Madison Hoffman: Animal & Range Sciences
Mentor: Emily Glunk, Megan Van Emon -- Animal & Range Sciences
Evaluating Hay Feeding Methods on Heifer Performance, Hay Waste, and Economics

Hay feeders have been evaluated in many studies, and have shown a significant reduction in amount of hay wasted compared to feeding without a feeder. A new feeder on the market, the Cattle System by LS feeder, has been developed to decrease hay waste compared to other commercially available feeders. The objective of this project was to compare the Cattle System by LS feeder, a new feeder on the market, to a popular alternative, a cone feeder. Our hypothesis was that due to the design of the new Cattle System feeder, this treatment would result in decreased hay waste compared to the traditional cone feeder. This study was a replicated crossover design, with four periods lasting five days each. A single large round bale (50/50 legume grass mixture) was provided to each pen every 5 days. Bales were individually weighed prior to feeding. Each feeder was placed on concrete in separate pens for ease of hay waste collection. Heifers had ad libitum access to water and minerals throughout the duration of the trial. Measurements taken included: beginning heifer weights and final heifer weights, weight of hay waste, beginning bale weight, and final bale weight. Hay was weighed on day 1 of each period before being placed into the feeders, and hay orts was collected at the end of each five day period to calculate period pen intake. Hay waste was defined as any hay outside the feeder that had not been weighed, and was collected on days three and five of each period. Hay core samples were collected from each bale to ensure uniformity and will be sent to a commercial lab to determine forage quality. Hay waste will be weighed at the end of the study, as all waste was bagged separately by treatment and period, to determine percent waste. The waste will also be sorted into forage species by legume or grass in order to determine individual species composition. This evaluation is still on-going and final results have not been concluded, however, visual differences have been noted in hay wastage between the feeders.

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Erin Calkins: Health & Human Development
Mentor: Vanessa Simonds -- Health & Human Development
Exploring Pregnant Women's Perceptions, Knowledge, and Behaviors Related to Fish and Seafood Consumption

The purpose of this project was to explore the perceptions, knowledge, and behaviors of pregnant women related to fish and seafood consumption during their pregnancy. We conducted individual interviews with 10 pregnant women living in Park County, MT. We asked questions related to demographic information, perceptions about fish and seafood risks and benefits, fish and seafood health information sources, fish and seafood consumption behaviors, and preferences in information sources. Participants consisted of pregnant women ages 18-45, seeking prenatal services from a partner clinic and dietary nurse advisor. A registered nurse was present at all interviews to provide assistance debriefing and to clarify any diet related questions that arose for participants. Women reported that they avoided fish because they felt it was unsafe. Some women perceived their risk for exposure to contaminants as low because of low consumption of fish and many did not know about any of the nutritional benefits of eating fish. Many women obtained information from the internet and had not consulted providers about the information they found. Our project provides evidence that educational materials are needed to clarify this topic for pregnant women. We plan to use these findings to develop an educational tool that health care providers can use to facilitate conversations with their pregnant patients.

Kathryn DesLauriers, Bryant O'Leary, J. Mitch Vaterlaus: Health & Human Development
Mentor: Dawn Tarabochia -- Health & Human Development
How do contemporary adolescent - parent triads conceptualize the concept of health?

The World Health Organization (WHO; 1948) has defined health in three parts of well-being which include, physical, mental and social, not simply an absence of disease or illness. Adolescence is a period of risky time for the development of obesity, and obesity has many lasting physical and psychosocial consequences (Jones & Vaterlaus, 2014). Family contexts are important for making diet and exercise decisions (Freeland-Graves & Nitzke, 2013) and psychosocial development in general (Bronfenbrenner, 1979, & Lytle, L. 2009). In order to understand adolescent health and behaviors surrounding health a common definition should be identified and used within a family. Studies regarding family health frequently consist of only one person from the family and the health care provider (Persson & Benzein, 2014). Additionally, health research is focused on the adolescent alone or one parent. Much of that literature with respect to adolescents contains a focus founded on specific singular categories of the WHO's definition like obesity, disease, or mental illness, but are deficient in the entire scope of wellness (Kircaldy, Shephard, &Siefen, 2002; Rolland-Cahera, 2011; Skelton, Buehler, Irby & Grzywacz, 2012). This study is unique in that it investigates health from a triadic versus a dyadic or singular lens. Researching the adolescent-mother-father triad grants another avenue to understanding perceptions of health, through the perspective of the adolescent and the inner circle of their family influences. Adolescents' perceptions of health are formed from a foundation of their relationship with their parents. The focus of this research was to understand the definition of health from the adolescent's perspective in relation to that of their parents.

Acknowledgements: Bryant O'Leary (MSU Undergrad Student)

Deb LaVeaux: Education
Mentor: Vanessa Simonds -- Health & Human Development
Development and implementation of an environmental health literacy facilitator's guide: Integrating Western and Indigenous science for American Indian youth

Environmental Health Literacy (EHL) includes the understanding of the actions one can take to reduce their health risks and protect their water and environment. Improving health literacy at an early age by focusing on skills related to protecting water quality in their environment may provide an opportunity for youth, their families, and their community to critically evaluate environmental risks and take actions to protect their health. This presentation will describe the process used to design and implement a community-based participatory research EHL intervention for elementary school youth living on a Northern Plains American Indian reservation. The Guardians of the Living Water facilitator's guide was designed to increase 4th grade students' water-related EHL skills. The guide was co-developed and co-implemented by university and community partners, integrating western and indigenous science, tribal research data and published learning activities. Students attending the summer camp and after-school sessions participated in hands-on activities, field trips, and learned from community member guest speakers. The development and implementation of the guide has been an iterative participatory process, consisting of facilitator training, activity assessment and evaluation, and learning objective clarification. Direct involvement of tribal cultural leaders and elementary teachers have been important components to the curriculum development, revision and implementation. The collaborating partners continue to revise the intervention components to further incorporate the EHL model components into the current after school and upcoming summer camp venues.

Acknowledgements: Velma Pickett (Little Big Horn College), Erin Smith (MSU Graduate Student) - Health & Human Development, SaRayne Stops (Little Big Horn College), Jess Milakovich (MSU Graduate Student) - Health & Human Development

Jess Milakovich: Health & Human Development
Mentor: Vanessa Simonds,Suzanne Held, Lynn Kelting-Gibson -- Health & Human Development, Education
Students as agents of change: An environmental health intervention for American Indian Youth.

Elementary school students have the capacity to share knowledge with their caregivers, peers, and community. While previous research suggests that children can successfully act as change agents for health, empirical evidence is lacking. This study explores the transfer of knowledge between elementary school students and their parents during and after a 5-day summer camp focused on water-related environmental health. This study was part of a larger community-based participatory research project in the Crow community. We conducted open-ended interviews with caregivers. Questions focused on what their child had shared with them, and to what degree they had participated in camp related take-home activities. Interview transcripts were analyzed using thematic analysis. We found that children can serve as agents of change relaying information to parents. Children shared knowledge, and demonstrated attitude and behavior changes related to environmental health as a result of the camp. The overarching community context impacts how children share knowledge, and experience attitude and behavior changes. This context and evidence of the reciprocal relationships between caregivers and their children support that children did act as agents of change for environmental health, or 'Guardians of the Living Water'.

