynamics Application

The field of computational fluid dynamics (CFD) provides insight into fluid flows that are difficult, expensive, or impossible to measure using experimental or analytic techniques. This project will focus on developing a custom, and adaptable, CFD application to solve the Navier-Stokes equations, and generate simulations of fluid flows. Uncertainty analysis will be added to the application to explore the effect of uncertain model data on fluid flows. Including the effect of inexact knowledge of boundary and initial conditions, system forcing, and physical properties of the medium in question. This project will provide an application that can be utilized by future graduate students who will work on adding a multi-phase component to the application.

Miles Sorlie: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Interactive Data Dashboard for Tracking App Utilization

This project involves building a data dashboard that creates utilization metrics of Pulsara's marquee software. The dashboard eliminates much of the effort and time needed to create reports. Prior to this functionality, it was difficult to aggregate data from our databases; which took up valuable working hours by forcing customers to manually track data in a spreadsheet. New backend technology supporting the dashboard extracts, transforms, and loads relevant data into a datastore. A critical feature is the sanitation of sensitive data that strips all personal information. The datastore is implemented using a dataset in Google BigQuery with a specialized schema specific to the dashboard and suited for fast statistical calculations. The dashboard then automatically pulls data from this datastore and loads it in a single page application (SPA). The SPA is written in Javascript and generates markup information. The design and architecture of the project is modularized in order to minimize corrections and increase cohesiveness. This is expected to pay off over time as it will provide a sound platform for diagnosing bugs and will provide for easy extensibility.

Miguel Strunk: Chemical & Biological Engineering
Mentor: James Wilking -- Chemical & Biological Engineering
3D Printing of Biofilm Scaffolds

Tissue engineers are developing techniques to print three dimensional tissue structures, e.g. scaffolds, that are biocompatible and ready for transplant into human patients, but little to no work currently exists using these techniques to study bacterial biofilms. We are working to create a bioprinter by modifying a Solidoodle 2nd Generation fused deposition modeling 3D printer, which normally prints thermoplastics, to print a sodium alginate based hydrogel that can support the growth of *Bacillus subtilis*. Numerous modifications have been made to both the printer's hardware and software to allow the printing of various soft materials. Hardware modifications include the creation of a coaxial flow extrusion head to print a sodium alginate "filament" in an outer layer of $CaCl_2$ crosslinking solution, minor alterations to the stepper motor system to accommodate the new print head, and integrate syringe pumps to control the flow of the alginate and $CaCl_2$ solution. Software modifications were necessary to integrate the syringe pumps with the stepper motor system in Repetier Host to properly calibrate various printing parameters vital to fused deposition modeling systems. Calibration of the system for optimal performance has proven difficult, but preliminary results are promising and could provide a new method to study biofilms in a three dimensional structure.

Genevieve Suwara: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Speech Therapy Number Recognition App

In the United States alone, there are an estimated one million people suffering from aphasia, a condition that causes problems with speech processing and production. This widespread problem requires speech therapy, a costly and time-consuming solution. The purpose of this project is to provide the foundation for an Android app that will allow stroke patients to practice recognizing and producing symbol, word, and auditory representations of numbers. It is meant to act as an enhancement to speech therapy that could be used to reduce the recovery time for the patient and overall cost. The app is set up like a game to make practice more engaging and has a user-friendly interface. In one of the activities, the app displays a symbol for a number, '7' for example. Then, the user is asked to type the word that would correspond to that symbol, 'seven.' Other similar activities are included that give auditory or word cues and ask for symbolic or word responses or a combination of those. Future development of the app would likely include practice with recognizing and producing words as well as numbers. However, the scope of this project will simply give a strong prototype to be built upon in the future.

Ryan Thompson: Computer Science
Mentor: Brittany Fasy -- Computer Science
Applying Techniques from Topological Data Analysis on a Celestial Data Set

As the field of Topological Data Analysis (TDA) continues to grow and develop, there are an ever increasing amount of applications that present and lend themselves towards this special type of data analysis. This research applies the processes of TDA on a celestial data set provided by the Sloan Digital Sky Survey, with the hopes to help show

and demonstrate the galactic uniformity that has been observed by astronomers. In order to achieve this, the large point cloud must first be parsed into different groups, or "windows", that focus on a select spatial region present in the data. This allows for the scope to be narrowed to that specific view while also reducing the large magnitude of the data into these much smaller and computationally manageable sectors. Once these viewing areas are established, the methods of TDA can be employed on each individual region, ultimately producing a persistence diagram that then acts as a descriptor for that chosen window. These diagrams are then able to be compared and contrasted, revealing the spatial nature that is inherently present in these celestial manifolds.

Una Trivanovic: Mechanical & Industrial Engineering
Mentor: Stephen Sofie -- Mechanical & Industrial Engineering
In Situ Alignment of graphene reinforced Na-CMC

Graphene is a two dimensional carbon allotrope with extraordinary functional and mechanical properties which can significantly alter the properties of a polymer matrix. Given its low cost, graphene has the potential to be an environmentally friendly, inexpensive modifier for the tailoring of composites. The 2-D structure of graphene is naturally anisotropic which if oriented in specific directions can be used to further manipulate properties. This study explores the in-situ alignment of graphene in a natural polymer carboxymethyl cellulose (CMC) matrix by means of alternating current electrophoresis. High shear mixing of graphite in aqueous solution is utilized as an inexpensive method for exfoliating defect free, few layer graphene. The water solubility of CMC provided an ideal testbed for processing thin films. A 0.1 Hz square wave at 10 volts was applied to the graphene reinforced CMC gels in a Teflon mold using graphite foil electrodes to achieve high quality films for testing. AC voltage electrophoresis is used to examine the effect of graphene platelet oscillation and hence alignment without inducing a net migration, and gels were dried under a constant voltage. In addition to the optimization of processing parameters to prepare flaw free CMC films, the influence of graphene orientation on the electrical and structural properties of CMC films will be reported by utilizing DC conductivity measurements and Differential Scanning Calorimetry (DCS).

Acknowledgements: Julie Muretta (MSU Graduate Student) - Mechanical & Industrial Engineering

Aubree Trunkle: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
Fuel Cell: Water Management

In recent years, hydrogen fuel cells have received attention because they are considered a promising alternative to fossil fuel engines. A main issue that has been the focus of research is water-management inside the fuel cell. The fuel cell needs a delicate balance between too little water (dehydration) and too much water (flooding) to combat low performance. The goal of the research is to investigate various methods that help to moderate water build-up within a fuel cell. One specific technique used is called anode water removal (AWR). It was found that through AWR a substantial proportion of accumulated water (i.e. due to flooding) in the fuel cell could be removed via the anode fuel stream. To investigate the water content of the cell, some conditions, including, relative humidities ranging from 0% to 100%, a hydrophilic versus hydrophobic gas diffusion layer, pressure at 1 atm and 2 atm, and temperatures at 65°C, 75°C, & 85°C were used. By manipulating these conditions, the collected data, specifically, the pressure drop which predicted the relative humidity of the exit gas, helped to deduce how much water was actually being removed from the system. Analysis of the data showed that in setups with lower initial voltage due to high water accumulation, the amount of water evaporated and removed by the dry gas stream could be accurately estimated. This result of water removal rate correlated to an increase in resulting voltage as well. Further research will continue the analysis approach with more methods developed & refined for the future.

Acknowledgements: Logan Battrell (MSU Postdoc/Research Scientist) - Chemical & Biological Engineering

Kelly Walls: Mechanical & Industrial Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
Characterization of a High Temperature Chlorosilane Corrosion Environment for Improved Polysilicon Production

Poly-crystalline Silicon (polysilicon) is a high quality product manufactured for use in many real world applications, most commonly in solar panels. Polysilicon is produced in large pressure vessels using a vapor deposition process which requires high temperature chlorosilane gas streams flowing through them. Chlorosilane gas is made of hydrogen (H2), silicon (Si) and chlorine (Cl) and it is known that many metals form silicide and chloride compounds. In a high temperature environment, the presence of chlorine and silicon creates a unique corrosion environment dependent on time, temperature, and material composition. Thus, a high temperature chlorosilane corrosion environment was created to replicate industrial processes in order to understand the corrosion interaction of this gas with certain metals. In this study, temperature dependence on corrosion of 316L stainless steel was investigated. Specifically, this 316L stainless steel was subjected to four different temperatures above 500C with the same starting chlorosilane gas composition. It was observed that mass gains increased exponentially with temperature increase. The results, conclusions and characterization of this test system are discussed further in this poster.

Acknowledgements: Josh Aller (MSU Graduate Student) - Mechanical & Industrial Engineering

Nicholas Ward: Civil Engineering
Mentor: Joel Cahoon, Christopher Allen -- Civil Engineering
Air Entrainment in Open Channel Flows

The goal of this study is to establish an empirical relationship that will allow the effective use of a simple and versatile method to measure air concentrations in open channel flow. The presence of air can have a significant impact on the physical interactions between objects and the water. Air entrainment at the bottom of a fish ladder can make it more difficult for fish to jump upstream. In a similar way, high levels of aeration below a waterfall serve to cushion the impact for a plunging kayaker. The Souquet, which is a device similar to a large syringe, can be used to extract a known constant volume of air and water from an aerated section of flow. By comparing the air content in the Souquet with an observation of air content calculated volumetrically in the flow chamber, a model can be formed to estimate the amount of air entrained in a particular volume of fluid at a specific Froude Number. The Froude Number is a function of the velocity of the inflowing fluid and the depth of the flow in the channel, and it provides a measure of the resistance to an object moving through the fluid. The hypothesis being tested is that a statistically valid relationship between the sample air content in the Souquet and the observed air content will be found for each variation in Froude Number. If successful, this relationship will allow the use of the Souquet in field settings to quantify air content. Ultimately, the ability to accurately measure air entrainment in a fluid will drastically improve the usefulness and accuracy of current fluid dynamics models.

Joseph Watkins: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
Two-dimensional modeling of water vapor transport in PEM fuel cells

The proton exchange membrane fuel cell (PEMFC) is a promising energy conversion device being developed for a wide range of applications. A challenging design issue is ensuring that the PEM is sufficiently hydrated, promoting ionic transport, while avoiding flooding that occurs when water accumulates and covers reaction sites in the catalyst layers. To find this balance, a fundamental understanding of the transport phenomena within the cell is needed. A two-dimensional transient model coupling single-phase flow, species transport and heat transfer processes is developed to investigate the transport of water vapor within a PEMFC. The model uses the Naiver-Stokes equations to model flow through the gas channels and the Brinkman equations to model flow through the porous Membrane Electrode Assembly (MEA). Laminar velocity conditions are specified for the channel inlets while pressure conditions are specified for the channel outlets. The convection-diffusion equation is used to model the transport of vapor throughout the cell using Bruggeman effective diffusivity corrections to account for transport through the MEA. Heat transfer is modeled with the heat equation utilizing equivalent volumetric heat capacities and thermal conductivities to account for transfer through the MEA. The effect of varying the inlet temperatures (65-85°C), relative humidities (0-100% variations for the anode and cathode) and average velocities (0.1-2 m/s for air and 0.1-5 m/s for hydrogen) on the distribution of water vapor throughout the cell is

demonstrated with this model. More water vapor is transported from the cathode side to the anode side when temperatures increase, the anode RH is reduced, and the anode flow rate is increased. These results will later be compared to experimental PEMFC data.

Shu Ying Wee: Chemical & Biological Engineering
Mentor: Christine Foreman -- Chemical & Biological Engineering
Role of Pigments in Antarctic Bacteria Stress Response

Microorganisms in polar regions are exposed to a variety of environmental stressors including: temperature extremes, pH, nutrient limitation, ultraviolet radiation, and oxidative stress. One adaptation that cold temperature organisms have developed is the ability to regulate membrane fluidity in order to cope with imposed stressors. Membrane fluidity at low temperatures is achieved through the incorporation of carotenoids, into the membrane. This project sought to determine the role of pigmentation in organisms' environmental stress responses. Results will provide insight into survival mechanisms for life in the extreme. Six bacterial isolates from the Cotton Glacier supraglacial stream in Antarctica were selected as they contain a variety of carotenoid and non-carotenoid pigments. At mid-exponential growth, cells were exposed to an array of stressors including: acid, alkali, osmotic, oxidative, UV stress, freezing and heating. Organisms were exposed for 2, 6, 12, and 24 hrs after which the percentage survival was calculated. CG9_1, a F*lavobacterium sp.*, with zeaxanthin pigmentation had overall low survival rates. Specifically, when exposed to 1M NaCl for 2 hrs 4.45±0.918% of cells survived. CG9_1 had complete mortality when stressed under acidic conditions (pH 3) and 1.23±0.581% survival under basic conditions (pH 10). In contrast, the astaxanthin pigmented CG9_6, a *Cryobacterium sp.*, had a survival rate of 728±36.2% in 1M NaCl for 2 hours. While analyses are ongoing, these results suggest that different pigmentation among cold temperature organisms contributes to the organism's ability to withstand a variety of imposed environmental stressors.

Acknowledgements: Laura Fisch (MSU Undergrad Student) - Chemistry & Biochemistry, Heidi Smith (MSU Graduate Student) - Land Resources & Environmental Sciences

Christopher Wiley: Chemical & Biological Engineering
Mentor: Jeff Heys -- Chemical & Biological Engineering
Modelling and Optimization of Selective Hyperthermia using Gold Nanorods

Hyperthermia using gold nanorods (GNRs) is a method of cancer treatment which uses lasers to heat the GNRs and, subsequently, nearby cancerous cells to the point of protein denaturation, inducing cell death. This method can be enhanced by the use of heat shock protein-inhibitors (HPIs) that inhibit the creation of heat-resistant proteins in the cells, making them selectively more susceptible to hyperthermia. Much work has been done to develop these techniques, but little has been done to optimize them, especially as related to minimizing the death of surrounding healthy tissues. Due to the large number of tunable controls (e.g. laser beam width, intensity, duration; concentration of GNRs; diffusivity of HPIs), optimizing the treatment experimentally would require a prohibitively large number of trials. However, finding promising configurations using a mathematical model has been shown to be very feasible. This project will build a mathematical model, comprising heat transport, cell death, and HPI diffusion submodels, using the Python coding language. The differential equations involved in the model will be solved using Python's Numpy and Scipy libraries, and the therapy parameters will be optimized to achieve sharp separation between the 99% cell death zone, bounded by the cancerous region, and the surrounding healthier tissues. This optimization will be carried out using a simplex algorithm. The results of this project will inform experimental researchers as to the configurations of therapy best suited for selectively killing cancer cells, while minimizing harm to healthy tissues.

COLLEGE OF LETTERS & SCIENCE

Kirina Amada: Microbiology & Immunology
Mentor: Eric Boyd, Zoe Harrold -- Microbiology & Immunology
Characterization of the growth of a chemolithotrophic subglacial isolate on thiosulfate under oxic and anoxic conditions at low temperatures

The subglacial environment is characterized by what humans would consider harsh conditions, which includes low temperature and no sunlight. Despite these harsh conditions, microbes have adapted to not only live in the subglacial environment but to thrive under these conditions. In the absence of sunlight, microbial primary producers that make up the base of the microbial community food web in subglacial systems must obtain their energy from inorganic compounds through a metabolic process called chemolithoautotrophy. Pyrite (FeS_2) found in the bedrock underlying many subglacial systems may provide an important source of energy for chemolithoautotrophs in subglacial microbial communities. Abiotic FeS_2 oxidation releases thiosulfate, a stable reduced sulfur compound, into the subglacial environment. The mechanism that allows for chemolithoautotrophic microbes in the subglacial environment to oxidize thiosulfate for use in energy metabolism at low temperatures and under anoxic conditions is still not known. I propose to investigate the metabolic capabilities of a subglacial chemolithoautotroph to obtain energy from thiosulfate at low temperatures. This work will involve measuring the growth of an isolated subglacial bacterium on thiosulfate under oxic and anoxic conditions at 15 ^{o}C. Data collection will include both geochemical and cell count data to monitor the concentration of thiosulfate and production of sulfate (product of thiosulfate oxidation) and cells as a function of time. I will compare my bacterial growth data to data from killed controls. Results from my work will advance our understanding of the role of chemolithotrophic metabolism in sustaining subglacial communities and will allow us to better understand the complex relationship of microbial communities and geochemical cycling in the subglacial environment.

Noah Archer: Physics
Mentor: Hugo Schmidt, Chi-Shun Tu -- Physics
Development of Lead-Free Piezoelectric Compounds for Environmentally Friendly Applications

Piezoelectric actuators and sensors have a wide range of applications from smaller applications such as medical ultrasound to large scale arrays, as used in sonar by the Navy. Presently, the ceramics with the best piezoelectric properties contain lead; however, growing concerns about the negative environmental impact lead presents has led to a significant need for research to find suitable and environmentally friendly replacements for the currently used ceramics. One area of research, and our current research focus, is on $(Bi_{1/2}Na_{1/2}O_3)_{0.925}(BaTiO_3)_{0.075}$ doped with Manganese (Mn) which in amounts up to 2% increases the depolarization temperature, above which the piezoelectric property is lost.

Cooper Ashley: Physics
Mentor: Jiong Qiu -- Physics
Differential Cooling of Coronal Loops

The Sun has the strongest magnetic field in the solar system. Within this magnetic field, plasmas are trapped to create coronal loops that extend millions of meters into the Sun's atmosphere. These plasmas cool over time in a very interesting way. Using images and data from solar telescopes these loops can be studied in great detail. With the help of computer software, several different temperature filters were applied to images of coronal loops in order to study how these loops cool over time. The loops were studied in the temperature range of 800,000K to 6 million Kelvin. It was found that it takes roughly 40 minutes for coronal loops to cool from 6,000,000K to 800,000K. In addition to the time it takes to cool, how the loops cool was also studied. At lower temperatures and higher densities, radiative cooling dominates and is the primary way that coronal loops cool. At higher temperatures and lower densities, conductive cooling dominates.