Acknowledgements: Velma Pickett (Little Big Horn College)

Kevin Burt: Civil Engineering
Mentor: Ellen Lauchnor, Neerja Zambare -- Civil Engineering, Center for Biofilm Engineering
Calcium Precipitation and Trace Metal Co-Precipitation During Fluid Flow and Mixing

This project observes calcium precipitation and trace metal co-precipitation during fluid flow and mixing. Observations are made by utilizing a dual influent flow cell system, which mimics subsurface conditions. The environment being recreated for the analysis simulates the remediation of contaminated groundwater using microbial induced calcium carbonate precipitation (MICP). The fluid flow and mixing within the flow cell represent the interaction between groundwater contaminated with heavy metals, and the injected remediation solution containing urea and microbial nutrients. The metals examined include two alkaline earth metals, strontium (Sr) and barium (Ba). In addition to being common contaminants of hydraulic fracturing, Sr and Ba radionuclides are the product of uranium fission, and are present in nuclear waste. By comparing crystal size and formation of the precipitate within the flow system, results suggest that more calcium/heavy-metal precipitate formed when flow rates were similar throughout the system. Optimal flow conditions for the remediation of contaminated groundwater through MICP were evaluated using precipitation rates and a parameter for the removal of trace metals from the liquid phase into the solid phase relative to calcium precipitation. These results will be presented.
These results have the potential to aid in the optimization of MICP and its use in the field of environmental remediation. Ultimately this research asks the question of how simultaneously operating varied flow rates in a dual influent flow cell during MICP affects calcium, strontium, and barium precipitation rates and the occurrence of precipitation spatially within the system.

Geoffrey Zath: Chemical & Biological Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering
A High-Throughput, Multiplexed Microfluidic Method Utilizing an Optically Barcoded Drop Library

The power of drop-based microfluidics promises reduced biological assaying times and greater sample throughput; however, current drop-based microfluidic methods focus on single-input single-output techniques to provide these benefits. To achieve truly high-throughput analysis of biological assays, a multiple-input approach must be taken. The research presented here is focused on the development and validation of a drop-based microfluidic method that is capable of encapsulating, in parallel, 96 assay samples in drops and optically tracking them in a barcoded drop library. The advantage of such a method is its ability to be integrated with current biological assays performed on a 384-well plate. The first step was to fabricate a three-dimensional microfluidic device capable of accepting 96 sample inputs. Second, formation of drops within the device was characterized by creating a state diagram using Capillary and Weber numbers of the two-phase flow. Finally, the use of fluorescent microbeads was investigated for the purpose of optically barcoding drops. As a proof of concept, the microfluidic device was used to encapsulate 50 µm diameter drops from 24 wells barcoded with fluorescent microbeads at a drop formation rate of 3 kHz per well. Fluorescent detection of the barcoded drop mixture was performed at a rate of 200 Hz and density-based clustering algorithm DBSCAN was used to identify barcoded drop clusters from the fluorescent signal data. The results presented here show the microfluidic platform has the potential to be a useful tool in biological assays involved with tracking a large number of samples in a well-plate format.

Sarah Rubin: Geology & Writing
Mentor: Dale Greenwalt -- Paleobiology (National Museum of Natural History
Science Writing as Applied to Deep Time

This two-part internship through the Smithsonian Institution was a unique, one-in-a-lifetime experience that brought together every aspect of museum work from the research before the fieldwork to the publicizing of scientific articles. The two weeks of fieldwork, facilitated by Dr. Dale Greenwalt, near Glacier National Park integrated paleoecology with critical thinking when finding insects and fish in the Eocene's Kishenehn Formation. This formation is world-renowned for its spectacular preservation of these specimens, with many new species being found every year, and the discovery of all of the specimens brings to light questions such as what the conditions were to preserve the insects so well and what are the mineralogical differences in the layers containing insects and those containing fish. This same critical thinking transitioned into the second portion of the internship, which took place this past Spring break. At the Smithsonian, John Barrat, the lead science writer and creator of the Smithsonian's Insider website, oversaw the writing of articles to be published on the site museum's Facebook page that made scientific articles more accessible to the lay community. Articles ranging from Earth-based radar and cutting down on ivory smugglers, to new art techniques and aerial photography were the subjects for the translated articles, which required a mindset that allowed for filtering the original articles through the public's lens and condensing them appropriately. Both parts of the internship provided invaluable skills and experience that encourages critical thinking in scientific and creative ways, joining the two to create a complete museum experience.

Acknowledgements: John Barrat (Smithsonian Institution)

Kenneth Flagg, Christopher Barbour, Andrea Mack, Jordan Schupbach, Huafeng Zhang: Mathematical Sciences
Mentor: Lillian Lin, Katharin Banner – INBRE
Statistical Consulting and Research Services: Past, Present, and Future.

Statistical Consulting and Research Services (SCRS) is a group of statisticians at Montana State University (MSU) whose mission is to collaborate with domain experts across campus to improve the scientific research conducted at MSU and within the Montana University System. Since its inception, SCRS has grown at a tremendous rate and our statisticians continue to work with student and faculty researchers from a variety of scientific domains across the Montana University System. We present an overview of the history regarding how SCRS came to be, the services we perform, and the diversity of researchers that we collaborate with. We discuss the technical tools we incorporate in our workflow process and the steps we perform from the initial meeting to the final product. We will also highlight our vision moving into the future including what opportunities we see to continue improving the scientific research across the Montana University System, specifically highlighting the additional services we hope to provide here at MSU.

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Joseph Bretz: Physics
Mentor: Bennett Link -- Physics
Selective Excitation of Stellar Oscillations of a Magnetar with a Tangled Magnetic Field

Magnetars are strongly magnetized neutron stars. Some of them produce giant flares that exhibit quasi-periodic oscillations which have been attributed to stellar oscillations that modulate the emission. A tangled magnetic field model introduces a spectrum of magnetic normal modes that can explain the observed quasi-periodic oscillations, as expected from stability considerations. We show that reasonable initial conditions selectively excite stellar oscillations, and find promising agreement with data.

Acknowledgements: Anthony van Eysden (MSU Postdoc/Research Scientist) - Physics

Cooper McCann: Physics
Mentor: Kevin Repasky -- Electrical & Computer Engineering

Semi-automated creation and classification of high-resolution multi-swath hyperspectral data using Landsat 8 surface reflectance data as a reference target and a novel histogram based unsupervised classification technique to determine natural classes from

Flight-based hyperspectral imaging systems have the potential, due to their low-cost and high coverage area, to provide important information for ecosystem and environmental studies as well as aide in land management. In order to realize this potential, automated methods must be developed to provide large-area calibrated data allowing for temporal data sets at the mesoscale. A semi-automated method of producing a high-resolution, large-area, radiometrically-calibrated hyperspectral data set using the Landsat surface reflectance (L8SR) data product as a reference target is presented, along with a histogram based unsupervised classification scheme. The radiometric calibration method uses standard hyperspectral processing techniques that are extended to include removal of uneven illumination conditions between flight passes in order to create large-area radiometrically consistent data. Additionally, through spectral and spatial resampling Landsat 8 surface reflectance data are used as a radiometric reference target. Advantages of the calibration technique include the need for minimal site access, no ancillary instrumentation, and automated data processing and can be extended to arbitrarily large areas. The classification technique uses a mathematical model based on biophysically relevant parameters to fit the hyperspectral data on a pixel-by-pixel basis thus achieving a degree of noise reduction and data compression. Histograms of these fit parameters can be selectively split in order to naturally classify the data for anomaly detection of other class specific analyses. Data from hyperspectral flights acquired 06/21/2014, 06/24/2015, and 06/30/2016, covering 18.5M m2 (4500 acres), are presented.

Acknowledgements: Mikindra Morin (MSU Graduate Student) - Land Resources & Environmental Sciences, Rick Lawrence (MSU Faculty Member) - Land Resources & Environmental Sciences, Scott Powell (MSU Faculty Member) - Land Resources & Environmental Sciences

Reema Najjar: Psychology
Mentor: Rebecca Brooker -- Psychology
Parenting is Associated with Delta-Beta Coupling in Preschoolers

Parenting behaviors serve as early influences on children's developing regulatory capacities (Kopp, 1982). Sensitive parenting, or parents' ability to correctly interpret and respond to children's signals is believed to support the development of regulation. In contrast, harsh parenting, or uninvolved, or punitive parent behaviors, is thought to diminish regulatory development (Ainsworth et al., 1974). Delta-beta coupling is believed to index functional crosstalk between cortical and subcortical systems of the brain (Knyazev, 2007). Though coupling has been studied as an index of neural systems of regulation in children, it is unclear whether parenting impacts coupling in ways that are consistent with developmental theory. Thus, we tested associations between parenting behaviors and delta-beta coupling as regulatory systems are developing. Using a measure of resting EEG, we found that preschoolers (N= 91, Mage= 3.60, SD = 0.15) with fathers low (vs. high) in harsh parenting showed greater coupling in parietal electrode sites ($z = 2.66$, $p = 0.00$) while fathers' high (vs. low) harsh parenting was linked to greater coupling in frontal electrode sites ($z = -2.14$, $p = 0.02$). There were no significant findings in mothers ($zs < 1.36$). Heightened coupling was also seen at frontal sites for preschoolers who were high (vs. low) in social fear ($z = -2.11$, $p = 0.02$), suggesting that enhanced early coupling in frontal regions may expedite the development of frontal regulatory networks in order to cope with negative parenting and may serve as proxy of regulation-based risk for anxiety problems in young children.

Summer Whillock, Lucca Reiter: Psychology
Mentor: Ian Handley -- Psychology
Unconscious Thought: Biased by Negative Framing?

Individuals chose best options from complex information more often if they are distracted from consciously thinking about that information, and have an evaluation goal versus none (Bos et al., 2008). However, people heavily weight negative information, and are risk averse. Thus, this effect might exaggerate when people must choose a worst option, or disappear because the worst-framing serves as an implicit processing goal. Testing these possibilities, participants randomly received a goal to choose the best or worst roommate, then information regarding three potential roommates, the best (worst) associated with mostly positive (negative) traits and the third with balanced traits. Next, participants' goal was satisfied or not via random assignment before they engaged in a distraction task, then reported their choices. Logistic regression revealed participants with a processing goal during the distraction (vs. not) chose the correct option significantly more often, but only when asked to choose the best roommate.

Paul Wilson-Harmon: Mathematical Sciences
Mentor: Mark Greenwood -- Mathematical Sciences
Demystifying the Carnegie Classifications

The Carnegie Classifications of research activity are used to compare like institutions in higher education. In 2015, the newest update of the Carnegie Classifications was released, with Montana State University moving from the top-tier category of “Highest Research Activity” to second highest tier, “Higher Research Activity.” The classification system is based on two separate indices calculated using principal components analysis. The first index is based on a set of aggregate covariates and the other on a set of per-capita metrics. This analysis re-creates the calculation of the classifications and examines how sensitive they are to changes in the underlying characteristics of a given institution. Moreover, I demonstrate an app that will track how Montana State would compare to other institutions with increases in each variable used to calculate the classifications. This static analysis informs how difficult it would be to move from the R-2 status to R-1 in the future, but more importantly, it further illuminates the reasons for why Montana State was placed in the “Higher Research Activity” classification in 2015. This project was completed in cooperation with the Department of Mathematical Sciences and the Office of Planning and Analysis.

Mara Canen: Psychology
Mentor: Rebecca Brooker -- Psychology
ERN AND THETA DYNAMICS: LINKS WITH ANXIETY RISK IN PRESCHOOLERS

The Error Related Negativity is a neural marker for error monitoring (Botnivick et al., 2001) that has been linked to anxiety risk in children (Torpey, Hajcak, & Klein, 2009) and adults (Olvet & Hacjak, 2008). However, this finding has been inconsistent. For example, more negative ERN amplitudes are related with increased anxiety in children over age 12, but not under age 12 (Meyer et al., 2012). The neural dynamics underlying childhood ERN are also unknown. In this study, we investigate interactions between ERN and the Theta frequency band, which is associated with attentional control (Jensen & Tesche, 2002) as contributors to childhood anxiety risk. We recorded EEG from 59 3.5 year old children (M=3.56, SD= 0.35) during a modified Go-No-Go task. A repeated measures ANOVA and follow-up tests revealed a significant ERN at Fz, FCz, and Cz, but not Pz ($F(3,168)= 2.93$, $p= .04$). Theta power was visible for both correct and incorrect trials ($F(4,54)= 20.798$, $p <.05$). Parents reported on children's anxious behaviors such as social inhibition and withdrawal and asocial behaviors with peers. Greater Theta power during incorrect trials predicted greater anxiety risk ($B = 1.31$, $p < .05$); however, this association was moderated by ERN ($B = .11$, $p = .04$) such that when ERN was small, theta negatively predicted anxious behaviors ($B = 1.19$, $p = .04$). Theta and anxious behaviors were unrelated when ERN was large ($B = -.87$, $p > .05$). The current study provides evidence that ERN and theta may jointly contribute to anxiety risk in early childhood.