Madison Bautista: Microbiology & Immunology
Mentor: Jill Holder, Carmen Byker-Shanks, William Stadwiser -- Gallatin County Food Bank, Health & Human Development, INBRE
Establishment of an internal compost system for Gallatin Valley Food Bank

Each day, Gallatin Valley Food Bank receives hundreds, sometimes thousands of pounds of food donations. Because the organization's primary mission is to improve food security throughout Southwest Montana, food spoilage and waste are areas of critical concern. Produce, in particular, has a short shelf life, and donations with mixed qualities of freshness occur frequently. Gallatin County Food Bank is interested in combining existing microbiology research with current food composting best practices to reclaim food nutrients at risk of spoilage. The ultimate aim of the project is to evaluate the feasibility of establishing an internal composting program and, if deemed feasible, to determine how best to redeploy reclaimed nutrients in ways that support the organization's mission and improve human health in Gallatin County.

Juliana Beauchene: Microbiology & Immunology
Mentor: Jodi Hedges, Emily Kimmel -- Microbiology & Immunology
Human TLR4 versus Mouse TLR4

This project focuses on the immune response of Toll-like receptor 4 (TLR4) and its potential to be an important receptor in the transformation and creation of vaccinations used today. Vaccines contain adjuvants, which are substances that help enhance your body's adaptive immune response. Adjuvants are necessary additives to vaccines as they ensure the body produces memory B-cells, which must be created in order for vaccines to succeed in making your body immune to disease. TLR4 is a receptor found on cells of the innate immune system. It detects signals associated with certain types of pathogens and initiates a chain of events that activates the immune system. TLR4 has two different signaling pathways: TRIF and MyD88. The TRIF pathway is the more desirable pathway in vaccine creation because it efficiently activates the body's immune system and stops illness without an inflammatory response. Currently, there have only been studies that show mice TLR4 is biased towards the TRIF pathway. In order to be helpful in human vaccines, we have to demonstrate that the human TLR4 gene is biased towards TRIF pathway. This study focuses on studying cells from mice genetically engineered to contain the human TLR4 gene. Showing that adjuvants can be used to stimulate the human TLR4 gene and therefore initiating the TRIF pathway, would be the first step in showing how adjuvants that stimulate TLR4 could improve human vaccines.

Sonja Benton: English
Mentor: Ben Leubner -- English
LGBTQ Perspectives in 20th Century American Poetry

In many forms of media, LGBTQ perspectives and voices are frequently unheard and considered less important than other stories and viewpoints. This, however, becomes less so as one analyzes the voices represented in poetry. The expressions and emotions inherent within a multitude of poetic voices provides a backdrop to ones experienced in the 21st century. The interaction with collections of work where one is represented also allow for a greater self-acceptance which is inherent in social activism and changing societal perceptions. By collecting various intersectional LGBTQ poetic voices, like Audre Lorde, Allen Ginsberg and many others, from within the last century, the progress and difficulties of these identities can be mapped within a larger narrative of marginalized experience and activism. Critical analyses are utilized to interpret and categorize feelings of disclusion, joy, pain, separation, confidence and more to help Montana State University students further recognize their own responses to identity. Upon completion, bound copies will be given to the Diversity Awareness Office in order to help increase the amount of representative works available to students.

Peter Billman: Ecology
Mentor: Matt Lavin -- Plant Sciences & Plant Pathology
Multi-intron Analysis of Aquilegia flavescens in the Central and Northern Rocky Mountains

The columbine plant genus appeared in Asia approximately 6.5 million years ago (mya) and migrated to North America around 3.13 mya using the Bering Land Bridge. Due to this relatively recent migration, this genus is ideal for studying rapid speciation. Of the 70 species of present-day columbine in the Northern Hemisphere, the yellow columbine (*Aquilegia flavescens*) is one of the least studied. These plants are found in the montane and subalpine zones of the Rocky Mountains, extending from Utah to British Columbia. Little research has been conducted to understand how geographically separated populations interact with one another. Our study analyzed 45 populations of yellow columbine across Montana, Wyoming, Utah, Idaho, Oregon, Washington, British Columbia, and Alberta to better understand gene flow. Dispersal of seeds occurs when the follicles dry and seeds fall right below the parent plant, limiting the movement of these plants on the landscape and between mountain ranges. We hypothesized that isolation-by-distance was therefore occurring. Using polymerase chain reaction, we analyzed two separate regions of DNA. The regions were the trnL and ITS2 sequences. The trnL and ITS2 introns are several hundred base pairs in length and appear rather conservative. These regions were selected due to their non-coding nature, making them more susceptible to mutations relative to coding exons. Isolation- by-distance does not appear to play a significant role in this species, potentially due to pollinators. Differences in both regions of DNA did appear between several samples. We also explored variables encouraging speciation including climate data. There appears to be differences in the DNA occurring in a northeast versus southwest fashion and these regional differences also differ in precipitation and temperatures.

Nathan Blaseg: Microbiology & Immunology
Mentor: Douglas Kominsky -- Microbiology & Immunology
The Role of IFN- γ Induced IL-10R1 Expression in Restitution of Epithelial Barrier Function during Gastrointestinal Inflammation

Inflammatory bowel diseases (IBD) are debilitating diseases of unknown origin, but a combination of genetic and environmental factors are thought to be involved in disease pathology. Ongoing inflammatory responses are paralleled by significant alterations of epithelial cellular responses, including changes in barrier function and cytokine response. Preliminary studies indicate that epithelial IL-10 signaling plays a critical role in barrier function and tissue restitution and IFN-γ mediates the upregulation of IL-10R1 expression. Further, studies in a murine colitis model demonstrate that loss of epithelial IL-10R1 dramatically worsens inflammation and disease outcomes *in vivo*. Based on these preliminary studies, we hypothesize that epithelial IL-10R1 expression is crucial to tissue homeostasis and IFN-γ-induced upregulation of IL-10R1 primes the tissue for pro-resolving IL-10 signaling. To define these principles, two specific aims are being pursued. The first aim is to define the molecular mechanisms of epithelial IL-10-dependent maintenance of barrier function. This is done by focusing on the examination of apical junction proteins and the impact of IL-10 signaling on expression, protein level, and localization of these targets using a host of molecular biology techniques. The second aim is to elucidate the mechanisms of IFN-γ-mediated induction of epithelial IL-10R1 expression. Since preliminary studies suggest that tryptophan metabolites play a major role in this induction, these metabolites and their associated genes and receptors are being further investigated. A better understanding of these principles may lead to improved treatment for those suffering from IBD, controlling the inflammatory response and ultimately decreasing the severity of disease.

Rachel Bruns: Microbiology & Immunology
Mentor: Diane Bimczok -- Microbiology & Immunology
Optimization of Growth Conditions for Human Gastric Organoids

Long-term In vitro culture of primary gastrointestinal human epithelial cells has recently become an important research tool for studying epithelial cell function. Culture of these cells has been achieved using an innovative model called organoids, which are stem cell-derived, three dimensional structures grown using growth-factor optimized medium in a basement membrane matrix. The objective of this project is to optimize the growth conditions for human gastric organoids for use in Dr. Bimczok's lab where we are investigating gastric dendritic cell (DC)-epithelial cell interactions during *Helicobacter pylori* infection. Optimization of the gastric organoid model is the first step in establishing whether the gastric organoids respond to *H. pylori* and whether DCs co-cultured with the organoids interact with the epithelial cells. Thus far in the project, we have quantitatively and qualitatively

described organoid growth over time using imaging software. Our data shows that on average, organoids follow a typical sigmoidal growth curve with growth peaking at 10-11 days. We also show that organoid growth is not limited by proximity to nutrients or to other organoids and that growth rate is not influenced by initial size of the organoid. Overall, our data show a staggering amount of variation between individual organoids in a single well. We anticipate that as we continue to optimize the media for organoid growth, we will be able to provide more uniformity in size and growth rate amongst organoids in each well so that they can be better manipulated for investigation of DC-epithelial cell interactions during *H. pylori* infection.

Logan Cain: Earth Sciences
Mentor: Colin Shaw -- Earth Sciences
Cordillera Blanca Detachment Channel Analysis

The Cordillera Blanca Detachment (CBD) is a major normal fault bounding the western flanks of the Cordillera Blanca, the highest range in the Peruvian Andes. Prominent fault scarps and triangular facets indicate that the fault has a history of significant slip during the last 12,000 years (Holocene), but it is unclear whether past events ruptured the entire 200-km-long fault, or smaller segments. Constraining the dimensions of past ruptures is important for forecasting the magnitude of future earthquakes on the fault. This poster examines stream knickpoints on different fault segments of the CBD as indicators of the rate of fault slip. Channel profiles were extracted using the MIT stream profiler and knickpoints were identified using elevation vs. distance and gradient vs. drainage area plots of the stream profiles. Using aerial imagery, channels with varying degrees of evidence of past glaciations will be identified in order to provide a baseline of glacial effects on channel profiles. Preliminary data shows that in the northern section of the CBD migrating and stationary knickpoints are interspersed along the profile while in the south migrating knickpoints tend to occur up stream of stationary knickpoints. Further analysis will attempt to classify knickpoints based on the geological and geomorphological processes that created them in order to focus on those that evolved from fault slip. Once completed, these data and analyses can be used to determine how the Cordillera Blanca landscape responds to sudden seismic events like earthquakes and rapid increases in fault slip rate.

Charlie Carpenter: Mathematical Sciences
Mentor: Mark Greenwood, Jenny Green, Jim Robinson-Cox -- Mathematical Sciences
Does a randomization introductory statistics curriculum prepare students for intermediate statistical concepts better than consensus curricula?

Recent years have seen massive changes in the curriculum used in STAT 216 (Introduction to Statistics) at Montana State University. The purpose of this study is to assess the differences between different curricula in STAT 216 on performance of the students in a future statistics course. Student outcome information from spring of 2013 to fall of 2015 was collected for students that took STAT 217 (Intermediate Statistical Concepts). Student success in this course was considered in two different ways. First, we looked at the WDF rate (withdrawing or receiving a D or lower as a final grade) of STAT 217. Generalized linear mixed models were used to explore differences in WDF rates across curricula while controlling for the random variation among sections of 217. Second, for those who completed the course, we used linear mixed effects models to assess the impacts of the different STAT 216 curricula on the GPA points earned in 217 while controlling for the random variation among sections of 217. Both of these models also controlled for students' GPA going into 217 and GPA points earned in STAT 216. There is not strong evidence that the different STAT 216 curricula have impacted WDF rates in STAT 217 for MSU students or the performance of STAT 217 students who complete the course.

Katherine Chamberlain: Physics
Mentor: Nicolas Yunes -- Physics
Constraints on Modified General Relativity with Advanced LIGO

Gravitational waves (GWs) are the result of some of the most energetic and violent events in the known universe. Generated by the inspiral and merger of black hole or neutron star binary systems, GWs propagate through space, stretching and compressing spacetime by less than the width of a nucleus of an atom by the time they reach Earth.

The detection of gravitational wave GW150914 by the Advanced Laser Interferometer Gravitational Wave Observatory (aLIGO) last September sparked public interest in General Relativity once again. While there has been extensive testing of Einstein's General Relativity (GR) on the solar-system scale, GR has yet to be constrained in a high speed and incredibly dense regime in which extreme conditions may break certain "pillars" of GR. This project focused on four modifications to GR: the presence of dipolar radiation, extra dimensions, a massive graviton, and gravity parity violation. Using Fisher Analysis, we worked to determine how well these modified theories of GR could be constrained as a function of instrument sensitivity by implementing our own phenomenologically modified aLIGO noise curves. We then compared the constraints to those given by noise curves constructed with data from aLIGO. We found that theories with a lower Post-Newtonian (PN) order can best be constrained by an improvement in the low frequency regime of the noise curve while higher PN orders require an improvement of instrument sensitivity in mid-range frequencies. There are obvious extensions of this work to the Evolved Laser Interferometer Space Antenna (eLISA) that can place further constraints on modified theories of GR by detecting GWs emitted from supermassive black hole binary systems and from the early inspiral of low mass binary systems.

Hanbyul (Hannah) Cho: Microbiology & Immunology
Mentor: Agnieszka Rynda-Apple -- Microbiology & Immunology
Determining Composition of Lung Microbiota before and after respiratory viral infections

For a long time, lung was believed to be a sterile mucosal site, and it was just recently that researchers realized microbial communities (microbiome) exist in the lung. However, it is still unclear how the composition of lung microbiome affects the immune responses to pathogens and allergens in the respiratory tract. This project is a continuation of my summer research project entitled "Determining Composition of Lung Microbiota in the C57BL/6 and Balb/c mice". During my summer internship with Dr. Agnieszka Rynda-Apple, I demonstrated that lung microbiota composition differs between two strains of laboratory wild type (WT) mice, namely C57BL/6 and BALB/c mice. Here I propose to expand this research by determining how different is composition of microbiota of mice lacking type I interferon signaling (IFNAR-/- mice) and that of WT C57BL/6 mice. IFNAR-/- mice can be more susceptible to some infections than WT mice, because, type I interferon signaling in host's cells is known to be a very potent and early mechanism of anti-viral and some anti-bacterial responses. Thus, I will determine composition of lung microbiota in both (1) steady-state lungs (healthy lungs without infection) and (2) in lungs of mice that were either infected with influenza virus (mouse adapted H1N1 influenza virus strain) or inoculated with not infectious virus-like particles (VLPs) by polymerase chain reactions (PCR and qPCR). Results of this study will expand our understanding of the role of lung microbiota in directing the immune responses to both pathogenic and non-pathogenic viruses.

Niall Clancy: Ecology
Mentor: Wyatt Cross -- Ecology
The effects of a large river impoundment on river channel complexity: implications for macroinvertebrate community structure

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.

Acknowledgements: Eric Scholl (MSU Graduate Student) - Ecology

Nolan Clark: Psychology
Mentor: Lori Christenson -- Gallatin City-County Health
Community Readiness Assessment

For my INBRE research I worked with the Gallatin City-County Health Department (GCCHD) whose mission is to promote and protect health while preventing disease. In 2011 and again in 2014, GCCHD completed a comprehensive Community Health Assessment, which led to completion of a Community Health Improvement Plan (CHIP) for Gallatin County. The resulting Gallatin Community Health Improvement Plan– a document driven by community participation and priority setting – established three broad areas of emphasis, including one focused entirely on reducing the impact of use of alcohol, tobacco, and illegal drugs. In order to assess the community's capacity to take action on this particular issue I performed a Community Readiness Assessment focused specifically on binge drinking in youth under the age of 21. The Community Readiness Assessment Model allows identification of characteristics related to problem awareness and readiness for change. By examining specific dimensions of readiness community partners can better understand where to intervene as well as identify what types of strategies will be most efficient and have the greatest potential for success. Data from this assessment will be used to create a community action plan and further community dialogue related to binge drinking in youth under the age of 21.

Patrick Cole: Chemistry & Biochemistry
Mentor: Mary Cloud Ammons, Valerie Copie -- Chemistry & Biochemistry
Developing Novel Anti-Biofilm Agents

The primary goal of this project is to identify the metabolic and transcriptomic changes that occur in biofilms of *Pseudomonas aeruginosa* when undergoing various treatment regimens. These regimens contain lactoferrin, xylitol, and/or erythritol. Combined treatment with all three agents has proven to produce novel antimicrobial effects on *P. aeruginosa* biofilms by an as of yet unknown mechanism. Preliminary data points to an increase in the degradation of branched chain amino acids in erythritol treatments as well as the treatments containing lactoferrin in combination with one or both of the sugar alcohols. Further evidence suggests that these cells are coping with osmotic pressure, which may be leading to metabolic changes throughout the biofilm colonies, including a reduction in production of the virulence factor pyocyanin.

Acknowledgements: Brian Tripet (MSU Postdoc/Research Scientist) - Chemistry & Biochemistry

Rebecca Davis: Modern Languages & Literatures
Mentor: Patricia Simpson -- Modern Languages & Literatures
Digital Media Strategies of the German Far Right

Muslim immigration to Europe has increased dramatically in the last three decades. With a growing Muslim population in countries such as France and Germany, among others, social and political tensions are also rising between immigrants and the receiving nations. In response to this, far-right political organizations are quickly gaining influence among generations of young and old in the media, and never has there been a more appropriate time to study the influence of today's digital media strategies. This project focuses on media platforms such as Facebook, Twitter and other various news outlets used internationally to advertise the presence and values of extreme political organizations. My research focuses specifically on the German group PEGIDA which roughly translates to 'Patriotic Europeans Against the Islamization of the West'. In this project I analyze the methods and platforms the organization and their supporters use to prevent what they perceive as the Islamization of the West. In addition, I briefly research additional organizations throughout history in Europe and compare the motives used to gain followers. This research showcases the importance of understanding the use of digital media as a modern platform for propaganda.

Alec Dinerstein: Physics
Mentor: Graham Austin -- Business
That's Right, You're Wrong

Research Question: What are the relationships between social identity theory, individual ideology, motivated reasoning, solution aversion, and ancestral consumption? Modern society has created a breeding ground for competing ideals. Research shows that individuals cling tightly to ideas, values, and behaviors, especially when faced with opposition. Based on their ideology, people evaluate scientific information (specific examples include science related to climate change, the paleo diet, evolution, GMOs, and vaccination) appearing in the popular press, decide whether they believe it's legitimate, and subsequently choose behaviors in accordance with their views. I aim to build a theory-based conceptual model to clarify the connections between these behavioral constructs. I will build this model based on conversations conducted in the public domain, related to science and consumer behavior. In order to probe these connections, I will be conducting a netnographic study that uses the 2015 Disney measles outbreak as the context. Netnography is a research technique that qualitatively analyzes data collected from online sources, such as chat rooms and discussion boards. The model I generate can be used to develop empirical research designs related to consumer evaluation of scientific information. These results may inform education, public policy, and further research.