Hayden Bateman: Plant Sciences & Plant Pathology
Mentor: William Dyer, Barb Keith -- Plant Sciences & Plant Pathology
Molecular Effects of Insect Herbivory in Multiple Herbicide Resistant Avena fatua

This project is a continuation of ongoing research done by the Dyer lab showing that multiple herbicide resistant (MHR) *Avena fatua* (wild oat) plants express elevated levels of volatile monoterpenes which are implicated in disease and pest resistance. I investigated whether the expression of selected genes in MHR (*A. fatua*) in response to insect herbivory and mechanical wounding differed from herbicide susceptible (HS) plants. Plants at Zadok 35 growth stage were subjected to mechanical or biological injury from beet armyworm (*Spodoptera exigua*) feeding. Plants were harvested 6 h after injury and leaf area damage quantified. To gain insight into differential gene expression, genes known to be upregulated in response to biotic and herbicide stress were quantified using qPCR: GSTF1-GST phi, UDPGlu5-UDP-glucosyltransferase, ABC2-ABC transporter C subfamily, OAT1-Ornithine aminotransferase, RPP1-NBS-LRR (RPP13- like), SNF3-SNF2 ATPase, and Antho1-Anthocyanin bHLH-Myc transcription factor. qPCR results were normalized against two validated reference genes with stable expression. The results will allow us to gain insights into the relationship between MHR and plant defense against biotic stressors.

Nathan Blaseg: Microbiology & Immunology
Mentor: Douglas Kominsky -- Microbiology & Immunology
The Role of IFN-Y Induced IL-10R1 Expression in Restitution of Epithelial Barrier Function during Intestinal 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. Importantly, during ongoing inflammation 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. Here we are 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 further investigate the role that differentiation defects may play with regards to the barrier function of epithelial cells lacking IL-10R1. To this end we are investigating expression and protein level of factors critical to intestinal epithelia differentiation in vitro, as well as using staining techniques on tissues derived from colitis mouse models. 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.

Laura Ippolito, Paul Rychener: Land Resources & Environmental Sciences
Mentor: Bruce Maxwell -- Land Resources & Environmental Sciences
Course organic matter distribution and soil moisture retention capacity

Organic matter (OM) is a critical component of the soil in agriculture in arid or semi-arid regions in particular because of its ability to retain water in the soil. This raises the question, how does spatial distribution of OM in soil play a role in efficiency of soil moisture retention. The purpose of this experiment was to recreate three treatments, mimicking different ways OM is incorporated into the soil in an agricultural setting, along with a control which has no additional OM. To do this, the first treatment had OM fully submerged beneath the soil surface to show an increase of OM content compared to the control. The second treatment had 80% OM buried and 20% sticking out, mimicking a tilled agricultural setting. The final treatment had OM 80% buried with 20% stubble sticking out with intact root systems, to mimic summer fallow. To measure water retention, each pot was ¼ submerged under water overnight to fully saturate the soil. After saturation, the pots were weighed and then placed in a drying oven. The pots were periodically re-weighed at time 0, 0.5, 1, 2, 4, 8, 12, 24, 36, 48, 60, 72, 96, 120, 144, 168, 192, 216, 336 hours. Preliminary results show the fallow treatment had the most loss in water, followed by the unamended soil control, tilled soil treatment, and the most water retention was in the soil with an increased OM content. This study suggests that additionally completely buried OM has the highest water retention.

Kory Kirby: Land Resources & Environmental Sciences
Mentor: Tony Hartshorn -- Land Resources & Environmental Sciences
Does greater saturation lead to faster soil carbon accumulation in a restored wetland?

Wetlands provide many ecosystem services. In Bozeman, MT, Story Mill wetland site is being restored and converted into a public park by The Trust for Public Land and The City of Bozeman because of these services. Carbon sequestration via restoration of wetland soils is receiving a lot of interest to mitigate carbon dioxide increases. An initial step in restoring these ecosystem services was the creation of the Bozeman Creek Backwater Slough (BCBS), a side channel constructed by excavating nearly ~6200 yds3 of soil to improve surface water quality by enabling Bozeman Creek to spread over a much greater area during flood events. This excavation has established a time zero for measuring baseline rates of carbon accumulation. My previous research has already answered how much soil carbon was lost due to excavation: I estimated 26%. This research looks to answer if carbon is accumulating at Story Mill, and, if so, at what rate? My hypothesis is that organic matter accumulation rates will be greatest in the most reduced/anaerobic location and organic matter accumulation rates will be lowest in the most oxidized/aerobic location along my sampling transects. I will characterize twelve soil profiles, nine in the BCBS, three outside the slough in which I can compare these results to last year results establishing if carbon is accumulating, and if so how much has accumulated over the course of one year. Though my work will only help quantify how much soil carbon can be sequestered in one part of Montana under these conditions, hopefully I can contribute to the statewide portfolio of Montana solutions to climate change.

Danica Kluth: Plant Sciences & Plant Pathology
Mentor: Clain Jones, Terry Rick -- Land Resources & Environmental Sciences
The Effects of Soil Depth and Soil Phosphorus Levels on Nitrogen Fixation and Protein of Field Pea

Pea production in Montana has increased more than 5 fold in the past decade yet essentially no research has been conducted on variables that affect key properties of pea plants. For example, little is known about what affects pea protein and the amount of nitrogen fixation, which is the conversion of nitrogen gas to plant available nitrogen that occurs on pea roots. This study is currently investigating the effects of soil depth and soil phosphorus availability on nitrogen fixation and pea protein. Nitrogen is typically the limiting nutrient in agriculture and phosphorus is one of the most limiting nutrients in Montana. Two fields located in central Montana were used to collect soil, weed, and pea tissue samples. The pea grain, pea chaff, and weed tissue were processed and analyzed for 15N in order to calculate the amount of nitrogen fixed by the peas. The soil samples collected will be analyzed for plant available phosphorus using a sodium bicarbonate extraction. After sample analysis, a multiple linear regression with depth to gravel and plant available phosphorus as fixed independent variables and nitrogen fixed in grain and protein in grain as dependent variables, will be analyzed. It is expected that soil depth and phosphorus will control nitrogen fixation and pea grain protein. Ideally, a “critical” phosphorus level for nitrogen fixation (meaning minimum P concentration that maximizes N fixation) will be developed from this research so pea producers will have a value to target when fertilizing to optimize the vitality of their crop. Although depth to gravel cannot be controlled, learning its influence on protein and N fixation can allow producers to select fields that optimize N fixation and pea protein.