Charles Dyson: Microbiology & Immunology
Mentor: Eric Boyd, Melody Lindsay -- Microbiology & Immunology
Geochemical and microbiological characterization of unique hot springs in Smokejumper hot springs basin, Yellowstone National Park

In Smoke Jumper hot springs basin, the bedrock geology is putatively unique, and the waters are thought to interact almost exclusively with silica-rich rhyolite. This is different from other regions of YNP, where interactions of hydrothermal waters with iron-rich rocks are more prevalent. Thus, we expect to see unique geobiology and substantial variation in the geochemical composition of these hot spring environments when compared to previously sampled hot springs. This research aimed to identify and quantify active H_2 metabolizing organisms, and link responsible microbial species with microbially mediated H_2 oxidation and preferred oxidants in this unique system. The availability and concentrations of geochemical species including potential oxidants and dissolved gases such as H_2 and CO_2 were determined in four chemosynthetic hot springs in the Smoke Jumper hot springs basin. Samples of sediments for microbial community analyses and biologically viable samples for culturing efforts were collected as well. Concentrations of geochemical species and dissolved gases have been determined for all sites sampled. Most probable number experiments reveal the presence and quantities of active microbial community members that are capable of H_2 oxidation coupled with oxidants such as O_2, NO_3^-, Fe^{3+}, SO_4^{2-}, S^0. These experiments have facilitated the extraction of genomic DNA from cultures leading to the identification of these responsible microorganisms. Ongoing work includes the sequencing of SSU rRNA gene and transcript sequences from *in situ* samples, as well as targeted transcriptomics aimed at elucidating the enzymes and pathways involved in H_2 cycling.

Matthew Evans: Psychology
Mentor: Frank Marchak -- Psychology
The Effect of Racial and Gender Differences in the Recognition for Subjects Viewing Altering Facial Features and Configurations

My partner Mason Harrelson and I are going to be using a program called comPHOTOfit to alter a series of mugshots which we present as the visual stimuli. We will be using a machine that measures eye saccades during the viewing, present a distractor task, ask a series of questions that will constitute a recognition task, and finish with an exit interview. Our hypothesis is that subjects will be more likely to distinguish between subtle facial differences better with their own gender, and the measurements of their eye saccades will give us raw data to support our conclusions.

Acknowledgements: Mason Harrelson (MSU Undergrad Student) - Psychology

Ryan Galloway: Physics
Mentor: Randy Babbit -- Physics
Laser Linewidth Narrowing Via Passive Spectral Hole Burning

Spectral hole burning is a unique property of rare earth ion doped crystals, that have been cooled down to near absolute zero. The rare earth ions in the crystal absorb light according to the wavelength of the light. As the ions absorb light and go into an excited state, they can no longer absorb light. This means that if there is a lot of light of a particular wavelength, the crystal will 'saturate' at that wavelength, and all light at that wavelength will be let through the crystal. The rest of the light is at a different frequency, and because there is usually a peak frequency, the light that is not at the peak (which is being saturated), will be totally absorbed by the crystal. This will lead to a filtering effect, where the spectrum of the laser will be 'cleaned' of any noise around the peak frequency which means a narrower laser linewidth. A laser linewidth is the frequency spectrum of a laser and the narrower the linewidth the more monochromatic the laser. Using the effect of spectral hole burning, a noisy laser can be filtered by its own spectral hole to produce a highly monochromatic laser, in a fairly simple setup. Here we used a thulium^{3+} doped crystal, in the attempt to replicate observed filtering of 30dB by an erbium^{3+} doped crystal. A lower bound on crystal length and absorption cross section was determined for adequate filtering to be observed. Having a highly monochromatic laser is a key property for applications in precision metrology, spectroscopy, laser ranging, and will be necessary in any future quantum information systems.

Emma Gann: Chemistry & Biochemistry
Mentor: Bern Kohler -- Chemistry & Biochemistry
Photodegradation Quantum Yields of Cerium Oxide Nanoparticles

Cerium oxide (CeO_2) is a redox catalyst with a wide range of applications. The mechanisms behind CeO_2 nanoparticles' activity are largely unknown, but are hypothesized to result from CeO_2's ability to accommodate oxygen vacancies in its fluorite lattice. Quantifying the amount of Ce(III) present in CeO_2 nanoparticles is difficult, as traditional XPS techniques lead to Ce(IV) reduction. However, our preliminary results indicate that Ce(III) may not be retained in the nanoparticles under some conditions. By quantifying the steady state quantum yields and combining this information with ultrafast transient absorption data, the photoreactivity and general reactivity of various CeO_2 nanoparticles can be better characterized. Ce(III)'s fluorescence allowed *f–d* transition enables it to be detected with sensitive emission techniques. Fluorescence quenching experiments of Ce(III) were conducted using nitrate as a quencher to allow for the quantitative determination of Ce(III) in the presence of nitrate. Increasing the concentration of nitrate caused the fluorescence of the cerium nanoparticles to decrease. Actinometry was used to determine the photon flux of a photoreactor, which will be used to determine various quantum yields of CeO_2 nanoparticles. The photoreactor was standardized using azobenzene and 1,3-dimethyluracil as actinometers. Azobenzene has a strong absorption band at 358 nm. When irradiated at 313 nm, azobenzene converts from its trans isomer to the cis isomer. The back isomerization process (cis to trans) can then be observed and used to standardize the photoreactor because the quantum yield of azobenzene is known.

Acknowledgements: Natasha Pettinger (MSU Graduate Student) - Chemistry & Biochemistry

Britney Gibbs: Cell Biology & Neuroscience
Mentor: Mensur Dlakic -- Microbiology & Immunology
PCR-based Engineering of Spinach Aptamers to Detect Novel Metabolites

Conditionally fluorescent dyes undergo environment-induced conformational changes, causing them to emit light of different colors. These dyes, in conjunction with bound RNA aptamers, can be used to monitor metabolites in a cell. One dye, DFHBI, fluoresces green when bound to an RNA aptamer called Spinach. When Spinach is linked to a second RNA aptamer that binds the metabolite of interest, that metabolite's concentration and cellular distribution can be monitored. The Spinach and other RNA aptamers are linked together by an RNA connecting junction that must be determined by trial and error for each different complex. Because the same connecting junction does not work for all combinations of aptamers, it must be re-created for every complex. One way to

simplify this problem is to have access to multiple different connecting junctions that have the potential to work. Our project is to create multiple cloning sites within Spinach so that different aptamers can be inserted. These variants of the original Spinach aptamer were built by combining smaller oligos using assemblyPCR. This procedure takes overlapping oligos and extends them into a larger DNA piece. It is hopeful that when an aptamer is inserted into one of many different restriction sites, one of these combinations will provide a successful connecting junction. This will simplify the creation of RNA aptamers for various new metabolites without relying on trial and error.

Kyle Glose: Cell Biology & Neuroscience
Mentor: Jovanka Voyich -- Microbiology & Immunology
Using expression of a hlgA-GFP reporter as a proxy for SaeR/S induction in S. aureus

Staphyloccus aureus is a gram-positive bacteria responsible for numerous infections globally, including bacteremia, infective endocarditis, and necrotizing pneumonia. The frequency of antibiotic resistant strains of *S. aureus* in healthcare settings creates barriers for the effective treatment of *S. aureus* infections. A key effector of *S. aureus* virulence is the Sae two-component regulatory system. Sae has been identified as a key component of the ability of *S. aureus* to survive phagocytosis by neutrophils, a trait necessary for the establishment of infection. Sae is further responsible for the differential regulation of numerous virulence factors, and is responsive to signals of innate immunity such as α-defensin and neutrophils, however the signals that cause activation of Sae are incompletely defined, as Sae is still activated in murine models lacking α-defensin. Production of γ-hemolysin transcripts (*hlgA*, *hlgB*, and *hlgC*) is heavily increased by the activation of Sae. Of these, *hlgA* is most heavily influenced, exhibiting nearly a 100-fold increase in transcription, and therefore production of *hlgA* can be used as a proxy for the induction of Sae. A strain of *S. aureus* with a GFP reporter attached to the *hlgA* gene has been created, and this strain can be used to quantify *hlgA* expression and Sae activation. The validity of the hlgA-GFP reporter as a proxy for Sae induction was assessed, and was found to be unreliable in demosntrating Sae induction. RT-PCR was instead used to quantify relevant transcripts in strains of *S. aureus* possessing single amino acid mutations in the extracellular loop of SaeS that were challenged with PMNs or whole human blood in order to determine the importance of individual amino acids in Sae induction in response to host immune signals.

John Griffith: Mathematical Sciences
Mentor: William Dyer, Barbara Keith -- Plant Sciences & Plant Pathology
Development of Semi-Quantitative PCR Assay to Determine Molecular Markers of Herbicide-Resistance in Avena fatua (wild oat)

The focus of this project is the use of semi-quantitative RT-PCR (qPCR) to assess the genetic and molecular basis of non-target-site-based multiple-herbicide-based resistance in *Avena fatua* (wild oat). Preliminary RNA Sequencing results have identified candidate genes that are constitutively and differentially expressed between susceptible and resistant plants. Validation of these results will answer fundamental questions about the mechanisms by which these activities evolved under intense herbicide selection.

Andrew Gutknecht: Chemistry & Biochemistry
Mentor: John Peters -- Chemistry & Biochemistry
Elucidating the Pathway for Coenzyme M Biosynthesis in Bacteria: A Role for a Lyase 1 Superfamily Protein in Dephosphorylation

The coupled activity of two proteins involved in the biosynthesis of Coenzyme M in *Xanthobacter autotrophicus* Py2 is hypothesized to be inorganic phosphate-producing. CoM was once thought to be utilized only in methanoarchaeal pathways but it has been confirmed to play a role in propylene metabolism in *X. autotrophicus* Py2. The methanoarchaeal biosynthesis has been elucidated but the bacterial biosynthesis has yet to solved. The two gene products mentioned afore, XcbB1 and XcbC1, are two of five protein products coded for on the linear megaplasmid in *X. autotrophicus* Py2. XcbB1 is the only protein, however, that is homologous to the methanoarchaeal biosynthesis. The gene, xcbB1, encodes a product homologous to ComA, the first enzyme of the

PEP-dependent methanoarchaeal CoM biosynthetic pathway. ComA catalyzes the addition of sulfite to PEP to yield (R)-phosphosulfolactate. In the methanoarchaeal pathway, this intermediate undergoes dephosphorylation via phosphohydrolase reaction catalyzed by ComB to yield sulfolactate. However, the putative CoM biosynthetic pathway in *X. autotrophicus* Py2 does not contain a ComB homolog, indicating that there must be a different mechanism for the removal of inorganic phosphate. By investigating the chemical reactions catalyzed by the protein families of the other products encoded by the gene cluster, a hypothesized mechanism can be formulated for PEP-dependent CoM biosynthesis in *X. autotrophicus* Py2. Several activity assays are to be carried out to detect the production of inorganic phosphate. The goal being to determine if XcbC1 will produce inorganic phosphate when supplied with (R)-phosphosulfolactate from XcbB1.

Acknowledgements: Sarah Partovi (MSU Graduate Student) - Chemistry & Biochemistry

Danielle Hanger: Psychology
Mentor: Keith Hutchison -- Psychology
The Role of Working Memory Capacity and Cognitive Load in Producing and Detecting Deception

Individual differences in working memory capacity (WMC), a construct that includes short-term memory and attention control, underlie individual differences in many cognitive tasks. This is especially true when those individuals are placed under extra cognitive load. Lying has been shown to be a cognitively demanding task and therefore could be influenced by WMC and cognitive load. In the present study, subjects completed two tasks that determined a WMC score. In the dyad paradigm, subjects were asked to attempt lying under high and low cognitive load as well as to attempt detecting lies in an interview setting. In the single paradigm, subjects were asked to attempt lying under high and low cognitive load while being video taped. In the dyad paradigm, one measure of WMC predicted the ability to successfully tell lies when under high cognitive load. This was not replicated in the single paradigm. Significant effects of WMC, cognitive load, and their interaction were not found in either paradigm, however marginal effects suggest that further investigation of the phenomenon is warranted.

Acknowledgements: Ted Maldonado (MSU Graduate Student) - Psychology

Heidi Hanson: Psychology
Mentor: Wendy Bianchini-Morrison, Shelly Hogan -- Health & Human Development, McNair Scholars Program
A Sustainable Model for Health Programs: A Case Study in Zambia

Akros is an international non-government organization founded in Lusaka, Zambia (Winters &Winters, 2015). One of their goals is to use a community based model to implement their water, sanitation and hygiene (WASH) program through Community Led Total Sanitation (CLTS). Building and using latrines can make a large impact on the health habits developed in the community and surrounding areas. By involving the community, Akros can encourage and bridge communication with its staff, local government, tribal government, and resources that are already implemented (Kjell, 2011). Akros invited a group of 14 MSU students to survey and observe Akros protocol and operations. Interviews were conducted with government officials and members of Zambian tribes/towns. Technology use between tribes/towns that may not have power has been a noted difficulty for Akros to receive data, but overall the current system of involving community members to participate in taking charge of their own health has been successful in spreading awareness and implementing adequate latrines and sanitation protocol into many districts (Unite for Sight, 2015).

Andrew Helming: Chemistry & Biochemistry
Mentor: Seth Walk -- Microbiology & Immunology
Study and Isolation of Nontoxic, Plasmid Curing Agents

Antibiotic resistance is a major public health problem responsible for the proliferation of nosocomial methicillin- and vancomycin-resistant bacteria in recent years. Bacteria can carry genes responsible for antibiotic resistance (AbR) on small, circular pieces of DNA, called R-plasmids. Through horizontal gene transfer, especially conjugation, resistance phenotypes can rapidly spread through a bacterial population. The prolific nature of this horizontal gene

transfer not only allows bacteria to mitigate the effects of commonly-used antibiotics, but also to outpace the effectiveness of newly developed drugs. Thus, there is urgent need to decrease the prevalence of R-plasmids. Plasmid curing, or the removal of plasmids from bacterial cells, has the potential to slow, or even eliminate, the spread of antibiotic resistance. A variety of compounds, such as acridine orange and ethidium bromide, have been found to cure plasmids, but these chemicals tend to be mutagenic or antimicrobial (i.e. cytotoxic). Alternatively, essential oils with low antimicrobial activity have been shown to cure R-plasmids in *E. coli* cells. The goal of this project is to quantify plasmid curing by menthol in clinical isolates of *Klebsiella pneumoniae*. Quantitative PCR and a culture-based plating assay was used to quantify the abundance of plasmids in menthol-treated and untreated cells. I also evaluated the rate of R-plasmid conjugation following menthol treatment to determine whether cell-cell transfer of DNA was affected. Collectively, these experiments help establish whether menthol is a suitable option for decreasing the reservoir of resistance genes on R-plasmids.

Acknowledgements: Jonathan Martinson (MSU Graduate Student) - Microbiology & Immunology

Tacey Hicks: Chemistry & Biochemistry
Mentor: Robert Szilagyi -- Chemistry & Biochemistry
Modeling the Structure and Reactivity of Al^{3+}/Fe^{3+} Substitution in Kaolinite

Clay minerals are rapidly emerging materials having a significant societal impact from their industrial applications, such as the production of porcelain, paper, rubber, paint, plastics, ink, medicines, absorbents, and other manufactured products. Many of these applications however, greatly depend on the inherent surface chemistry. The surface modifications of these clays are primarily designed and optimized on the basis of trial-and-error, empirical procedures. We propose that computational modeling can thus rationalise experimental research, providing a quantitative image of the characteristics and reactivity of these clay surfaces. The goal of our study is to develop an accurate molecular cluster model for the kaolinite mineral surface that can be used to study characteristics of both the pure and Fe^{3+} substituted form at the atomic level. The study was focused on the successive reactions of the Fe^{3+} substituted octahedral layer with H_2S molecules, which resulted in the replacement of the three surface- and inner-hydroxide groups coordinated to the central Fe^{3+} ion. A 130-atom computational model was constructed to capture the complete coordination environment of a central Al^{3+} ion, which was the 'reactive site of interest,' including the inner sphere, first outer-sphere and terminating ions and groups of the peripheral region. All structural optimizations and reactivity studies were carried out using the B3LYP density functional theory and def2TZVP converged basis set. The results obtained from our models are being used to rationalize experimental conditions for synthetic work conducted in our laboratory, providing new ideas for specific future projects.

Trace Hobbs: Chemistry & Biochemistry
Mentor: Robin Gerlach -- Chemical & Biological Engineering
Comparison of Struvite Precipitation under Biotic and Abiotic Conditions

Kidney stones form when ions in urine become supersaturated, resulting in mineral precipitation and aggregation. Infectious kidney stones typically contain struvite ($MgNH_4PO_4 \cdot H_2O$) and calcium phosphates. Infectious stone formation is induced by a urinary tract infection, often including *Proteus mirabilis* biofilm. *P. mirabilis* is a ureolytic bacterium; it produces urease, an enzyme that catalyzes the hydrolysis of urea ($CO(NH_2)_2$), raising the pH of the urine and causing precipitation of struvite and calcium phosphates. The goal of the comparison between biotic and abiotic infectious stone formation was to gain further insight into the role of microbial organisms in infectious stone formation during urinary tract infection. The hypothesis that was tested was that the microbes play a critical role in infectious stone formation. The biofilm may play an active role in concentrating ions, producing regions favorable for struvite and calcium phosphate precipitation. The microbes may also act as the nucleation site for initial struvite and calcium phosphate precipitation. Abiotic and biotic precipitation was compared by using a dialysis membrane to produce an environment including *P. mirabilis* and an environment free of all microbes that were chemically similar. Chemical analyses and imaging techniques, both scanning electron and confocal fluorescence microscopy, were used to analyze the differences between precipitates formed in each environment.

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Zane Huttinga: Mathematical Sciences
Mentor: Tomas Gedeon -- Mathematical Sciences
Linear Extensions of Additive Switching Networks as a Model for Gene Regulation

I present an investigation of a common type of mathematical model for gene regulatory networks. The model consists of a system of nonlinear ordinary differential equations (ODEs), each of which models the behavior over time of a particular chemical species. It is crucial in applications to understand the dynamics of a model as its parameters vary. Each ODE in the system depends on a decay term, gamma, and a set of so-called switching terms, which each act as an ON/OFF switch, switching between two constant values a and b as time passes a certain threshold value, theta. Each ODE is associated to a set of switching terms, which may be combined by multiple operations, such as addition and multiplication. Therefore, at any particular time value, each time-derivative included in the system is associated to a combination of a and b terms, for instance a1+b2+b3, a1·a2·a3, or a1·(b2 + b3). Call the set of these combined terms S. We can assume without loss of generality that a < b for all indices i, which implies a partial order on S. The tuple (gamma,a,b,theta) is called a parameter of the system of ODEs, and the set of all possible values for these parameters is called the parameter space. I present a method for determining the size of the parameter space, which is an important step in understanding the model's dynamics. Prior work implies that we can determine the parameter space's size by counting all total orders of S that respect the inherent partial order. I present an algorithm which, given a handful of results, counts the number of total orders on the set, as well as a proof of the algorithm's validity.