Aishwarya Kothari: Plant Sciences & Plant Pathology
Mentor: Michael Giroux -- Plant Sciences & Plant Pathology
New Dwarfing Alleles and Their Impact on Wheat Growth and Development

The semi-dwarf genes in wheat are mutant forms of the Reduced Height (*Rht*) genes that make wheat plants shorter and higher yielding. Because of their reduced stature, these semi-dwarf wheat varieties are less prone to lodging when increased water and fertilizer is applied. The goal of this research project is to test and screen three wheat populations segregating for new *Rht* alleles and measure plant phenotypes on the same populations. The populations being screened are BC_2F_2 segregating populations. The populations were screened by isolating DNA from individual plants and doing two stage PCR to amplify the *Rht* coding sequence from each DNA sample. Then the samples were sent in for sequencing and the results were analyzed for single point mutations within the *Rht* gene. The impact of the new *Rht* alleles will be assessed by measuring the growth and yield of wheat plants that are homozygous for the presence or absence of the new *Rht* mutation. Some of the plant phenotypes that are being measured are plant height, tiller number, coleoptile length, and photosynthetic rates. This will allow us to assess the impact of the new *Rht* alleles upon wheat growth and development. The goal of this research is to overcome the negative aspects of currently utilized *Rht* dwarfing alleles by identifying *Rht* variants conferring height, protein content, and coleoptile length intermediate between full height and semi-dwarf.

Acknowledgements: Emma Jobson (MSU Graduate Student) - Plant Sciences & Plant Pathology

Miles Maxcer: Land Resources & Environmental Sciences
Mentor: Robert Peterson, Michael Gates -- Land Resources & Environmental Sciences, Smithsonian Instituation
Entomology Collections Curation of Hymenoptera at Smithsonian Museum of Natural History

With the over 35 million specimens housed at the Smithsonian Department of Entomology's National Insect Collection, there comes an extensive challenge in keeping the collection organized, updated, and recorded in online databases. Additionally, the Smithsonian is tasked with engaging the public. This project will include the learning and application of taxonomical and curatorial techniques, in addition to the production of entomological film media for the Smithsonian Institution and its partner, the U.S. Department of Agriculture's Agricultural Research Service. Because the Smithsonian is a major repository for insect specimens from important research worldwide, preparation for the project was necessary to ensure that the requisite knowledge and techniques would be used to preserve the integrity of the collection and make the work efficient and accurate. The presentation will include information and media relating to the internship experience at the Smithsonian Department of Entomology. My specific focus will be on the curation of parasitic Hymenoptera in the superfamily of Chalicidoidae wasps. The poster presentation will cover the concepts learned, including critical skills in museum curation (handling fragile museum-quality specimens, labeling, databasing, and sorting specimens), systematics, taxonomy, basic research, and media creation.

Uriel Menalled: Land Resources & Environmental Sciences
Mentor: Jane Mangold -- Land Resources & Environmental Sciences
Understanding the Effects of Herbicide Application on Hoary Alyssum (Berteroa incana L.) Seed Biology

Hoary alyssum (*Berteroa incana* L.), a non-native plant, invasive plant is difficult to manage because of its long flowering period, during which it simultaneously flowers and produces seeds. Consequently, improper herbicide application may kill flowers but not seeds. Since hoary alyssum reproduces exclusively by seed, we examined how different herbicides affect its seed production, viability, and germination. Invasive plant managers treated hoary alyssum with various herbicides on six rangeland sites across southwestern Montana. Managers recorded flower and seed pod development of hoary alyssum. We randomly collected 20-30 hoary alyssum plants from treated and non-treated areas at each site about four weeks post-treatment. We determined seed production and analyzed seed viability using tetrazolium tests. Seed germination was examined for two sites under current and predicted temperatures. At four of six sites, herbicide treatments reduced hoary alyssum seed production by 49-98% compared to non-treated areas. Herbicide treatments significantly reduced seed production at sites sprayed at early developmental stages, or when on average, <50% of a flowering stem had seed pods. All herbicide treatments, except for chlorsulfuron + 2,4-D, significantly decreased seed viability. Seed viability in non-treated areas ranged from 36-73%. Seeds from treated areas, except those treated with chlorsulfuron + 2,4-D, exhibited 0-21% viability. While we are still analyzing germination, we predict that germination will increase with temperature, but the relationship may vary across herbicides. Our research suggests that the application of some herbicides early during hoary alyssum flower and seed pod development can effectively reduce seed production and viability.

Acknowledgements: Stacy Davis (MSU Postdoc/Research Scientist) - Land Resources & Environmental Sciences

Carine Riley: Animal & Range Sciences
Mentor: Shannon Moreaux -- Animal & Range Sciences
The correlation between facial hair whorl patterns and a horse's stress levels and reactivity among a feral population.

The relationship between facial hair whorl patterns and objective measures of stress and reactivity will be examined among 15 mustangs of the same herd, obtained from the Bureau of Land Management. Data collection will include assessments of salivary cortisol levels and heart rates at rest, during, and after exposure to a potentially frightening stimulus or situation. These tests will include trailer loading and isolation from other horses, interactions with trainers, and exposure to novel visual and auditory stimuli such as an opening umbrella or a moving tarp. Data from the heart rate monitors and salivary cortisol test kits will be analyzed and compared to the number, direction, and vertical and lateral position of each horse's facial hair whorl(s). Correlations between certain whorl patterns and higher heart rates or cortisol levels may support long-standing claims that a horse's hair whorls can be indicative of his temperament or reactivity, which could provide a simple method of predicting animal behavior.

Paul Rychener: Land Resources & Environmental Sciences
Mentor: Tony Hartshorn -- Land Resources & Environmental Sciences
Tests of Various Compost Inoculum on Rate of Decomposition and Food Production

As universities work to reduce their carbon footprints, campuses are composting, rather than landfilling, food waste. Unfortunately, few studies of composting outcomes exist, and there are even fewer studies analyzing compost methods. This study analyzed 3 methods for treating food waste at various concentrations. Bokashi is a compost inoculum, which uses a wheat bran-type substrate hosting "effective microorganisms". Here we report the results from a three-phase compost study of pre-consumer food waste. Five food waste treatments included a no inoculum control, and single or 3-layer treatment, of Bokashi or soil. For Phase 1, we fermented the food waste in five-gallon buckets, measuring the headspace carbon dioxide (CO2). The CO2 to soil ratios declined from approximately 300 to approximately 100 over 4 weeks showing little variation between treatments. For Phase 2, compost decomposition completed in the field, measured by soil respiration rates, showed a large initial spike (above 150 micromoles of CO2/meter2/second), then declined over a 6-week period. For Phase 3, the compost was dried and ground, then used as a nutrient amendment to grow lettuce. Biomass increase occurred for all amended treatments, surprisingly, the largest increase (150%) was found for the food-only compost treatment. Our results suggest Bokashi and soil amendments provide little to no additional benefit compared to food-only compost. Future work should assess emissions produced through these types of composting efforts, to more quantitatively evaluate the benefits of composted food waste versus potentially avoided greenhouse gas emissions (e.g., methane and nitrous oxide) associated with landfilled food waste.