Kevin Jones: Ecology
Mentor: Chris Organ, John Fisher -- Earth Sciences, Sociology & Antropology
A Comprehensive Ape Tree - From Extinct Apes to Modern Humans

The hominin fossil record is scant and incomplete, which leaves relationships between species open to much interpretation. Recent fossil discoveries such as *Homo sediba* and *Homo naledi* suggest an increasingly diverse hominin family. These new fossils are challenging older phylogenetic models, making our own lineage less certain. Phylogenetic trees not only describe how species are related, but also how traits and characteristics arise and evolve within lineages. In particular, phylogenetic trees describe how species are related to each other and underscore the fact that species are not independent entities; they share common ancestry all the way back to the origins of life. Previous phylogenetic models have tended to focus on creating separate trees for hominins and hominoids, despite the close evolutionary relationship between both groups. The first goal of this research is to create a comprehensive ape database that includes both molecular data and morphological trait characteristics of all known hominin and hominoids. The second goal is to create a time tree in order to track the evolutionary history of hominins and hominoids. The third goal will be to introduce a Bayesian stratigraphic model during inference that uses maximum likelihood in order to estimate phylogeny, examine the congruence between the stratigraphic record and phylogeny, and to root our phylogenetic tree. As new fossil ape discoveries challenge older phylogenetic models, a Bayesian stratigraphic model using maximum likelihood has the potential to resolve relationships between species that have long been open to interpretation.

Meghann Karsch, Logyn Bloms, Jacob Seymour: Microbiology & Immunology, Cell Biology & Neuroscience
Mentor: Jean Pfau, Deborah Keil -- Microbiology & Immunology
Nevada Amphibole Asbestos: Exposure Induces Production of TNFα in Mouse Macrophages Comparable to Libby Amphibole

Libby Amphibole (LA) asbestos was a contaminant of vermiculite mined near Libby MT for decades, leading to exposures not only to workers at the mine, but in the entire community. The health effects vary, but seem to have in common an immune/inflammatory reaction in the lungs. Recently, amphibole asbestos fibers similar in composition to LA were discovered just east of Boulder City, NV. The health risk of these fibers is being debated. Our objective was to determine whether the Nevada Amphibole (NA) has similar effects as LA on cultured

RAW264.7 mouse macrophage cells. Mouse macrophages were challenged in vitro using either No Treatment, or 2 doses of each amphibole, 35 μg/cm2 or 70 μg/cm2. Culture media was collected after 24 hr of treatment, and tested for Tumor Necrosis Factor alpha (TNFα) using a sandwich ELISA. The respective low dose (35 μg/cm2) and high dose (70 μg/cm2) treatment groups associated with each type of amphibole (LA and NA) were individually analyzed for any significant deviation from base-line TNFα production, as established by the No Treatment group. No significant deviation in TNFα production was observed for cells treated with the low dose of LA. However, a significant increase ($P < 0.05$) in TNFα production was noted with the high dose of LA. For cells treated with NA, both low dose and high dose groups demonstrated a significant increase. Additionally, we found that NA induced a higher level of TNFα production compared to LA, in both low and high dose treatment groups. These results suggest that, similar to LA, NA does induce TNFα production in mouse macrophages. Therefore, although the fiber types are similar in composition, NA asbestos may incite a greater immunotoxic effect than LA. We initiated in vivo studies to further explore this effect.

Scott Killian: Cell Biology & Neuroscience
Mentor: Mac Burgess -- Plant Sciences & Plant Pathology
Grafting: An alternative approach to curbing Verticillium wilt

The fungus *Verticillium dahliae* causes wilt within a wide variety of economically important plants, including eggplants. However, the rootstocks of some plants, like Maxifort F1 Tomatoes, are resistant to the soil-born fungus. That resistance can effectively be transferred through the process of grafting, or the insertion of the shoot of one plant into the rootstock of another. Yet, for a successful grafting the shoot and rootstock must be of homogeneous diameter. In this case the diameter was 2.0mm for the 2.0mm silicon top-grafting clips used for grafting. So in order to create a procedure to efficiently graft Traviata F1 Eggplants shoots to Maxifort F1 Tomato rootstocks the germination time and growth rates were compared between the two. This was accomplished though the careful observation of the time it took for each plant to sprout. To limit variation all seedlings were grown on a thermostatically controlled heat mat within a misting chamber in the MSU Plant Growth Center. The chamber effectively cutting the light intensity in half. Data was quantified by the meticulous planting of six seeds per species every three days over the one month period of October 20th 2015 to November 19th 2015. The experimental results portrayed Maxifort F1 Tomatoes germinating and growing, on average, to the 2.0mm stem diameter five days faster than the Traviata F1 Eggplants. The data collected created an effective procedure in grafting the shoots of Traviata F1 Eggplants to the rootstock of Maxifort F1 Tomatoes under these specific controlled environmental conditions.

Michelle Knerr: Microbiology & Immunology
Mentor: James Berardinelli -- Animal & Range Sciences
The Use of NMR Spectroscopy in the Identification of Metabolic Pathways in Pregnant Ungulates

The objective of this preliminary study was to determine if NMR spectroscopy can be used to predict metabolic profiles of Rambouillet ewes treated with long term progesterone. The NMR spectroscopy used as a non-invasive tool to evaluate these characteristics would be beneficial in the advancement of domestic livestock and wildlife populations. Animals used in this study were Commercial Rambouillet ewes from Red Bluff treated with long-term progesterone. The extraction of serum was performed using a 1:4 ratio with acetone. DSS was then added to the sample. The spectrum for spectral analyses was then identified with the aid of the NMR machine and the computer program Chenomx. Chenomx has the ability to identify 300+known analytes. The concentration of analytes were discovered once the spectra matched one of the known analytes. Currently, the data collected is being analyzed. No results or conclusions can be determined at this time.

Acknowledgements: Rashelle Herrygers (MSU Graduate Student) - Animal & Range Sciences, Jennifer Thomson (MSU Faculty Member) - Animal & Range Sciences

Natali Kragh: Earth Sciences
Mentor: Jean Dixon -- Earth Sciences
Utilizing Lake Cores to Examine Past Geomorphic Alteration in Yellowstone National Park

Cores from Blacktail Pond in Yellowstone National Park have been extensively used to study past environments of southwestern Montana. Topics like fire, vegetation, ecology, precipitation, and temperature fluctuations have all gained meaningful insight to their histories based on data collected from these cores. However, the cores have much more information to give, specifically regarding geomorphic alteration that has occurred in the Blacktail Pond area since the end of the Pleistocene. Over the course of a semester, I looked at sediment geochemistry to determine sediment source variation throughout the lake cores. I worked with Dr. Jean Dixon (Earth Sciences) and Rachel Jensen (MS Student) and conducted a series of carbonate dissolutions, titrations, and loss on ignition analysis. These tests provided a thorough understanding of the chemical, mineralogical, and organic makeup of the core. Results show that at some point in the Holocene, sediment source changed dramatically from a siliciclastic terrigenous source to an in-situ biogenic carbonate source. This switch suggests that landscapes altered quickly then stabilized following the deglaciation of the Yellowstone Ice Cap.

Acknowledgements: Rachel Jensen (MSU Graduate Student) - Earth Sciences

Adelheid Langner: Cell Biology & Neuroscience
Mentor: Ian Handley -- Psychology
Internal versus External Expectation Belief Bias and the Placebo Effect

This project examines a possible difference between the impact of external and internal expectations on the placebo effect. Some previous publications have shown that individuals who believe their expectations bias the outcome of an event may correct against that bias and eliminate or even reverse the placebo effect. Other research has seen that these individuals actually show a greater placebo effect. These studies differ in whether the expectations given are internal (the person has been in the situation before and has an expectation based on past experience) or external (another person gives them the expectation). In this project, expectation belief is measured, and the difference between external and internal expectation is evaluated.

Gabrielle Law: Chemistry & Biochemistry
Mentor: Matthew Taylor -- Microbiology & Immunology
Assessing evolutionary pressures on alphaherpesvirus genomes in vivo

This project quantified evolutionary pressure, through mutation and selection, of the herpes simplex virus (HSV) during replication and spread in neurons and immortalized cell lines. HSV is a neuroinvasive virus that infects more than 80% of the world population. HSV-1 is the leading cause of viral encephalitis in developed countries, and, even with drug treatment, mortality rates for herpes simplex encephalitis remain high. HSV can also develop resistance to antiviral drugs through point mutations in the thymidine kinase gene. Resistance to antiviral treatment is an outcome of evolutionary pressure and selection on HSV genomes which develops from viral population diversity. Understanding how HSV responds to antiviral selections during replication and spread will enhance current treatment for herpes infection and provide possible ideas for vaccine developments. But how can viral population diversity and the effects of evolutionary pressure on HSV be quantified? This project used two assays to quantify genetic change to HSV genomes. The first was a marker transfer assay that measured inter-viral genomic recombination that was performed with HSV infections done *in vitro*. The second was a point mutation assay to study frequency of nucleotide substitutions by quantifying the development of antiviral resistance. Both recombination and point mutation are assessed to understand the impact of selection pressures such as antiviral treatments and neuron replication on viral diversity.

Acknowledgements: Alix Herr (MSU Graduate Student) - Microbiology & Immunology, Irina Kochetkova (MSU Faculty Member) - Microbiology & Immunology

Shea Layton: Ecology
Mentor: Laura Burkle, Anthony Slominski -- Ecology
The effects of climate change on second generation plants of the species Heterotheca villosa (Asteraceae): An examination of germination, phenology, morphology, and nectar and pollen production

Climate change has many effects on different organisms, and it continues to become an immediate issue. I plan to study the effects of climate change on the morphology, phenology, germination, and nectar and pollen production of the second generation of the species *Heterotheca villosa*. I hypothesize that increased temperature will lead to decreased plant height, decreased abundance of flowering, decreased amounts of pollen produced, and decreased amounts of nectar in *Heterotheca villosa* individuals. I will conduct my experiment in the Plant Growth Center.

Savanah Leidholt: Ecology
Mentor: David Willey -- Ecology
Effects of Precipitation on the Mexican Spotted Owl

The Mexican Spotted Owl (*Strix occidentalis lucida*) is a sub-species of spotted owl that lives in the southwestern U.S. in both forested and rocky canyon territories. Using the owl's breeding season, which runs from March through August each year, I looked for patterns in diet associated with variation in the total amount of precipitation for each sub-period. The sub-periods included incubation, nestling, and fledgling. Using an existing data base for owl diets, I identified several correlations between amount of precipitation that occurred in each sub-period and patterns of variation in the owls diets and among different owl sites.

Axl LeVan: Chemistry & Biochemistry
Mentor: John Peters -- Chemistry & Biochemistry
Comparing Hydrogenase Crystal Structures in relation to Catalytic Bias

In *Clostrodium pasteurianum* two primary [Fe-Fe]-hydrogenases exist that vary in their respective proton reducing ability, or ability to create hydrogen fuel. Slight differences in the conserved amino acids of these protein types leads to separate catalytic biases in reduction and oxidation. Understanding how these changes in amino acids affect the catalytic bias could allow creation of efficient synthetic hydrogen production. The primary focus of this project is crystalizing CPII to provide a x-ray crystal structure to compare to the current CPI structure. Since both proteins contain the same catalytic center, x-ray crystallography may reveal how catalytic center changes based on the protein environment. Both hydrogenase proteins are oxygen sensitive so anaerobic protein technique is required to ensure that the protein remains viable throughout purification and crystallization. Currently the purification process is being refined to produce enough quality protein for capillary crystallization in an anaerobic glove box. This has required a non-chemical lysis of the cells with nitrogen in a high-pressure container a method that was refined last semester. Any protein crystals formed will be processed using the synchrotron x-ray source at Stanford before comparison to CPI. Perhaps the most important product of this work so far is a refined oxygen sensitive lysis method.

Acknowledgements: Jacob Artz (MSU Graduate Student) - Biochemistry

Oscar Machado: Cell Biology & Neuroscience
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
Determining the Place of aqp3b in the Wnt/Ca^{2+} Noncanonical Pathway

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 aqp3b prevents convergent extension of the mesoderm and that aqp3b 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 aqp3b acts through the noncanonical Wnt/Ca^{2+} pathway and that it acts upstream of the cytoplasmic Wnt signaling pathway member Disheveled. The Frizzled7 membrane receptor is part of the noncanonical Wnt/Ca^{2+} pathway and also acts upstream of Disheveled. I will test, whether in this signaling cascade, aqp3b acts upstream or downstream of Frizzled 7. Thus, I will test whether Frizzled 7 activates aqp3b, if aqp3b activates Frizzled 7, or if aqp3b 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 +aqp3bMO (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 aqp3b within the Wnt/Ca^{2+} pathway will be determined.

Weston McCue: Cell Biology & Neuroscience
Mentor: Amy Cory -- INBRE
Food Insecurity Outreach in the Pediatric Clinics of Montana

Introduction: I have been working with the Montana Chapter of the American Academy of Pediatrics (AAP) to examine the current problems facing our state's children. I intended to look at, more specifically, the issue of food insecurity. Here in Montana, with a large percentage of the population living in rural, underserved areas, food insecurity outreach is an issue that needs to be reevaluated in our pediatric clinics. The Montana Chapter of the American Academy of Pediatrics has established that this is a major issue for physicians nationwide, and therefore carries much relevance as a public health internship project. Methods: The research portion of my project included gathering and analyzing information from online data sources to better identify the demographic of children at risk of food insecurity, as well as attempt to get a better idea of the geographic regions of the state that are more likely to be plagued by food insecurity. I also reached out to the state's pediatricians via the Montana Chapter of the American Academy of Pediatrics in order to get the primary physicians view on the way in which food insecurity is treated here in the state of Montana. This involved creating a short online survey for the physicians that included questions regarding their in-clinic resources, as well as their technique for screening for food insecurity. Results: The research portion of the project provided valuable information as to the location and demographic of our food insecurity issues. In the big picture side of things, our state, when compared to the national average has a high rate of children below the poverty line as well as a very high rate of students receiving reduced-price/free school lunches (an indicator that food security in the home might be a problem). When looking at the statistics between counties it can be seen that communities that are farther away from large population centers have a higher rate of food insecurity indicators (using parameters such as enrollment in the SNAP nutrition assistance program, reduced price/free school lunch, etc.).

Elijah Meyer: Mathematical Sciences
Mentor: Mark Greenwood -- Mathematical Sciences
Statistical methods for detecting groups of patterns in daily step count activity profiles

In recent years, "step counting" has become a constant pre-occupation for some people as a way of trying to tie activity to fitness goals. This has been spurred on by inexpensive digital devices that provide a suite of information on how and how much you move during the day. Many of the consumer interfaces to these data provide summary information that often focuses on daily totals and visual displays of patterns of activity if the user dives a little deeper. This suggests that how and when you move throughout the day is just as much of a story as how much you move in total. The purpose of this research is to explore cluster analysis of daily step count profiles using a new dissimilarity measure that allows days that are similar but start slightly earlier or later to be grouped together. We illustrate the method with self-recorded step count activity data from the activity tracker band Fitbit over a 70 day span. The results show days that may be similar in total step counts that are separated in this analysis by looking more closely at the daily count profiles. This provides a unique way to understand patterns in activity profiles that just comparing daily totals fail to do.

Acknowledgements: Tan Tran (MSU Graduate Student) - Mathematical Sciences

Ashley Micklewright: Ecology
Mentor: Lance McNew -- Animal & Range Sciences
Age Determination of Live-captured Beavers by Weight in Southwest Montana

Studies evaluating demography and age-specific space use of beavers require accurate methods for aging live-captured individuals in the field. Unfortunately, techniques for aging live-captured beavers in the field are often unreliable and can require previous experience in handling beavers. Previous age-weight relationships developed in other regions (e.g., Midwest) may not be suitable, because differences in diets, seasonal behavior, and selection

for life-history traits likely results in significant regional variation in age-weight relationships. Thus, regional assessments of age-weight relationships are necessary for accurate inference. In the fall of 2015, we began a two-year study with the goal of developing accurate growth curves for beavers occurring in southwestern Montana. We are collecting beaver carcasses from local trappers and animal control experts. Carcasses are weighed and the molar teeth extracted for laboratory analysis of cementum annuli which provide an accurate age for each beaver. Regression analysis will be used to model age-weight relationships for beavers, and model predictions will be tested using a hold-out dataset and cross-validation. We expect our results to provide useful information for researchers in forested headwater habitats of Montana, and provide baseline data for calibrations for broader-scale assessments in the region.

Acknowledgements: Torrey Ritter (MSU Graduate Student) - Animal & Range Sciences

Sarah Miller: Chemistry & Biochemistry
Mentor: Trevor Rainey, Ben Fauber -- Chemistry & Biochemistry, Genatech
Addition of potassium organotrifluoroboronates to N,S-sulfonyl acetals to provide 1 substituted tetrahydro-β-carbolines

The tetrahydro-*β*-carboline ring system found in alkaloid natural products and pharmaceutical agents is often assembled using the Pictet Spengler reaction. Several variants of this powerful reaction have been described over the past century, providing access to a variety of 1 substituted tetrahydro-*β*-carbolines. Work done previously by Silveira *et* al. described the intermediacy of an *N,S*-sulfonyl acetal. The sulfur moiety of the acetal was then readily displaced with organosilane or Grignard reagents to provide 1 substituted tetrahydro-*β*-carboline products. We envisioned an expansion of this method in which we would introduce the 1-position substituent with an organoborane reagent. Our approach capitalized on the ready availability of potassium organotrifluoroborane reagents, providing broad substrate scope and a complimentary approach to the Pictet Spengler cyclization.

Courtney Owens: Mathematical Sciences
Mentor: Mark Greenwood -- Mathematical Sciences
A statistical analysis of student ratings of a web-based textbook versus more conventional formats

Students in STAT 217 (Intermediate Statistical Methods) currently have access to purchasing a paper copy of the textbook, downloading a free PDF of the entire book, or accessing a browser-based conversion of the text prepared through the end of the second chapter. Students were encouraged to explore all versions early in the semester and then were surveyed about their experiences. The results of the survey were summarized graphically and explored with factor analysis to understand the underlying structure of the instrument. Results for comparing the usability and motivation to reading comprehension are also presented. This project is partially funded by the IMLS Sparks! Grant (SP-02-14-0002-14).

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Alexander Paterson: Agricultural Economics & Economics
Mentor: Wendy Stock -- Agricultural Economics & Economics
The Impact of Antidiscrimination Laws on Women's Likelihood of Marriage

In the United States rates of marriage have rapidly decreased over the past century. The United States Census Bureau indicates that less than half of all US households in 2012 include a husband and wife, down from the peak of 78 percent in 1950. Moreover, average age of first marriage has significantly increased since 1950; women's average age of first marriage has increased from age 23 to 29 and men's from age 20 to 27. My research examines whether antidiscrimination laws impact women's decision to marry. In this relationship, the independent variable of interest indicates whether or not an individual's state enacted gender-specific antidiscrimination laws before the Equal Pay Act of 1963. The dependent variables are women's probability of marriage and their age of first marriage. My hypothesis is that antidiscrimination laws delay a woman's age of first marriage and decrease the overall probability of marriage. Economic theory predicts that antidiscrimination laws will cause an increase in the

average wage women receive which will in turn raise the opportunity cost of marriage. As a result, I predict that women's probability of marriage will decrease and age of first marriage will increase in states with antidiscrimination laws relative to states without these laws. After controlling for state-time trends, I estimate that antidiscrimination laws increase age of first marriage and increase rates of marriage.

Kirra Paulus: Microbiology & Immunology
Mentor: Lindsey Albertson -- Ecology
Microplastics in a Freshwater Environment

Microplastics, defined as plastic particles of a diameter less than five millimeters, are a growing concern for global ecology. They have the ability to concentrate persistent organic pollutants, such as DDT or PBA, by sorbing to the exterior of the tiny plastic particles. This characteristic poses a threat to both aquatic ecosystems and our own health, as the consumption of the particles can biomagnify sorbed toxins by several orders of magnitude as they move up the food chain. One study even calculated that the "annual dietary exposure for European shellfish consumers can amount to 11,000 microplastics per year." However, the vast majority of research and publicity to date has been concentrated on microplastics in the marine environment. This project aims to write a comprehensive scientific review of the potential sources, effects, and remediation of microplastics in the freshwater environment. In addition to compiling and comparing microplastics research in a scientific text format, it will also aim to create a ten-minute video version to share with the public in order to increase both awareness and funding for future freshwater microplastics research.

Gabrielle Pinc: Cell Biology & Neuroscience
Mentor: Sheila Nielsen -- Microbiology & Immunology
Increased susceptibility of Candida albicans to antifungal agents in microgravity - the role of ergosterol

Many pathogens develop increased virulence when cultured in space or simulated microgravity. Humans traveling in conditions develop a compromised immune system. These properties lead to concern for flight crews during extended space expeditions. *Candida albicans* (*C. albicans*) is an opportunistic human pathogen and has been studied by our laboratory in simulated and true microgravity environments, with the goal of learning more about its pathogenicity and cell physiology that is unveiled under this extreme environment. The microgravity experiments revealed characteristics consistent with increased pathogenicity and an increased resistance to the antifungal agent amphotericin B. The first step at understanding the mechanism underlying the antifungal resistance, we are studying the role of ergosterol, which serves as a binding platform for amphotericin B, causing homeostasis-disruption pores in the yeast membrane. *C. albicans* were treated with the ergosterol sequestering agent, methyl-beta-cyclodextrin. Methyl-beta-cyclodextrin causes filamentation in *C. albicans*, a morphological transition that is implicated in pathogenicity and similar to that observed in microgravity studies. The focus is to determine whether yeast treated with methyl-beta cyclodextrin are protected from amphotericin B-induced death. The antifungal agent Fluconazole, also used to treat yeast infections, will be used as a control in the methyl beta cyclodextrin experiments because it is an inhibitor in the biosynthetic pathway rather than a cell surface binding target. Quantifying and locating ergosterol before and after treatment of MβCD will help to deduce how the pathogens gain resistance and provide insight into the physiological adaptation process that occur in space.

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Kaitlin Poole: Physics
Mentor: Rufus Cone, Charles Thiel -- Physics
Spectroscopy of resonant optical materials at non-traditional wavelengths

We report on the development and testing of wavelength-tunable external cavity diode laser (ECDL) systems operating at new wavelength ranges that have not be previously explored for coherent photonics applications. The wavelength of an ECDL is determined by both the type of semiconductor laser diode and the resonant optical cavity that uses a diffraction grating as a wavelength-selective element. In this work, we focus on two ranges

enabled by modern laser diode technology that are of interest for probing unexplored optical transitions of rare-earth-activated materials, specifically the 412 nm $^7F_0$ - $^5D_3$ transition Eu^{3+} that overlaps with commercial blu-ray laser diodes, and the 1310 nm $^6H_{15/2}$ - $^6H_{9/2}$ transition of Dy^{3+} that is within the telecom O band. The lasers produced in this project are used to characterize the rich spectrum of optical absorption lines of rare-earth ions and to exploit the unique properties of these new absorption lines to enable specific commercial and scientific applications where a limiting factor has been the availability of laser sources.

Paul Puettmann: Cell Biology & Neuroscience
Mentor: Roger Bradley -- Cell Biology & Neuroscience
NF-Protocadherin in the Neural Tube

Soon after neural tube closure cells inside the neural tube begin to organize and differentiate into motor, sensory, and interneurons. These fates are established by a variety of factors and signals coming from cells both in and adjacent to the neural tube. One group of cell adhesion proteins, the protocadherins, has been proposed as a possible mechanism for neural organization and axon extension inside the neural tube. In the frog *Xenopus laevis*, the NF-Protocadherin (NFPC) is expressed in the ventral neural tube and in developing motor and interneurons. The aim of my research has been to investigate this expression of NFPC in the neural tube. This was done using indirect immunofluorescence to double stain for NFPC and known neuron makers. I have also used a dominant negative NFPC in inhibit NFPC function to observe what effect this has on the organization of developing neurons in the neural tube. This dominant negative NFPC is driven by the beta-tubulin promoter. Beta-tubulin is exclusively expressed by developing neurons at this stage in development, meaning that NFPC knockdown is targeted to these cells and will not disrupt NFPC function in other cells in the embryo.

Acknowledgements: Dana Rashid - Museum of the Rockies

Colleen Rooney: Chemistry & Biochemsitry
Mentor: Mark Young – Plant Sciences & Plant Pathology
Characterization of Nanoarchaeota associated virus isolated from Yellowstone National Park hot spring

The Young Lab has discovered evidence of a virus replicating within Nanoarchaeota isolated from Yellowstone National Hot Springs. Nanoarchaeota are obligate symbionts with reduced genomes. Single cell genomic analysis of NL10 hot spring sample revealed a viral-like sequence within a *Nanobsidianus*—a species of Nanoarchaeota—genome. PCR primers designed off of this sequence were used to confirm this sequence exists in the viral fraction of NL10, and CHAS01 hot springs. As there is currently no protocol to co-culture *Nanobsidianus* and its host *Acidicryptum;* environmental methods have been used to further characterize this virus. Density of this virus has been determined to be 1.36 g/cm^3. Possible morphologies have been identified by transmission electron microscopy of concentrated purified environmental samples, and a viral genome will be sequenced out of such a sample.

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Elisa Santori, Maria Rodriques, Jacob Seymour: Microbiology & Immunology, Cell Biology & Neuroscience
Mentor: Deborah Keil, Jean Pfau -- Microbiology & Immunology
Epigenetic modifications of global methylation following heavy metal dust exposure

The Nellis Dunes Recreational Area (NDRA) is a popular off-road vehicle (ORV) site in Clark County, Nevada, and is visited by roughly 300,000 driving enthusiasts each year. Recreationists of the NDRA are exposed to metals, minerals, and small particulate matter (PM) from both natural wind erosion and dust emissions related to ORV activity. Exposure to geogenic PM comprised of minerals and heavy metals has been linked to a variety of human health effects including alterations to the epigenome. In this study, adult female B6C3F1 mice were exposed to dust (median diameter: 4.4 µm) collected from active and vegetated sand dunes in NDRA suspended in phosphate-buffered saline and delivered at concentrations ranging from 0.01 to 100 mg dust/kg body weight by oropharyngeal aspiration, once per week for one month. Tissues were collected and frozen at -80 until analysis.

DNA was extracted from the liver tissue using DNeasy Tissue DNA Extraction kit, and evaluated for global methylation using a 5-mC DNA ELISA. Methylation between the high dose group and control group for CBN6 and CBN7 were compared. Significant changes ($P < 0.05$) between the control and high dose groups indicated that exposure to dust from these site-specific areas of NDRA contributed to changes in DNA methylation of the liver. However, it is recommended that lower dose treatment groups represented by environmental exposure in the individuals visiting the NDRA should be included in future studies. Exploration of toxicoepigenomics would lead to further understanding of the molecular mechanism of toxicity between environmental exposures and disease pathogenesis.

Acknowledgements: Lacey Murphy (MSU Alumna) - Microbiology & Immunology

Jakob Sax: Cell Biology & Neuroscience
Mentor: Eric Boyd -- Microbiology & Immunology
An Analysis of Subterranean Life Under Yellowstone National Park: Microbial Ecology of Fumarole Vents

This project is an important look into subterranean microbial life in Yellowstone National Park (YNP). Specifically, this project pertains to extremophiles that have evolutionary adapted to living in the effluent gases coming out of fumaroles in Amphitheater Springs and Mud Volcano areas of the park. Microorganisms have been previously gathered from around but, never directly inside these vents. The proposed project will not only address the questions about what environment these unknown microorganisms persist in, but as well as the identity of the collected organisms and their metabolic pathways for obtaining energy. A variety of culturing methods and molecular methods will be used to identify and classify this unknown organism. It is expected to find through these methods, relatively what environmental factors this microbe prevails under. Another expected outcome is to isolate the structure of its genome, hopefully leading to the identification of the organism that resides in a currently unexplored part of the park.

Acknowledgements: Maxamillio Amenabar (MSU Graduate Student) - Microbiology & Immunology

Sage Schiller, Justin Johnson: Microbiology & Immunology
Mentor: Mary Cloud Ammons, Valerie Copie -- Chemistry & Biochemistry
PCR analysis of S. aureus biofilms examining programmed keratinocytes death and cell binding capabilities of IsdC

Staphylococcus aureus, a gram-positive bacteria, is a facultative anaerobe which causes opportunistic infections in the immunocompromised. *S. aureus* can be cultured in two different phenotypic states: biofilm and planktonic. In order to grow into a biofilm state there needs to be adhesion of cells to a surface, and adhesion between cells to form multilayered clusters. The biofilms are surrounded by a matrix made up of exopolysaccharides, nucleic acids, and proteins and are significantly more resistant to both therapeutic treatment and the endogenous immune system when compared to planktonic cultures. Previously, it has been observed that small molecules secreted by *S. aureus* induce programmed cell death in keratinocytes through distinct mechanisms. We use PCR (polymerase chain reaction) array mapping of the human programmed cell death signal transduction pathways to determine how secreted factors from *S. aureus* biofilms are killing the keratinocytes. By evaluating these pathways, we can determine the difference in programmed cell death of keratinocytes between the *S. aureus* biofilm interaction and the planktonic state. Additional experiments involving the *S. aureus* biofilms target characterization of *IsdC,* a protein thought to have certain iron acquisition and cell binding capabilities in *S. aureus* and a potential target for inhibiting biofilm growth. To further study the properties of *IsdC*, we are cloning out the *isdC* gene to express *in vitro* and to examine its overall structure.

Lisa Schmall: Psychology
Mentor: Rebecca Brooker -- Psychology
Emotional Regulation: Changes in Neural Markers in Pregnant Women due to stress

Measured via electroencephalography, the Late Positive Potential (LPP) is believed to index emotional reactivity (Hajcak et al., 2012). The LPP is reduced when emotions are successfully regulated (Hajcak & Niewenhuis, 2006), making it a potential neural marker for emotion regulation and putative index of risk for mental health problems. In this study, we investigated links between LPP, perceived stress, and social support in expecting mothers. We anticipated that stress would deplete regulation, leading to increases in LPP, but that these increases would be diminished in mothers with high levels of social support. In a sample of pregnant mothers (N = 31) we found that LPP was enhanced for emotional relative to nonemotional stimuli in pregnant mothers (F(4,112) = 4.73, p<0.05). Consistent with expectations, we found that social support moderated the association between perceived stress and LPP (B = -0.65, p < 0.01) such that, at low levels of social support, greater perceived stress predicted greater LPP (B = 0.51, p < 0.01). However, perceived stress was unrelated to LPP at high social support (B = -0.18, p > 0.10). Results are consistent with the idea that social support may buffer associations between stress and emotional reactivity by supporting emotion regulation.

Liam Scott: Chemistry & Biochemistry
Mentor: Jennifer Dubois -- Chemistry & Biochemistry
Structure-Function Studies of the Novel HemQ from Staphylococcus aureus

Heme, the complex of iron with protoporphyrin IX, is absolutely essential for aerobic life. The biosynthetic pathway for this molecule, as it is described in every biochemistry textbook, has recently been shown to be not all inclusive. Instead, a large group of bacteria including most gram-positive species have a different way of catalyzing this pathway's final three steps. The protein known as HemQ catalyzes the final step: the conversion of coproheme III to heme b. The mechanism of this reaction is poorly understood. The goal of this project is to begin filling that knowledge gap. The hypothesis to be tested is that glutamine 185 (Q185), an amino acid that we expect to be directly over the coproheme III substrate, is a key regulator of the protein's reactivity. Our approach is therefore to make systematic substitutions of other amino acids at this site, and then to evaluate how the protein's properties change. By completing these experiments, we will begin to understand how HemQ works in gram positive bacteria, and contribute to studies evaluating this protein's viability as a potential antimicrobial target. This is extremely important for fighting illnesses caused by gram-positive bacteria, such as Multidrug-resistant *Streptococcus pneumoniae*, *Staphylococcus aureus*, and *Enterococcus spp*., particularly when the typical antimicrobial resistance of these bacteria is taken into account.

Acknowledgements: Bennet Streit (MSU Postdoc/Research Scientist) - Chemistry & Biochemistry, Arianna Celis (MSU Graduate Student) - Chemistry & Biochemistry

Anna Scott: Chemistry & Biochemistry
Mentor: Joan Broderick -- Chemistry & Biochemistry
Insights into the Structure of the 2Fe Subcluster Synthesized on the HydF Scaffold Before Insertion into the [FeFe]-hydrogenase

The [FeFe]-hydrogenase (HydA) catalyzes the production of molecular hydrogen and for this reason is a promising source of hydrogen for clean and renewable energy needs. In order to activate HydA three enzymes, HydE, HydF and HydG, are required to synthesize and insert a decorated 2Fe subcluster into the active site of HydA. Elucidating the mechanisms and roles of each of these enzymes is important in the development of HydA as a source of hydrogen fuel. HydF is a GTPase that is thought to be the scaffold protein upon which the decorated 2Fe subcluster is assembled before insertion into HydA. The completed 2Fe subcluster contains a dithiomethylamine bridge as well as carbon monoxide and cyanide diatomic ligands, which can be characterized using Fourier Transform Infrared (FTIR) spectroscopy. Although a crystal structure of HydF has been solved, the structure does not contain any of the FeS clusters that bind in the protein during synthesis of the subcluster. Because of this the exact structure and composition of the decorated subcluster is unknown. By mutating certain amino acids thought to coordinate the FeS clusters in HydF and analyzing these variants using FTIR spectroscopy, new information about the structure and composition of the subcluster may be determined. Insight into the structure of the subcluster and how it is bound in HydF based on preliminary FTIR data will be discussed. Also to be discussed are

the results of the mutagenesis and FTIR studies along with any additional insight gained from various computational chemistry methods.

Kaitlyn See: Microbiology & Immunology
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
Cloning of aqp2, aqp7 and aqp9 in Preparation for Convergent Extension Rescue Experiments

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. In order to determine whether it is the water or glycerol permeability of Aqp3b that is required for normal convergent extension Aqp3b is inhibited and another aquaporin is substituted. If normal development is observed, the characteristics that are shared between Aqp3b and the substituted aquaporin are necessary to normal development. Before I can conduct these experiments aqp2, aqp7 and aqp9 must be cloned into a plasmid from which RNA can be transcribed. During this process I encountered many issues, namely the appearance of mutations in the genetic sequence that have yet to be resolved. I am still working to resolve these issues.

Acknowledgements: Jennifer Forecki (MSU Postdoc/Research Scientist) - Cell Biology & Neuroscience

Marisa Sewell: Cell Biology & Neuroscience
Mentor: Diane Bimczok -- Microbiology & Immunology
Identification of molecules responsible for the regulation of human gastric dendritic cells in response to Helicobacter pylori.

This project concerns the identification of the molecule or molecules responsible for the regulation of dendritic cells in the human gastric mucosa in response to *Helicobacter pylori* infection. The human stomach and intestines produce a peculiar immune response to *H. pylori* in that it is almost tolerated to the extent of a commensal bacterium, but its proliferation can cause serious health complications. In order to identify the specific molecules responsible, the lipid and protein fraction of cell-depleted gastric mucosal stroma have been separated and analyzed separately in an environment of monocyte derived dendritic cells and *H. pylori*. I have shown that DC maturation occurs in the presence of *H. pylori*, as is evidenced by the increase in the expression of DC activation markers, CD86, HLA, and CD83, measured using flow cytometry. I have also shown that this response is blocked in gastric S-CM. Additionally, I have shown that this response is markedly blocked in the low molecular weight fraction of the S-CM compared to the high molecular weight in all activation markers. I have also shown that DC maturation is significantly blocked in the organic fraction of the total S-CM compared to the aqueous fraction. This indicates that the molecule is most likely a low molecular weight immune mediator. This research has applications in public health and the development of a systemic vaccine against H. pylori infection, which would drastically effect the number of people around the world who suffer from *H. pylori* related gastritis, peptic ulcer, and cancer.