Casey Smith: Animal & Range Sciences
Mentor: Tom Murphy -- Animal & Range Sciences
The effect of late gestation shearing on ewe feed intake

In Montana, sheep are typically shorn in late winter or early spring when ewes have about 6 weeks left in their gestation. This results in increased dry matter intake as sheep try to maintain their body temperature, and ultimately, increased feed costs for the shorn ewe compared to the unshorn ewe. As a sheep's wool grows back, their increased feed needs will subside and feed costs will return to normal. Shearing ewes in late gestation may also affect lamb birth weight and survivability providing a trade-off for increased feed costs. Differences in feed intake and subsequent lamb performance between shearing and treatment groups will be the topic of this research project.

Bronwyn Stockton: Biotechnology
Mentor: Matthew Fields -- Center for Biofilm Engineering
Carbon Utilization in an Anaerobic Interdomain Consortium

A syntrophic relationship with a feedback loop occurs in a coculture between the sulfate reducing bacterium, Desulfovibrio vulgaris Hildenborough, and the hydrogen oxidizing archaeon, Methanococcus maripaludis. In this relationship, M. maripaludis utilizes hydrogen produced by D. vulgaris Hildenborough thus lowering the partial pressure of hydrogen gas through the production of methane allowing for D. vulgaris Hildenborough to avoid experiencing an inhibition in growth due to excess hydrogen thus forming a syntrophic feedback loop. Previous work in this field identified the potential for D. vulgaris Hildenborough and M. maripaludis to have genes that encourage syntrophy and the potential to adapt to using other metabolites to increase syntrophy and this project aimed to complement that work by testing monocultures of these organisms in several different metabolic growth substrates. This project studied the metabolites acetate, alanine, ethanol, formate, lactate, pyruvate, and sulfoacetate under anaerobic conditions in monoculture batch tubes where growth was determined through optical density (OD) readings. For comparison of growth, a control of D. vulgaris HIldenborough was done with lactate and added sulfate and, for M. maripaludis, the control was done with acetate and an overpressurization of hydrogen. Tests were also run to examine the growth differences between growing D. vulgaris Hildenborough with and without added sulfate and M. maripaludis with and without an overpressurization of hydrogen gas.

Acknowledgements: Laura Camilleri (MSU Graduate Student) - Center for Biofilm Engineering

Kelsey Wallisch Simon: Land Resources & Environmental Sciences
Mentor: Anthony Hartshorn -- Land Resources & Environmental Sciences
Can We Help Worms Help Us?

Scientists have been studying earthworm's effects on soil chemistry, specifically how they can affect the mobility and bioavailability of heavy metals in a contaminated soil. Studies have shown that their effects of this specific piece of soil chemistry vary greatly with soil properties such soil texture, pH and actual earthworm species. Very little data exists with respect how Montana worms influence Montana soils. This study looks at *Lumbricus rubellus* across two different contaminated soils from Montana: Neihart mine tailings outside of Helena, Montana and Silver Bow/Butte Parrot Mine tailings. Two soil amendments were used to assist the earthworms' survival and productivity. Lime is used in graduated increments to define the worms' pH tolerance. Organic matter is often sparse across mine tailings and is added as an additional treatment for soil physical, chemical and biological processes. Water and weak acid (ammonium acetate) were used to extract the metal-contaminated soils; these extracts were used to quantify the lead (Pb) mobility. This study is designed to mimic a low-cost, long-term approach to vermi-remediation of lead-contaminated soil to provide a model across mine tailings and the Northern Rocky Mountains.

Daniela Weber: Microbiology & Immunology
Mentor: Raina Plowright, Jovanka Voyich-Kane -- Microbiology & Immunology
Proposed Hypothesis for Host-Pathogen Interaction of Mycoplasma ovipneumoniae and Bighorn sheep (Ovis Canadensis)

Mycoplasma ovipneumoniae is an induced pathogen that causes disease in Bighorn sheep (*Ovis canadensis*). Many individuals develop pneumonia, exhibiting acute signs of infection such as coughing and nasal discharge. Some of these animals can recover, and a portion of these become chronic carriers. Little is known about the reason for this difference of infection state in a population. However, it is vital to understand this difference between the dormancy in the upper respiratory tract and an acute infection in the lower respiratory tract. From an extensive literature research, a hypothesis was developed to predict the major pathogenic differences of infection of the upper respiratory tract and the lower respiratory tract and how survival is linked to this difference of infection. The understanding of this mechanism of infectious action is vital in the development of treatment of infected individuals and the possibility of persuading the organism's immune system to take the route that will allow for survival of an individual.

Becky Anderson: Music
Mentor: Gregory Young -- Music
A Comparison of Flute Performance and Spoken French

More so than other nationalities there seems to be a connection between the French and the flute. As Leonardo de Lorenzo said in his book *My Complete Story of the Flute*, "It seems to have been developed more by the Germans than any other people; but it was the French who produced the first great performers." I've seen these connections in a few of my own observations; many of the best flutists in history are French and many more studied with french performers (e.g. Marcel Moyse) or at the Paris Conservatory. Every flutist knows about "the French school" style of playing and, of course, Paul Taffenel and Phillipe Gaubert's *17 Grands Exercises Journaliers de Mecanisme*. The goal of this paper is to show there's a connection specifically between flute playing and the French language. The paper will start off with comparing the musical structure of standard flute repertoire with *oïl* French. *Oïl* is a more "urban non-southern French of France" and "lines up quite closely with an intuitive perception of 'French'." Secondly, it will take a deeper look at the physiological aspects and mechanics of each by identifying the muscles and muscle actions to speak French, using phonetics as a base, and to play the flute. In conclusion, this paper aims to show one aspect of the connection between French and flute through the comparison of language and music.

Chase Breitbach, Megan Ely, Curtis Kau, Joseph Kilen, Andrew Kilpatrick, Peter Pomajevich, Adrien Wagner: Music
Mentor: Kristin Harney -- Music
Ring Those Bells: An Exploration of the MSU Carillon

All undergraduates at Montana State University are required to generate a scholarly project and participate in a research/creative experience. We participated in a collaborative 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. The seven students who were enrolled in MUSE 383, Assessment in Music Education, were introduced to a variety of research strategies in a safe, supportive environment as we engaged in a collaborative research study exploring the MSU carillon (the bells in Montana Hall). Together, we created research questions, created and administered a survey, created standardized open-ended interview questions, coded qualitative data, performed simple statistical analyses of quantitative data, created tables and graphs, and drew conclusions. Individually, each student developed a literature review, completed CITI training, made observations, conducted interviews, and transcribed interviews. Products from individual tasks were all brought back to the large group for discussion and analysis. Although the focus of the project was on the development of research skills, rather than on the generation of a specific research product, our conclusions point toward the importance of the MSU carillon to the campus community. Members of the MSU community perceive that music is a significant part of their lives and 95% of those surveyed feel the carillon should play melodies at least once a month or more. The MSU carillon enhances the campus atmosphere and we recommend utilizing it to its full potential.

Eric Bartz: Music
Mentor: Greg Young -- Music
Classical singing and non-classical singing tuning differences

By using a frequency spectrometer and focussing on three primary aspects of voice production I can look at how in tune different methods of singing can truly be. The initial onset of sound must be coordinated in a precise and accurate manner in order to ensure the frequencies do not distort upon initiation of vocal fold adduction. The acoustic balance of the primary resonating cavities of the human body need be focussed in an effort to maintain integrity of tuning. The proper balance of both TA and CT cartilage must be achieved in an effort to ensure the tone is neither flat no sharp and includes the necessary overtones.

Emily Bissen: Architecture
Mentor: Fatih Rifki -- Architecture
Experiencing Italian Hill Towns

The nature of exploring a new place is to wander, discover, and allow curiosity to guide one's path through the fragments composing the journey, transforming the hyper-real present into a wistful memory. One hopes to uncover an understanding of a certain place over time, beginning with the initial rush of encountering a new place and intimately being present in a foreign environment. Italian Hill towns, in their universal intrigue and 'other worldly' magnetism, are the subjects of this exploration, with the purpose of capturing the palpable, overwhelming sense of place composed of material, street structure/layout, community gathering spaces throughout, and overall 'otherness.' By focusing in on architectural properties, one can begin to understand how these tangible elements become intertwined in creating an intangible, harmonious experience.

Morgan Bloom, Alexis DeJarlais, Brooke Kervi, Jackson St Clair: Architecture
Mentor: Bradford Watson, Steve Juroszek -- Architecture
Kakuma Refugee Camp: Leveraging the Edge

As Kakuma refugee camp has significantly outgrown its capacity, promoting a life beyond the camp becomes vital. The current operational strategy for refugee camps is a short-term solution to a long-term problem. Life in Kakuma is heavily characterized by unavoidable dependency on governmental aid, minimal access to water, and lack of basic means to foster an education. To alleviate these issues and promote life outside the camp, establishing a new perspective on education is the solution; redefining education as a means of gaining opportunity, dignity, and the ability to make a living, a solution focused on well-being is proposed. Malnutrition is the most influential factor in children not obtaining an education. To alleviate the impact of malnutrition on the population, a community owned-and-operated farm is proposed. By introducing a water retention and filtration system, annual flood water from the Tarach River is harvested in a cistern and released via drip irrigation. This provides acceptable water for the maintenance of a community farm in Kakuma. As a result of implementing the community farm, people are able to reclaim ownership of their lives. In the same way that the community farm fosters livelihood, it also creates opportunity for social hubs to emerge. To complement the social hubs, a hexagonal modular kit-of-parts marketplace is proposed. Plots in the community farm will be divided among refugees, and specified portions of crop produced will be dispersed to the schools, incentivizing families to take advantage of education. Ultimately, establishing this water filtration system will feed the community, provide economic opportunities, and incentivize education.

Celina Brownotter: Architecture
Mentor: Thomas McaNab, Jillian Bertelli -- Architecture
Tipi Tectonics: An Analysis of How Culture, Beliefs, and Traditions Positively Affected 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 the Lakota 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.

Joseph Dresen: Music
Mentor: Gregory Young -- Music
Rocky Mountain Elk Suite Arrangement

The outcome of this project will be a wind ensemble arrangement of a work for orchestra entitled “Rocky Mountain Elk Suite: Movement 1/4, Out of the Darkness and Into the Night” written by Dr. Gregory Young. The dissemination of results will not only involve a poster presentation at the MSU Student Research Conference, but will also be the performance of the piece by the Montana State University Wind Symphony in the Kennedy Center. It may also be submitted for the 2018 National Conference on Undergraduate Research in Central Oklahoma. The significance of this project is that this piece has not been arranged for band. It will involve learning how to arrange music including issues such as timbre, balance, blend, dynamic contrast, and instrumental capabilities. The project will have a lasting impact on band literature as it can be performed world-wide after completion. New music in band literature is valuable to build the repertoire.

Sean Hartford: Music
Mentor: Jason Bolte -- Music
Winter Sports Album

For my project, I will play the musical tracks I have completed this past semester. I'll also present a power point that discusses the obstacles I had to overcome in the process of recording samples and the process of synthesizing and composing the album itself.

Susan McCartney, Miranda Lebrun, Rachel Wambaeke, Andrew Major, Logan Henke, Andrew Major, Logan Henke: Music
Mentor: Gregory Young -- Music
Undergraduate Research in Music

There has never been a textbook for the research capstone course in music until now. As a class we all contributed to writing a textbook for the class in the future. This textbook is designed to guide students through the process of deciding what topic to research and how to format the project.

Ariana Richard: Music
Mentor: Nathan Stark -- Music
A Meta-analysis of Marching Band Drill Design Techniques

This research looks at the varied techniques of coordinate-based drill design as used by marching band directors across the nation. The research goal is to classify recurring elements of drill design and identify innovative uses of these specific techniques. This is useful because there is very little consistency in the rhetoric surrounding drill design and the basic classification of design formations. The lack of existing classification of design elements and access to educational materials on basic show design leads to the inability of inexperienced teachers to create new programs in the marching arts. This research will create a repertoire of basic and advanced design techniques that can be used by music educators throughout the country. The research has two major components. The first consists of a compilation of data from about 20 sources of existing written materials. These sources, written by drill designers and band directors, show a wide variety of terminology used to describe similar techniques. This shows the lack of commonality in classification of basic designs. The second component of the research is a detailed analysis of archived video recordings, as primary sources, from notable programs around the country to discover major innovations in design technique and recurring patterns between ensembles. The data gathered from the videos will be compared against descriptors in the literature, with a goal of defining the same formations with one common name. Ultimately, this research aims to help future directors of band programs to be more knowledgeable about show design which will aid them to be successful marching band educators.

Kristie Russette: Art
Mentor: Melissa Ragain, Shelly Hogan -- Art, McNair Scholars Program
Visualizing Native America: Examining Depictions of Nativeness in Montana Institutional Spaces

Museums, information centers, and monuments all serve as institutions that shape public memory. In Montana, a state with a large Native American population, these institutions contribute to the way that Native groups are remembered and perceived by the public. As pedagogical spaces, Montana institutions project a specific body of images that signals to viewers how to think about Native American culture. The current study extends the dialogue concerning the representation of Native American/indigenous peoples in various institutions and its impact on the dominant public, especially non-native audiences.

Elva Dorsey: Business
Mentor: Andreas Thorsen -- Business
Can there be another Industrial Revolution?