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Erik Shaw: Cell Biology & Neuroscience
Mentor: Stephanie McDowell, Bill Stadwiser -- Bridger Care, INBRE
Understanding barriers to participation in HPV vaccination efforts at Bridger Care Clinic

Bridger Care Clinic's mission is to provide excellent, affordable reproductive and sexual healthcare and education in a safe, supportive, empowering atmosphere. These efforts include initiatives to increase HPV vaccinations within

Gallatin County and southwestern Montana. Internal organizational statistics indicate that its female clientele tend to be more likely to have and be more receptive to discussing the HPV vaccination than its male clientele. Bridger Care leadership is interested in identifying barriers and prioritizing methods and approaches to increase participation in the organization's HPV vaccination efforts. This study in particular is intended to identify any barriers preventing individuals age 18-26 from receiving the HPV vaccine. Additionally, it is likely the study will establish correlations between an individual's race, level of education, and sexual orientation with their vaccination status.

Veronika Shchepetkina: Cell Biology & Neuroscience
Mentor: Frances Lefcort -- Cell Biology & Neuroscience
Investigation of the retina and brain development in a mouse model for Familial Dysautonomia

Familial dysautonomia (FD) is a genetic disorder affecting the development and maintenance of the nervous system, and is prevalent in those of Ashkenazi Jewish descent. FD is caused by a point mutation in the gene called inhibitor of kappa B kinase complex-associated protein (*Ikbkap*), resulting in a decreased amount of the IKK complex-associated protein (IKAP). FD patients experience symptoms such as decreased sensitivity to pain or temperature, incoordination, hypotonia, various dysfunctions of the organs, and often die in early adulthood. In addition, FD patients experience progressive blindness due to the loss of retinal nerve fiber layer, which greatly affects their quality of life. In order to study the role of IKAP in the retina, the retina-specific *Ikbkap* conditional knockout (CKO) mouse model was developed using the Cre/lox system. The number of retinal ganglion cells, which make up the retinal nerve fiber, was counted in the CKO and littermate control retinas using immunohistochemistry. Another major implication of FD lies in the central nervous system (CNS), shown by behavioral alteration, a reduction in specific neuronal populations, depleting amounts of spinal motor neuron innervation, and alteration in cortical morphology for mice with FD. We have generated the *Tuba1*α*-Cre*$^{+}$; *Ikbkap*$^{flox/flox}$ mouse, a model in which *Ikbkap* is deleted in the CNS in order to address the question of whether the CNS deficits result due to reduced cell proliferation or, conversely, cell death. Our preliminary data show that loss of IKAP in the cortex does not affect cell migration, proliferation, and cell death during the development.

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Riley Shearer: Agricultural Economics & Economics
Mentor: Mark Anderson -- Agricultural Economics & Economics
Discerning whether Unpasteurized Milk Consumption is a Factor in Public Health

Raw milk has been known to contain disease-causing pathogens such as tuberculosis and listeriosis. For this reason, the widespread adoption of pasteurization in the 1920's has been hailed as one of the most successful public health interventions in the history of the United States. Recently, there has been increased debate on the nutritional value of pasteurized milk compared to unpasteurized milk as well as the real risk of consuming unpasteurized milk. Using data on raw milk producers across counties and over time from four states, we analyze the relationship between the availability of unpasteurized milk and infant and fetal mortality rates. Some of these results are statistically significant, but are unconvincing due to the low fatality rates. To further assess the effect of raw milk on public health in Washington we used hospitalization records and producer data at the county and month level of observation. These data allow us to analyze the importance of an individual's proximity to a farm using producer and hospital addresses. Using inspection records we are also able to assess the effect of cleanliness on a facility's likelihood of causing hospitalizations. This work has important implications for public policy as an increasing number of bills to either constrict or increase the supply of unpasteurized milk are being considered across the country.

Alex Sherman: Chemistry & Biochemistry
Mentor: Rob Walker -- Chemistry & Biochemistry
Spectroscopic Analysis of Pesticides in Model Membrane Systems for Environmental Remediation

Membranes are important biological structures for the survival of life through separation of cellular components from the outside environment, while allowing the flow of necessary substances between these membranes. An expanded knowledge of how these membranes work and their molecular properties can make for a better understanding of cellular processes, and environmental remediation. Most membranes can be described by a four region model containing differing solvation environments, and steric hindrances affecting membrane solubility important for pharmaceutical administration, and toxicity prevention. Due to the heterogeneity of most membranes, simple unilamellar lipid vesicles were studied to remove added variables due to proteins and other membrane attached substances. Previous experiments on membrane solubility and solvent partitioning have been conducted using 7-amino coumarin probes due to their desirable photophysical properties and thermostability. However, experiments investigating membrane interactions of more relevant molecules may lend more insight to physiological processes. For this reason, coumaphos, a pesticide used to control pests on domestic animals, was selected for membrane partitioning studies. Fluorescence lifetime measurements of coumaphos in PBS buffer solution resulted in two emission lifetimes. Upon the addition of DMPC lipid vesicles, a third lifetime was observed. From current results, partitioning of coumaphos was found to be thermally reversible over the membrane melting temperature, and fluorescence lifetimes suggest coumaphos partitions primarily into the non-polar region of a lipid bilayer. Future experiments will be conducted with coumaphos in DMPC vesicles and buffer to analyze the stability of coumaphos in solution and further refine the previous membrane partitioning results.

Joshua Sinrud: Physics
Mentor: Robert Walker, Melissa Mcintyre -- Chemistry & Biochemistry
Doping Solid Oxide Fuel Cell Nickel-YSZ Cermet Anodes with Al2TiO5 to Enhance Fuel Cell Efficiency

Previous studies have shown that Solid Oxide Fuel Cells (SOFCs) with Al_2TiO_5 (ALT) doped nickel-yttria stabilized zirconia (Ni-YSZ) anodes have increased performance and efficiency[1,2]. The mechanisms responsible for this improvement remain speculative, however. The objective of this study is to identify the 2^o phases formed when an anode is doped with ALT; and to determine what roles, if any, these 2^o phases play in the anodes electrochemical behavior. Several 2^o phases have been observed including nickel aluminate ($NiAl_2O_4$) and zirconium titanate ($Zr_5Ti_7O_{24}$). Electrochemical impedance data shows the zirconium titanate phase to be both ionically and electronically conducting and capable of expanding the cell's triple phase boundary. Reduced nickel coarsening also appears in ALT doped cells, however it is still unclear if a specific 2^o phase is responsible. Electrical attributes of the cell are measured using linear sweep voltammetry (LSV) and electrochemical impedance spectroscopy (EIS), while structural and secondary phase identification is conducted using field emission microscopy (FEM) and vibrational Raman spectroscopy respectively. Quantifying the role(s) played by the secondary phases is critical to developing strategies intended to create SOFC anodes with improved performance and durability.

Emma Sirr: Microbiology & Immunology
Mentor: Ryan Jones -- Microbiology & Immunology
Effects of Temperature and Nutrient Concentrations on Freshwater Diatoms

The Jones lab is currently conducting research on the influence of temperature and nutrient (nitrogen and phosphorus) concentrations on freshwater ecosystems in the Hengill Valley, Iceland. I am working in the laboratory on my own portion of this larger project. I am studying the diversity of diatoms in biofilm samples taken from the Iceland site and how their community compositions relate to environmental nitrogen concentrations and temperatures. I will be looking at the diversity of diatoms growing in test-channel biofilms at 5 different temperatures and with 6 different nutrient concentrations and analyzing this data. I will be performing PCR using 18S and gel electrophoresis to determine the diversity of the diatom populations. Diatoms live in many varied environments worldwide and provide primary production through photosynthesis in the freshwater and saltwater ecosystems they inhabit. They are one of the key primary producers in the world's oceans and it is therefore important to understand how climate change could effect their populations and production. The results I obtain can be correlated with the studies performed by others in the lab on bacteria and archaea in the Iceland biofilms, and any correlations between my observations and those of others working on the project can be combined to render a thorough picture of the importance and influence of diatoms.

Margaret Sizemore: Earth Sciences
Mentor: Colin Shaw -- Earth Sciences
Morphometric Analysis of Extensional Faulting in the High Peruvian Andes Using a Geographic Information Systems Approach

The great "White Mountains" or Cordillera Blanca mountain range of Peru is of great interest to scientists due to the 200-km fault that defines the western boundary of the range. Despite the research which has been conducted along the range, there is still a lot to be discovered about the history of the fault within the past 12,000 years. Geographical Information Systems (GIS) techniques have been applied to areas with similar geomorphology as the Cordillera Blanca Detachment (CBD) fault, however; the literature does not suggest that these methods have been used when analyzing the CBD. This research project uses previously collected data and newly acquired GIS data to further understand the geology and geomorphology of the area. By gaining an understanding of this information, it is possible that the general age of the fault could be discovered and the magnitude of future seismic activities could be predicted for the defined area. A geological map of the region was compiled and zonal statistics were analyzed using GIS to learn about the facets along the CBD. This research is in conjunction with another project that is using a GIS method of stream profiling to understand the evolution of the fault and the geomorphic response of the landscape. Upon completion of this research, the data produced can be used to determine how the Cordillera Blanca landscape has responded to seismic activities in the past and a general age of the fault.

Kori Smyser: Chemistry & Biochemistry
Mentor: Erik Grumstrup -- Chemistry & Biochemistry
Bottom-up ZnTe nanowire growth: Construction of a chemical vapor deposition chamber to facilitate vapor-liquid-solid growth

ZnTe is a p-type semiconductor recently gaining attention in material sciences for valuable properties related to its wide band gap. The goal of our research is to contribute to the understanding of its electronic structure and charge-carrier dynamics. A chemical vapor deposition chamber was constructed to achieve cost-effective ZnTe nanowire growth through the vapor-liquid-solid (VLS) mechanism. Following instrument construction, growth conditions of ZnTe has become the principal focus of our work. Tuning this process involves adjusting parameters such as system pressure and flow rate, source and substrate temperatures, choice of catalyst and substrate preparation, which are continually under investigation. As electronic properties are directly related to the dimension of nanowires with respect to the material's band gap, control of such features is of utmost importance. Ultimately, the resulting nanowires will allow for extensive structure-function observation through modification of the system and growth conditions.

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Scott Spring: Chemistry & Biochemistry
Mentor: Robert Szilagyi -- Chemistry & Biochemistry
Investigation of Kaolinite Reactivity in Grafting Iron Sulfur Clusters and Particles

The aim of our research was to investigate the reactivity of natural and synthetic kaolinite, the simplest clay mineral. We have obtained natural clay samples from Dillon - Montana, Kasama - Ibaraki, Felsopeteny - Hungary. These natural kaolin samples were compared and contrasted to the reference kaolinite obtained from Sigma Aldrich (high purity kaolin from Germany). The chemical modifications involved reactions with natural kaolin, hematite, and in situ generation of hydrogen sulfide. Exposure of the samples to sulfide ions produced iron-sulfur compounds as indicated by the appearance of black precipitate. While these hybrid Fe-S/clay materials are yet to be fully characterized, spectroscopic evidence indicate that we are forming Fe-S clusters on clay surfaces. Mössbauer spectroscopic measurements are being conducted at Montana State University, while X-ray absorption spectroscopic data for the sulfur insertion reactions were obtained at the Photon Factory in Japan and the Stanford Synchrotron Radiation Lightsource in California. Various Fe-S pathways were examined and found that the

biologically relevant, buffered mild acidic conditions provide the highest yield. We consider the Fe-S sites on clays as mimics of catalysts for many bio-relevant reactions. One of the implications is in the possibility for enabling abiotic synthesis of complex bio-organic molecules that were fundamental to the origins of life. The synthetic work is in sync with parallel theoretical studies and molecular modelling to rationalize surface reactivity of H_2S at the presence of naturally occurring Al^{3+}/Fe^{3+} substitutions.

William Sprow: Microbiology & Immunology
Mentor: Bill Stadwiser, Amy Cory -- INBRE
Improving community and primary care providers' awareness of existing mental health resources

It has become apparent through statistics, that Montana currently has the highest suicide rate in the country. Despite preemptive measures, and the availability of resources, this trend has not seen any effective reduction in the recent years. Especially adolescents represent a highly affected demographic out of all age groups. Different findings have shown a multitude of factors that account for this, though a truly effective measure for depression aid has not yet been found. One aim of this project therefore, was to improve community and primary care providers' awareness of existing mental health resources. Overall the aim of this project was to compile existing information together, influenced by what surveyed professionals determined as effective. With key findings from separate existing available information, it became apparent what resources would prove more value than others for the final outcome of this project. Primary resources used were research articles pertaining to depression treatment, existing community resources, and healthcare professional interviews. Results from these resources were evaluated to create a useful resource guide, specifically for the healthcare field in a few specific Montana communities. With the results and findings of this research project, a further piece has been added to creating a better networking of resources that are available. Additional goals of the Montana Chapter of American Academy of Pediatrics are to enhance the dissemination of effective mental health and wellness resources, make identification of warning signs more significant in the healthcare field and to ultimately create a decrease in the overall suicide rate in Montana.

Caleb Stair, Zoie Kaupish: Microbiology & Immunology
Mentor: Jean Pfau, Deborah Keil -- Microbiology & Immunology
Nevada Amphibole Asbestos leads to Increased TNF alpha within Mixed Splenocytes

Asbestos is a known carcinogen and also induces fibrosis of the lung. In addition, amphibole asbestos in particular has been shown to induce autoimmune responses. Despite these different outcomes, early stages are characterized by an immune/inflammatory reaction in the lungs, which can be used as a measure of the immunotoxicity of the fibers. Libby Amphibole (LA) asbestos was a contaminant of vermiculite mined near Libby MT for decades, leading to asbestos diseases not only to workers at the mine, but in the entire community. Recently, amphibole asbestos fibers similar in composition to LA were discovered just east of Boulder City, NV. It is very important to determine the relative toxicity of these fibers to establish the risk of disturbing this material. Our objective was to determine whether the Nevada Amphibole (NA) has similar biological effects as LA in a culture of mixed splenocytes. Fibers were collected and characterized by geologists at UNLV. Mixed splenocytes were challenged in vitro with five treatment groups: No Treatment, or 2 doses of each amphibole, 35 $\mu g/cm^2$ or 70 $\mu g/cm^2$. Culture media was collected after 24 hr of treatment, and tested for Tumor Necrosis Factor alpha (TNFα) using a sandwich ELISA, as an early indicator of inflammation. The results showed that there is a statistical difference when comparing the asbestos treatments and no treatment, as well as differences between LA and NA. The results of the experiment showed that both amphiboles elicited a high amount of TNFα within the samples tested. This indicates that NA can cause as much risk as LA and that NA should raise as much concern if not more concern than the Libby Amphibole. Further studies in our laboratory will measure other cytokines in this this comparison model.

Karen Stengel: Cell Biology & Neuroscience
Mentor: Susy Kohout -- Cell Biology & Neuroscience
Comparing the Functions of the Voltage Sensing Phosphatase in Sea Squirt, Zebrafish, and Chicken Species

The voltage sensing phosphatase (VSP) is a transmembrane protein which regulates the phosphatidylinositol phosphate (PIP) signaling pathway in a voltage dependent manner. VSP is unique because it is the first example of a voltage regulated enzyme and suggests a direct link between the electrical properties of the cell and the PIP signaling pathway. The phosphorylation states of PIP regulate many different processes in the cell including membrane trafficking, promoting cell death, and cell growth[1]. The membrane potential is also an important signal in normal cellular processes, controlling neuronal signaling, muscle contractions, and immune responses. VSP bridges these two pathways creating a direct link between the electrical state of the cell and PIP concentrations. The majority of research on VSP has been focused on the tunicate (non-vertebrate with a notochord) *Ciona intestinalis* (sea squirt) species of the protein (Ci-VSP) in part because it was the first VSP discovered. As a result, little is known about the VSP in vertebrate species. I have been studying the VSPs of vertebrate species *Gallus gallus* (chicken, Gg-VSP), *Danio rerio* (zebrafish, Dr-VSP) in order to compare the functions of these vertebrate species to Ci-VSP. So far, the Dr-VSP has given interesting data but, due to molecular biological complications, no data on Gg-VSP has been collected. Using voltage clamp fluorometry to test VSPs, Ci-VSP and Dr-VSP have shown very different movements at equivalent amino acids. This implies that, despite being the same protein, each VSP has unique characteristics. Due to these differences, a comparison between VSP species will prove interesting.

Mikayla Struble: Ecology
Mentor: Chris Organ -- Earth Sciences
Tracking the Convergent Evolution and Functional Morphology of the Raptorial Foot

The birds of prey, or raptors, are a unique group; it is composed of three unrelated lineages of birds which all arrived independently at very similar body plans, stemming from the raptorial footing behavior in which birds interact with their environment with their feet, not their beaks. In association with this footing behavior, the shortening, or abbreviation, of specific proximal phalanges in the foot is highly characteristic of raptors. The patterns of abbreviation we see indicate several complex trends, which we aim to explore in four distinct approaches: 1. What foot morphologies signify general raptorial behavior? 2. What foot morphologies are unique to each group of raptor? 3. What foot morphologies are specific to dietary or ecological niches? 4. When and in what order did the morphologies we see today originate? Raptorial convergent evolution has been difficult to study because of the uncertainty with which we have understood Avian phylogeny, but with the modern age of genetics, the Avian phylogenetic tree has been rigorously reorganized and finally offers scientists a well-supported view into the history of bird, and raptorial, diversity. Here we present data recounting these trends and regress them back into the Avian phylogenic tree to follow patterns of abbreviation and shed light on the evolution of predatory behavior in Aves.

Julie Theis: Psychology
Mentor: Adina Smith – Health & Human Development
Determinants of Suicide: The Rural Transgender Wellness Project

This pilot study identified the determinants of mental health and suicide for transgender persons in rural Montana using a community-based participatory research (CBPR) approach. Based on prior research, we estimate that approximately 3000 (0.3%) transgender individuals reside in the rural state of Montana. By transcending cultural gender norms, transgender persons living in Montana demonstrate strength and resiliency in the face of adversity. However, a significant proportion of this population experiences psychological distress, and it has been estimated that over 50% of transgender persons in Montana have experienced suicidality. The already high frequency of suicidality in transgender persons may be further exacerbated by rural-specific risk factors, such as limited availability of services due to geographic distance, concerns about confidentiality, rural ideologies, interpersonal isolation, and a dearth of primary healthcare providers trained to effectively diagnose depression and anxiety and work with transgender persons. While personal and family pride and community belonging may serve as buffers against suicide for rural individuals, transgender persons consistently experience marginalization, isolation and deficits in family and social support; thus protective factors may be extremely limited. Findings from 23 in-depth qualitative interviews with transgender persons living in the rural state of Montana will be presented. These results will include sample demographics, determinants of mental health and suicide, and also recommendations

for potential interventions. If positive interventions can be implemented, our study will have the potential to save lives, increase overall health, quality of life, and wellness for transgender persons and their families.

Acknowledgements: Kyndra Nevin (Project Coordinator)

Jordan Toles: Earth Sciences
Mentor: Colin Shaw -- Earth Sciences
Speleogenesis of Mill Creek Crystal Cave

The aim of this project was to compile a history of passage formation in the Mill Creek Crystal Cave system by interpreting field observations made within the cave. Crystal Cave is a significant cave that has formed in limestone of the Meagher formation in the Montana Absarokas. Cave passages are observed to have two distinct directional trends, both parallel (E/W) and orthogonal (N/S) to the Mill Creek drainage. The cave exhibits evidence of a complex history that can be accounted for by multiple stages of development under a variety of climatic and hydrologic conditions. Early formation of the N/S trending passages is thought to be the result of phreatic (below water table) dissolution along joint controlled passages, while later formation appears to be vadose (above water table) in nature as suggested by key-hole passage morphology and the presence of large, well rounded cobbles of granitic composition throughout the cave. Passages trending E/W are thought to have formed synchronously with the down cutting of Mill Creek drainage, which is presently situated 80 meters below the cave entrance. Cemented river cobbles in passage walls present evidence for a lull in cave activity, possibly during a period of glaciation when less CO_2 was available to produce dissolved H_2CO_3 for dissolution. This respite may mark the transition from phreatic dissolution to vadose entrenchment. Glacial or fluvial processes could have eroded the valley and brought Mill Creek Crystal Cave closer to the surface during this time, allowing for stream pirating of the surface channel above the cave. Detailed isotope dating of speleothem formations could provide a precise record of the timing of various stages of speleogenesis.

Coleen Trottier: Psychology
Mentor: Suzanne Held -- Health & Human Development
Encouraging good health among Apsáalooke people through traditional relationships

Messengers for Health is a community-based participatory research project that involves members of the Apsáalooke (Crow) Nation and students and faculty from MSU. Upon the request of Apsáalooke tribal members, the partnership is co-developing a culturally meaningful wellness program that addresses chronic illness management among the Apsáalooke people. Through interviews with Apsáalooke tribal members diagnosed with chronic illness, followed by culturally appropriate data analysis, project members identified barriers and facilitating factors to managing chronic illness utilizing Apsáalooke cultural values as a foundation. With awareness that both historical and current trauma affect Indigenous populations at disproportionately high rates and that these traumas have negative health consequences, trauma informed intervention components are being incorporated into the Baa nnilah program. These components, along with the traditional strengths and values of the community will encourage good health among the Apsáalooke people.

Will van Gelder: Earth Sciences
Mentor: Mark Skidmore -- Earth Sciences
Abiotic Subglacial Pyrite Weathering Experiments

Rock weathering experiments were conducted on bedrock samples from Robertson Glacier, Alberta, Canada, a three km long alpine glacier located in Peter Lougheed Provincial Park. The products of experimental physical and chemical weathering were measured in order to determine the abiotic solute contribution from glacial weathering of the bedrock. In particular, the contribution of weathering products from sulfide and sulfate minerals were evaluated. Pyrite nodule bearing micrite bedrock samples were collected from the Robertson Glacier catchment in conjunction with samples of glacial outflow waters and sediments used for geochemical and microbial analyses over multiple seasons (2010-2015). Anoxic and oxic abiotic weathering experiments were conducted at $4^{o}C$, using crushed bedrock samples and deionized water, to examine the contributions of chemical weathering with

oxygenated and anoxic subglacial waters. Preliminary results from the laboratory experiments demonstrate the production of low concentrations of thiosulfate (micromoles per gram sediment). This contrasts with results from the field where thiosulfate was only detected at less than one micromole in subglacial waters. An isolate from Robertson Glacier sediments, *Thiobacillus* sp. RG 5, has been shown to oxidize thiosulfate at 4^{o}C in the laboratory, and it is possible that this organism is active in the subglacial sediments utilizing abiotically produced thiosulfate.

Alyssa Van Hyfte: Political Science
Mentor: Jill Holder -- Gallatin County Food Bank
Viability of Gallatin County Food Bank serving as a leader in the development of a local community garden

The purpose of my INBRE project is to research the extent to which the Gallatin Valley Food Bank, located in Bozeman, MT, would be willing and/or able to take on a leadership role in the development of the Story Mill community garden currently planned in Bozeman, MT. Because the food bank's primary mission is to improve food security throughout Southwest Montana, the organization is interested in evaluating and utilizing community gardening best practices to diversify its programs and support its mission and enhance human health in Gallatin County.

Abigail Van Vuren: Microbiology & Immunology
Mentor: Martin Teintze -- Chemistry & Biochemistry
Characterization of the Activity of 18B-Glycyrrhetinic Acid Against MRSA Biofilms

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 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 most currently available antibiotics, there is an urgent need to develop novel antimicrobials. 18β-Glycyrrhetinic acid (GRA) is a compound found in licorice root that shows potential as a natural antibiotic against MRSA. Previous research has not only shown it to be an effective antibacterial, but to also be an active anti-viral and anti-tumor agent. This study investigated the interaction between GRA and MRSA biofilms through ^{1}H NMR metabolomics. It is possible that treatment of these biofilms with GRA may cause a metabolic change that can be taken advantage of for wound treatment against MRSA biofilms. Ultimately, this work looks to understand the mechanism of action of GRA in an effort to identify novel targets for future drug development.

Acknowledgements: Alan Weaver (MSU Graduate Student) - Chemistry & Biochemistry

Theodore Warthen: Cell Biology & Neuroscience
Mentor: Michael Giroux, Andy Hogg -- Plant Sciences & Plant Pathology
Genotyping of Starch Branching Enzyme II and Starch Synthase II durum cross

Normal wheat is approximately 25% amylose starch and 75% amylopectin, both of which are composed of glucose molecules. However, amylopectin has long chains of glucose with many side branches and is easily digested. Amylose is unbranched chains of glucose complexed with lipid and resistant to digestion. Because Amylose has a slower rate of digestion than amylopectin it is healthier, and therefore increasing wheat amylose content is desirable. It has been shown that mutations in the starch synthase genes starch branching enzyme II (sbeII) and starch synthase II (ssIIa) genes in durum wheat results in increased amylose content. These mutations also lead to reduced total starch content and reduced seed size. Presently it is unknown how to increase amylose content and retain high starch content and seed size. The objective of this project was to genotype a durum wheat (*Triticum turgidum*) population that was created by crossing a sbeIIa/b mutant line by a ssIIa mutant line as well as look at the effects these genes have on seed size and starch amylose content. PCR of genomic DNA extracted from the durum population was conducted, using gene specific primers. This was used to sequence, and genotype the durum plants. Currently we are measuring seed size and amylose content, with the goal being to identify the

starch synthase mutations that increase amylose content with less negative impacts upon seed size, starch content, and agronomic yield.

Hope Watts: Chemistry & Biochemistry
Mentor: Joan Broderick, Amanda Byer -- Chemistry & Biochemistry
ThiC: An Unconventional Radical SAM Enzyme

Radical species are extremely reactive; the ability to control these reactions would extend the applications of the ezymes they are involved in. Radical *S*-adenosyl-L-methionine (SAM) enzymes are a large superfamily that catalyze an immense range of reactions, including those in metabolic processes and antiviral responses as well as hydrogen oxidation and reduction. All radical SAM (RS) enzymes share initial mechanistic steps of SAM cleavage and production of the 5'-deoxyadenosyl radical (5'-dAdo•); RS enzyme structural similarities include a triosephosphate isomerase (TIM) barrel fold, and an N-terminal cysteine motif (CX_3CX_2C) that binds the [4Fe-4S] cluster to which SAM is ligated in the enzyme's active site. Typically, this N-terminal cysteine motif coordinates three of the four irons in the cluster, leaving one iron available to ligate SAM. The RS enzyme ThiC produces an essential vitamin in metabolism, thiamine pyrophosphate, and has notable differences in its unique cluster and SAM binding. Analyzing the differences in ThiC will provide more insight into the complex chemistry involved in RS enzymes and how the reactice radical species are mediated. Instead of the typical CX_3CX_2C cluster binding domain located in the N-terminal of the TIM barrel, ThiC contains a CX_2CX_4C cluster binding domain in a neighboring domain. Spectroscopic analysis will determine how this CX_2CX_4C cluster motif affects SAM ligation and will define key components required for RS enzyme radical control. Studying variation within the RS superfamily provides a more accurate understanding of this very diverse and beneficial superfamily.

Lindsey Whitcomb: Psychology
Mentor: Monica Skewes -- Psychology
Perceptions of Suicide Causes and Prevention Strategies Among Rural Alaska Natives

Suicide rates in rural Alaska are among the highest in the nation, with far-reaching and devastating effects for Alaska Native (AN) communities. A qualitative interview study was conducted with 25 ANs from rural villages to understand how their lives had been affected by suicide. Interviews were audio recorded, transcribed verbatim, and de-identified for analysis. The research team conducted open coding and content analysis to identify emergent themes. Participants discussed their perceptions of effective prevention strategies and provided recommendations for intervention. Key recommendations included enhancing communication skills, increasing time spent with elders, holding community gatherings to strengthen cultural traditions, increasing the number of counseling services available, keeping busy and physically healthy, increasing sobriety, increasing parent-child involvement, and most importantly educating the community as a whole about suicide. In addition, interviews were coded for participants' experiences as survivors of others' suicide, as well as beliefs and perceptions surrounding suicide. Several robust themes emerged from the data with regard to perceived causes of suicide which included substance abuse, depression, loss of culture, feeling alone, trauma from sexual abuse, and trauma experienced from multiple suicides in the community. Other suggested causal factors included lack of opportunity, boredom/isolation, and unresolved grief. Many participants stated that the high incidence of suicide in rural Alaska resulted in a common perception of suicide as a normal and viable option for resolving problems. Overall, participants largely believed that suicide is preventable and stated that communities need education about what leads to suicide, warning signs of suicide, and knowledge of resources available if someone is struggling. Participants emphasized the importance of culture, coping skills to manage painful emotions, connection with others, and talking about suicide as crucial components of intervention programming. Recommendations included both Western methods (i.e., psycho-therapy) and traditional cultural practices. Promising culturally-grounded intervention strategies will be discussed.

Acknowledgements: Fiona Grubin (MSU Undergrad Student) - Psychology

Jesse White: Cell Biology & Neuroscience
Mentor: James Berardinelli, Robert Garrott -- Animal & Range Sciences, Ecology

Developing Physiological Profiles Using Nuclear Magnetic Resonance Spectroscopy To Inform Bighorn Sheep (Ovis Canadensis) Management

This study employs new techniques using nuclear magnetic resonance (NMR) to assess the relative health, physiological condition, and reproductive function of wild bighorn sheep 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 µL 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.

Acknowledgements: M. Rashelle Herrygers (MSU Graduate Student) - Animal & Range Sciences, Valerie Copie (MSU Faculty Member) - Chemistry & Biochemistry

Brett Wilkins: Physics
Mentor: Rufus Cone, Charles Thiel -- Physics
Manipulation and Study of Index of Refraction in Rare-Earth-Activated Crystals for Optical Waveguides

Engineering the index of refraction (speed of light) in transparent crystals is critical to the development of “photonic circuits” for light, an emerging high-speed alternative to many current electronic technologies. Understanding how variations in chemical composition of materials affect the speed and resonant interaction with light is essential to understand and exploit the capabilities for guiding and controlling light in these optical waveguide structures. With this motivation, we study the effects of luminescent rare-earth ions (such as thulium) and other chemical additives (such as hydrogen) on the index of refraction of relevant opto-electronic materials such as lithium niobate (LN) and yttrium aluminum garnet (YAG). Measurement techniques including ellipsometry and reflectometry will be discussed and compared, as well as considerations required for the measurement of complex anisotropic materials. New results and analysis will be presented for a series of optical materials relevant for current photonic research efforts at MSU.

Kevin Zolman: Cell Biology & Neuroscience
Mentor: Susy Kohout -- Cell Biology & Neuroscience
Determination of the Role of the C2 domain of Voltage Sensing Phosphatase

The phosphatidylinositol phosphate (PIP) pathway is an important signaling pathway with a diverse array of physiological effects based on PIP phosphorylation states. Dysregulation of the PIP pathway can have profoundly detrimental effects, which range from epilepsy to autism to cancer. VSP is composed of three domains, which work in conjunction to dephosphorylate PIPs; the first, the voltage-sensing domain (VSD) moves in response to changes in membrane potential. The movement of the VSD propagates to the second domain, the catalytic domain, causing a conformational shift that initiates phosphatase activity. The function of the third domain, the C2 domain, is considerably less well understood. My work has shown that the C2 domain is absolutely necessary for normal VSP function. We and others have shown that VSP's substrate specificity varies.During my previous funding period I created chimeras with the voltage sensing and catalytic domains from Ci-VSP and the C2 domains from VSPs of other species as well as the tumor suppressing lipid phosphatase, PTEN. From these experiments I found that the chimera with the C2 domain from PTEN (Ci-PTENC2) changed the reaction specificity from that of Ci-VSP (as a 3- and 5-phosphatase) to a 5- phosphatase capable of acting on PIPs in only one phosphorylation state. The

goal of this project will be to elucidate the biophysical mechanism behind the C2 domain's regulation of VSP substrate specificity.

Acknowledgements: Paul Castle (MSU Alumnus) - Cell Biology & Neuroscience

University College

Laura Bussey: University Studies (National Student Exchange)
Mentor: Melenie Duval, William Stadwiser -- Gallatin City-County Health, INBRE
Potential for Use of TeleHealth Techniques to Implement Lactation Education Services in Rural Southwestern Montana

The mission of the Gallatin City-County Health Department (GCHD) is to promote and protect health while preventing disease. Included among these efforts is their Lactation Education Program, which serves breastfeeding families in Gallatin, Park, and eastern Madison counties. The program is designed to target rural mothers and families, who often have trouble connecting with such services. CDC state statistics indicate that the while rates of breastfeeding initiation are high (~91%), rates of exclusive breastfeeding at 3 months drop dramatically (~53%). In an attempt to lessen barriers to care, program leadership is interested in implementing its services in rural areas via TeleHealth telecommunication techniques. The overall goal is to increase breastfeeding duration rates among participating mothers through increased access to lactation education. This project requires identification and analysis of program implementation strategies. Development of an evidence-based implementation plan will promote successful outcomes for the program.

MONTANA INBRE NETWORK STATEWIDE SYMPOSIUM PRESENTERS

Kristen Bearchum: Other (Chief Dull Knife College)
Mentor: Dianna Hooker -- Mathematical Sciences
West Nile Virus Summer 2015

The purpose of the West Nile Virus study is to assess the prevalence of the West Nile Virus on the Northern Cheyenne reservation and surrounding areas. West Nile Virus is an infection of the brain that is transmitted from mosquitoes to humans & horses. 1 out of 1000 people that get infected from the virus will die. 20% of people that get WNV will develop other symptoms. Survivors can suffer from disabilities (fatigue and illness that can last for weeks and months.). When horses get infected with WNV, they will die.

Joanie Bull In Sight, Martin Zarco, John Big Knife: Addiction Studies (Stone Child College)
Mentor: LaVerne Parker, Ann Johnstone -- Rural Health
Promoting Resilience using a Culturally based Rural Health Curriculum

A study published in the *Community Mental Health Journal* dated July 28, 2012, revealed that American Indians have a higher incidence of substance abuse. It is assumed that the higher use of illicit drugs is related to historical trauma and ongoing intergenerational trauma; however, more data is needed to substantiate this assumption. Several studies have shown that recovery is possible using American Indian cultural practices. Our goal is to investigate instruments that would help us provide more insight into the connections between historical trauma and resiliency skills using American Indian cultural practices. Resilience is defined as "the capacity for adapting successfully and functioning completely despite chronic stress or adversity following exposure to prolonged or severe trauma "(Cicchetti and Cohen, 2006, p. 165). Historical trauma is defined as "cumulative emotional and psychological wounding across generations, including the lifespan, which emanates from massive group trauma" (Brave Heart, 2003, 1998). Historical trauma exists and can be confronted, understood and transformed through a cultural curriculum titled: Bixkanewin Ishkode (fire that is beginning to stand). We want to help by transforming these traumatic experiences so that health and wellness (resilience) are achieved. Historical trauma influences addictive behavior and with a better understanding, we can gain knowledge and raise awareness throughout our community.

Royalle Chavez: Other (Chief Dull Knife College)
Mentor: Dianna Hooker -- Mathematical Sciences
West Nile Virus on the Northern Cheyenne Reservation

We are trapping mosquitoes and looking for *Culex Tarsalis,* which is the carrier of West Nile Virus. The next step we do a RNA extraction, which is a step by step process. The RNA extraction pulls the RNA out of the *Tarsalis*. Then we prepare our samples with primers, probes, and the master mix for the PCR (polymerase chain reaction). The PCR has to run 2 hours to duplicate the RNA and after it's done, it's able to tell us if there is a positive or negative result. We are always hoping for a negative result.

Baili Connors: Chemistry & Geochemistry (Montana Tech)
Mentor: Michael Webb – Chemistry & Geochemistry
Synthesis of Ruthenium (II) Anticancer Agents

Ruthenium anticancer compounds are very prominent in modern medicine. Results from clinical trials suggest that selective delivery of ruthenium complexes to tumors, due to protein binding, may increase its anticancer activity. Current research has also produced results showing that adding hydrophobic ligands to ruthenium complexes stabilizes the compound. Stabilization helps to maintain the bond between the protein and complex for approximately six hours. This project focused on the synthesis and characterization of ruthenium complexes as

well as different ligands including those with ferrocene. Ferrocene is a biologically active chemical that is already in use in different pharmaceuticals. Theoretically, when the ferrocene compound and ruthenium complex are combined together their properties would produce an environment which would allow for targeted cancer treatment. Through future exploration of these ligands and complexes, it is hopeful they will combine to create a drug that is effective in treating certain cancer types.

Brittnee Crane: Chemistry & Biochemistry (Montana Tech)
Mentor: Joel Graff – Biology
TRIM69: Characterization of Binding Partners and Role in Viral Restriction

The superfamily of tripartite motif-containing (TRIM) proteins has expanded rapidly throughout evolution. Approximately 60 and 75 TRIM proteins have been discovered in mouse and human genomes, respectively. Subsets of TRIM proteins are induced by either type 1 or type 2 interferons (IFNs) and some of these TRIM proteins function to restrict infection by a variety of viruses. The function of most TRIM proteins in mice and humans have not been studied in great detail. Here, we focus on TRIM69, which is upregulated in human macrophages responding to type 2, but not type 1, IFN. Therefore, we hypothesize that TRIM69 may have role in immunity independent of type1 IFNs. A recent human interactome study based on yeast two-hybrid (Y2H) screens identified many potential TRIM69 binding partners including homotypic interactions. The latter Y2H result is consistent with observations that TRIM69 forms large, oligomerized structures within cells. We will assess interaction between TRIM69 and its putative interaction partners using Y2H assays, coimmunoprecipication techniques, and colocalization assessed by fluorescence microscopy. We will first assess the TRIM69-LARP1B interaction, since LARP1B is highly similar LARP1, a gene whose knockdown via siRNA enhanced influenza virus replication. If confirmed to interact, we will test the hypothesis that TRIM69, an E3 ubiquitin ligase, targets LARP1 family member for degradation and therefore restricts influenza virus replication.

Kaytlin Fowler: INBRE (Montana Tech)
Mentor: Joel Graff – Biology
TRIM31: Characterization of Binding Partners and Role in Viral Restriction

There are 75 tripartite motif (TRIM) family proteins encoded within the human genome, yet few have been studied in great detail. TRIM proteins have three specific motifs (RING finger, B-box, and coiled-coil) in common and often act as E3 ligases of ubiquitin or ubiquitin-like proteins. Interferon (IFN)β is involved in immune responses against viral infections. Some TRIM proteins, such as TRIM5 and TRIM19/PML, are known to be IFN-stimulated genes (ISGs) since their expression levels increase in re-sponse to IFNβ-initiated signaling and, interestingly, have been shown to have direct or indirect antiviral activities. In a recent transcriptomic analysis of polarized macro-phages, we found that TRIM31 was specifically upregulated in response to IFNβ treatment relative to the 32 additional activation conditions tested. We hypothesize that TRIM31 has antiviral activity, a role that may be dependent on formation of active E3 ubiquitin ligase complexes containing melanoma associated antigen (MAGE) proteins. We have initiated yeast-two hybrid-based experiments to confirm interactions between TRIM31 and three members of the MAGE family as well as to identify additional TRIM31 interaction partners. In vivo co-localization studies will follow. Rotavirus, which causes life-threatening disease in children under the age of five, encodes NSP1 to prevent IFNβ induction suggesting that ISGs can reduce the replication efficiency of this virus. Therefore, we will measure rotavirus replication in host cells that have enhanced or repressed levels of TRIM31. The overall aim of our research program will be to characterize TRIM31 and other TRIM proteins to shed light on this family of proteins that has been subjected to strong, positive evolutionary pressure.

Chyana Johnson: Health Sciences (Blackfeet Community College)
Mentor: Jim Kipp -- Health Sciences
Connection between salivary cortisol, trauma, and negative health

Significant health disparities affect much of American Indian/Alaska Native (AI/AN) and Native Hawaiian (NH) populations of America. Inequalities in health care and delivery of services for these populations are a contributing factor to disparate health conditions. Lack of equity in areas such as social services, education, environmental

contaminants, historical trauma and acute poverty strongly influence health conditions. People residing within the remaining tribal lands of the Northern Plains experience markedly higher incidence of disease than other ethnicity within this nation ultimately resulting in higher frequency of death and preventable death. This inquiry seeks to define the relationship between stress bio-markers, elevated incidence of infection, and chronic disease. A primary piece of this investigation is the potential connection between salivary cortisol, trauma, and negative health experiences. Enzyme-linked immunosorbent assay (ELISA) was used to establish salivary cortisol levels in 50 recruited participants, determining if they exhibited elevated levels of stress. A survey was developed to expose chronic disease and infection frequency, and adverse life conditions participants were experiencing. This self-report survey was coded using the extensively utilized Adverse Childhood Experiences (ACE) assessment. This research further explored additional stress bio-markers such as serum cortisol, c-reactive protein, serum IgG, salivary IgA, nor-epinephrine and epinephrine.

Skyla Kindt: INBRE (Montana Tech)
Mentor: James Aspevig -- INBRE
Geocoding Workflow Analysis for the MCTR

Introduction: The goal of this internship project is to develop a set of workflow processes for the Montana Central Tumor Registry (MCTR) in relation to its use of GIS. The emphasis of the internship is to suggest improvements which will help the MCTR accurately geocode the data it receives so that standard GIS software (i.e., ArcGIS) may be more confidently used in the spatial analysis and representation of tumor registry data. The work was focused on developing a procedure identifying the specific cases which need to be geocoded, dealing with inconsistences that arise after geocoding is complete, and how the registry processes data when those events occur. These issues become more complex for older data. As the need arises to determine what census tract variables need to be 'filled in." In other words does the program only require the Census data in use at the time of diagnosis or should the data conform to current Census tracts as well. Methods: Work is being conducted using the concepts of design science research, such as process analysis and process flow diagraming. Design science is used within disciplines that have a problem-solving focus such as information systems (IS) and engineering (Simon, 1996). As opposed to the routine practice of systems analysis and design, a design science research approach must be rigorous and focused on the relevance of the problem and the reproducibility of both the problem's context and the solution (Hevner, March, Park, & Ram, 2004; March & Smith, 1995).

Colbi Kipp: Health Sciences (Blackfeet Community College)
Mentor: Jim Kipp -- Health Sciences
The Link between serum cortisol levels

The purpose of this study is to understand the link between serum cortisol levels within an American Indian community. Stress levels can be determined by serum cortisol, which have a direct impact on the immune system. Historically, American Indian communities suffer from various stress disorders related to generational trauma, mental, and substance abuse. This has resulted in an increased frequency of infectious disease, autoimmune disease and various cancers. American Indian communities, potentially due to high-stress levels affecting their immune systems, suffer from the highest incidence of health disparities. This study seeks to find if there is a direct link between stress-related hormones and an increased vulnerability to disease.

TyAnn Kuehn: Chemistry (Montana Tech)
Mentor: Michael Webb -- Chemistry & Geochemistry
Using Click Chemistry to Modulate the Aggregation of the Parkinson's Disease Protein

Parkinson's Disease (PD) is a neurodegenerative disorder and one hallmark of PD is the accumulation of the protein, α-synuclein (αS), in neurons in the brain. α-synuclein is a 140 amino acid protein that is produced in the brain and has an unfolded native state. The misfolding of αS monomers creates oligomers, which then form aggregates in neurons known as Lewy Bodies. Importantly, the misfolding of this protein is accelerated in the presence of endogenous metal ions, particularly copper. One method of drug design for the removal of metal reactive ions is through chelation therapy. An approach is to selectively generate a copper ion chelator *in situ* using

Click Chemistry. Click Chemistry is a copper catalyzed cycloaddition between a functionalized alkyne and azide forming a substituted 1,2,3-triazole. This method has been successfully used in chelation therapy for Alzheimer's disease, where copper was removed from within amyloid-beta plaques causing the plaques to disaggregate. A similar drug design was adapted for Parkinson's Disease. A small set of click reagents were compiled from commercially available alkynes and synthesized azides. The prepared azides of 2-(azidomethyl)pyridine and 4-chloro-2-(azidomethyl)pyridine were reacted with methyl propiolate in the presence of copper producing the desired triazole within 30 minutes. Additional studies into the affinity of the triazole for free copper is ongoing, while further analysis of the click reaction will be performed in copper-containing aggregates of α-synuclein proteins.

Misty LaPlant: Health Sciences (Blackfeet Community College)
Mentor: Jim Kipp -- Health Sciences
What Societal and Behavioral Factors Affect the Immune system and Stress Biomarkers

The goal of this study is to examine the stress levels of participants within an American Indian community. Stress levels of participants in the study were investigated through a self-report survey and Enzyme-linked Immunosorbent Assay (ELISA) technique that analyzed serum and salivary samples of participants. Physiological data was attained through analyzing bio-markers with the ELISA technique which included salivary and serum Cortisol, serum C - reactive protein, serum Immunoglobulin G (IgG), and salivary Immunoglobulin A (IgA). A comprehensive examination of both the survey and bio-marker testing afforded investigators the ability to gauge levels of stress being experienced within this population.

Joseph LaPlant: Health Sciences (Blackfeet Community College)
Mentor: Jim Kipp -- Health Sciences
To identify why disease is measurably increased in Native American communities

The rationale of this research project is to identify why disease is measurably increased in Native American communities. Research suggests that stress hormones can directly inhibit immune system functionality, sequentially increasing the susceptibility to disease. Our direct objective is to analyze stress exposure within a tribal community and its affects on the immune system. This study examines a self-report survey and analysis of blood and saliva samples. The blood and saliva samples were evaluated via Enzyme-linked Immunosorbent Assay (ELISA) to determine stress bio-markers and immunological markers of the participants.

Cheyanne Madrigal: Other (Chief Dull Knife College)
Mentor: Dianna Hooker -- Mathematical Sciences
West Nile Virus

The purpose of testing and sampling the mosquitoes on the Northern Cheyenne Reservation in Eastern Montana was to make sure no one is infected with the virus. The WNV is an infection in the brain and comes from mosquitoes, and can spread the virus to humans and as well livestock. Living in Montana families depend on their livestock. Montana is one of the 4 states that reported the highest incidence of the virus in the United States. There is no vaccine for the virus and 70-80% of people who become infected do not develop any symptoms.

Kaitlin McAdams, Joshua Lieuallen, Krystal Lira, Karriann Kraus: Psychology, Sociology, Biology (Rocky Mountain College)
Mentor: Faraz Masood, Ambrin Masood -- INBRE
Education of Crow Middle School Youth about the Physical and Emotional Impacts of Substance Abuse

Substance abuse among American Indian adolescents has had a damaging effect on the American Indian peoples as a whole. This project, in its second year, conveys messages about the impacts of drugs and alcohol on the adolescent body and mind to students and their families. Using culturally relevant educational techniques, student educators from Rocky Mountain College and Little Big Horn College taught a group of 46 middle school students from two ideologically and geographically similar Catholic schools on the Crow Reservation. Sessions were

composed of a fusion of traditional teaching techniques and unique cultural methods, including kinetic/tactile activities, the use of traditional storytelling, the incorporation of community elders, and monthly take home assignments composed of activities to be completed by both students and family together. Prior to the first educational session, all student participants and an adult member of their family completed pre-program knowledge assessments. The pre-program knowledge assessment indicated that 68% of respondents recognized that both the use of methamphetamine and marijuana used once or twice causes some significant level of harm; whereas 88% of students identified the use of alcohol once or twice to cause some significant degree of harm, and 56% identified the use of alcohol once or twice to cause a lot of harm. Additionally, 92% of family members who partook in the parent pre-survey indicated that they would like the skills to better teach their own children at home. In comparison to our pilot year, attrition rates were significantly lower.

Vanessa McNeill: Psychology (MSU Billings)
Mentor: Sarah Keller, Joy Honea, C. Graham Austin – Communication & Theater, Sociology, Business
Social Isolation and Stigma: The Impact on Suicidal Ideation in Rural Montana

Purpose: This study used content analysis to identify themes expressed by Eastern Montana youth about suicide and suicidal ideation in three years of community-based theater production. Methods: Using video footage of a pilot Suicide Prevention program entitled *Let's Talk*, researchers coded for emergent themes, to identify commonly expressed factors of suicide, barriers to help-seeking, and attitudes about mental health. Findings: Results demonstrated that self-stigma is a significant barrier to help-seeking and a significant factor of suicide. Self-stigma comprises endogenous (internal beliefs) and exogenous origins by immediate (home) and extended social circles (school, church, etc.). Self-stigma takes many forms: Self-hatred, lack of authenticity, lack of interpersonal communication skills, fear of being shunned, experience of being shunned, disconnection from others, thwarted belongingness, perceived burdensomeness, and belief that one's death would be worth more than one's life. Practical implications: The strong relationship identified between common misperceptions about mental health and social isolation indicate a need for education to increase public acceptance of mental health problems and treatment. Conclusion: The cyclical relationship identified between stigma against mental illness and social isolation may indicate future areas for research on suicide prevention.

Acknowledgements: Kristin Neva (MSU Billings Graduate Student)

Suzanne Nalivka: Psychology (Montana Tech)
Mentor: Elyse Lovell -- Psychology
College Students Preferences in Technology Use for Mental Health Support

The purpose of this study is to consider differences of depression among college students and to consider student preferences in technology use for mental health support. Two research questions guided this study: What are college students' preferences on receiving inspirational texts from college counselors for their mental health support while considering students' indicators of depression? What are college students' preferences on receiving appointment reminder texts from college counselors for mental health support when considering students' indicators of depression? The participants (N=136) undergraduate college students completed the DASS21 survey to measure their levels of depression. Levenes Test for Equality of Variances was used for analysis. Significant differences were found for a preference of counseling texts by those with higher levels of depression in fourteen categories: couldn't experience any positive feelings, breathing difficulties, over-reacting, worried or panicked about making a fool of oneself, nothing to look forward to, getting agitated, down-hearted and blue, close to panic, unable to become enthusiastic, no self-worth, rather touchy, action in heart without exertion, felt scared without good reason, felt life was meaningless. These results would suggest that students experiencing depression have a preference to receive mental health related texts at a considerably greater rate than students with lower levels of depression.

Scott Ollinger: Civil Engineering (Blackfeet Community College)
Mentor: Jim Kipp -- Health Sciences
Investigates serum levels of cortisol

This project investigates serum levels of cortisol within a federally recognized tribe. These stress related hormones directly suppress immune function and thereby increase disease susceptibility. Historically, incidence of chronic disease is markedly higher within Native American populations, than other ethnicities. This study seeks to determine whether within this federally recognized tribe, members experience elevated occurrence of prolonged high-stress events, and whether or not stress levels are related to increased infection vulnerability and disease. Although our entire project investigates multiple stress bio-markers such as salivary cortisol, serum c-reactive protein, serum IgG, salivary IgA, serum epinephrine and serum nor-epinephrine, this report focuses on serum c-reactive protein and salivary cortisol and if elevated presence of this bio marker is indicative of immunology competence and how this correlates to participant self-report information relating to infection rates and chronic disease.

Susan Tangmo: Other (Montana Tech)
Mentor: James Aspevig -- INBRE
Newborn Hearing Screening Data Quality

BACKGROUND: The Children's Special Health Services section of the Montana State Department of Public Health and Human Services manages the statewide Newborn Hearing Screening and Intervention (NBHSI) public health program. The principle goal of the NBHSI program is to guarantee that all children born in Montana are provided with, and have access to, appropriate hearing screening services. OBJECTIVE: Assist Montana's NBHSI program with the use of their current data system to identify and support follow-up for children and families who may have either been "lost to care" or passively refused care and further services offered by Montana's Newborn Hearing Screening and Prevention program. METHODS: Reporting and tracking criteria are subject to both State and Federal mandate and similar public health programs exist in all 50 states, establishing the relevance of the research and importance of any solutions that may be developed. The basic measure of success will be the number of records whose status is updated from "lost to care" to (1) Pass (2) Refer (3) No Hearing Loss (4) Confirmed Hearing Loss. Factors to be reviewed include the success of follow-up efforts, specific characteristics of the NBSHI program in Montana and significant attributes, if any, of the program's subjects who have been classified as "lost to care."

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Mentor: Elyse Lovell -- Psychology
The Nuances of Alcohol Addiction and Depression Prior to and Following Substance Abuse Treatment

The purpose of this qualitative study is to clarify the nuances, personal factors, and lived experiences described prior to and following sobriety. The elements perceived as important to maintaining sobriety through the lived experiences of those achieving sobriety following treatment included four themes. The four themes were dimensionalized creating one theme leading to sobriety and one theme following and maintaining sobriety. Within each theme further dimensions transpired. Leading to sobriety was further explored through 1) love for a family member and overcoming self-hatred for one's self, 2) a click, an indescribable change within an instant that came over them, a powerfulness that had not been experienced ever before. Following and maintaining sobriety was further explored through 1) spiritual connections within described as a relationship with God or a greater power and self-actualization, 2) maintained a busy schedule to avoid free time and to fill some of that time with treatment practices. Interviews were conducted with eight recovering alcoholics. The design of this study used hermeneutic phenomenological perspectives, and data analysis utilizing horizonalization to identify significant statements followed by the identification of clusters of meaning. Evaluation methods included empathic neutrality, particularly with varied family structures, inductive analysis to create themes, and a holistic perspective. In conclusion external motivation, a loved one, and internally self-actualization, the indescribable click were prominent in the lived experiences.