My research will consist of identifying top features a manufacturing company is looking for and comparing that to the Blackfeet Reservation. I will look at the reservation to identify the health of transportation, policy/legal, labor force, and land use as it pertains to businesses. Once I have a strong idea of how the area measures up to the need of a small manufacturing firm I will look at possible ways to improve that areas that could be seen as weak to a potential manufacturer. Once there is a plan on improving weaknesses I will go to the same manufacturers and ask them to score the Blackfeet Reservation before the research is complete and once the research is done and they are presented with a feasibility study showing the strong qualities of the reservation as well as a plan on how to improve the weaker manufacturing features. I will than present the findings to Montana State University as well as the Blackfeet Tribe. My findings presentation to the tribe will have the goal of discussing and improving weakness to attract a manufacturing firm that will develop a site on the Blackfeet Reservation, reducing the unemployment rate while increasing jobs and income across Montana. With the reservation a designated area for government contracts it seems like an ideal place to develop manufacturing.

Tyler Elkins: Business
Mentor: Gary Caton, Francis Kerins -- Business
Dodd-Frank: An Explanation Of Mortgage Delinquencies

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) implementing changes in the oversight and supervision of US financial institutions was signed into federal law by President Barack Obama on July 21, 2010. We examine the effects of the Dodd-Frank Act on the delinquency rates in the US mortgage market where a mortgage is delinquent if payments are 30 or more days late. Using data from the period prior to Dodd-Frank, We identify the determinants of the delinquency rate, develop and calibrate a predictive model of delinquency rates, and determine if the predictive ability of the model changes for the period after the implementation of Dodd-Frank. We expect U.S. macroeconomic variables such as the interest, unemployment, and GDP growth rates, median household income, and changes in reported FICO scores, to be significant determinants of delinquency rates. The marginal effect of the Dodd-Frank Act on delinquency rates is my research question.

Austin Stonnell: Business
Mentor: Tim Harvey -- Business
Lending Outcomes Among Native American and Reservation Applicants

This study examines the impact of loan location on Native Americans applying for mortgages. The study specifically looks at what effect applying for a mortgage on reservation land has on loan outcomes. Due to their status as sovereign nations, repossessing homes that are in foreclosure within these areas is more difficult due to several legal challenges lenders face. The study is concerned with determining how big of a difference there is in these loan outcomes and among both Native American and non-Native American applicant groups.

Amanda Belleville: Health & Human Development
Mentor: Kalli Decker -- Health & Human Development
Parents of Children with Disabilities and Their Experiences with Montana's Early Intervention Services

Part C of the Individuals with Disabilities Act offers family-centered early intervention services to the families of children with delays and disabilities. Research shows us that family-centered services are considered best practice in the field of early intervention, but there is a dearth of knowledge when it comes to the perspectives of the parents who receive these services and what they believe are the strengths and weaknesses of those services. The need to better understand families' experiences in our state has been described as essential by the Montana Department of Public Health and Human Services (DPHHS). DPHHS identified a need to interview families who are receiving these services so that we have data to better understand how these early intervention services are influencing families' and children's lives. Therefore, the purpose of our research study was to gather data through in-depth interviews with parents of children with delays and disabilities regarding their experiences, so that this could be used to inform professional development for early intervention professionals. Data was collected via in-person interviews and surveys (N=30); interviews were transcribed and reviewed for common themes regarding parents' experiences. Preliminary results include that certain aspects of services are in line with family-centered recommendations (e.g., listening to families wants/needs, caring about the family in addition to the child), while there is room for improvement in other areas (e.g., services are primarily play-based and not inclusive of other important daily routines, services do not always occur within the child's natural environment).

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Alexandra Feigel: Health & Human Development
Mentor: Kalli Decker -- Health & Human Development
Quantities of Adult Language and How it Affects Child Language Development

In this project I am looking at possible sensitive periods of children's language development. I will be investigating the quantities of language used by parents with their children at multiple time periods when children are 0-30 months of age, and how this influences children's language skills when they are 30 months of age. A total of 78 parent-child dyads were originally recruited for this longitudinal study, which included 5 min free-play videos that were collected at 4 different ages for each child (e.g., 12, 18, 24, and 30 months of age). Across these four waves of data there are 264 videos that were used for this project. We transcribed these free-play videos between parents and their children at each of these waves of data collection. The purpose of this study is to build upon previous research regarding sensitive periods of children's language development and the effects of the quantities of language that adults use when interacting with children. In particular, I am investigating the quantities of language parents use with their children, in order to better understand when these quantities of parents' language are most crucial to and predictive of children's later language development (e.g., are there sensitive periods for children's language development, when their parents' use of specific quantities of language are most influential?). This research can help inform professional development for individuals in the field of early childhood, and it could also be used to inform parenting education and practices.

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Kailey Grover: Health & Human Development
Mentor: Lynn Owens -- Health & Human Development
The Effects of Music During Exercise on Performance of Active Individuals

The purpose of the research is to distinguish between different genres of music and the role music plays during exercise to motivate active individuals to perform their best during workout sessions. Specifically, the study explores what genre of music works best for specific workouts that lead to improvement, the differences in performance with music due to motivation and energy levels across gender, and the differences in motivation and energy levels between athletes and non-athletes when listening to music. 90 subjects participated in the study by a survey administered on a social media site. Survey Monkey quantitatively analyzed the data using descriptive statistics. Qualitative methods such as text analysis and constant comparison determined the specific qualities that music enhances during exercise. From the data collected, there were trends with motivation and perceived energy levels for each gender, athlete and non-athlete status, and genre. However, all music listened to during workouts led to an increase in motivation and energy levels which improved performance in all types of workouts. Throughout the data, almost every individual who participated in exercise, athletes and non-athletes included, saw an increase in energy during workout and increased motivation to complete the workout to the best of their ability. Athletes and non-athletes experienced the same amount of increase in motivation, energy level, and performance while listening to music when exercising. Future research will focus on music listening in the gym with females relating to distraction and self-consciousness.

Teale Harden: Health & Human Development
Mentor: Selena Ahmed, Mary Stein -- Health & Human Development
Exploring Connections between Food Security and Academic Success

It is generally accepted that in adolescents' food security increases academic outcomes. This acknowledged correlation has resulted in programs such as free and reduced price lunch and breakfast. However, quality and quantity of food is important no matter the stage of development. This research specifically examines connections between food insecurity in Montana State University students and their academic achievement. The preliminary research question for this project was: Does food insecurity in the student population at Montana State University correlate with a lower Grade Point Average (GPA) or an increased likelihood of being placed on academic probation at some point in their academic careers? Additional research questions that were explored were: Are there demographic factors that contribute to a more significant impact on academic outcome in food insecure conditions and does knowledge about emergency food security resources impact academic outcomes by balancing out food insecurity with knowledge on how to access food? The objective of this research was to build on previous research conducted at Montana State University surrounding food insecurity to determine if there are tangible outcomes that result in decreased academic performance when students are food insecure. To conduct this research surveys were utilized to determine the level of food insecurity of respondents as well as their academic success.

Dani Hess: Health & Human Development
Mentor: Suzanne Held, Bridget Kevane -- Health & Human Development, Modern Languages & Literatures
The use of social media in promoting Hispanic/Latino health and the implications for a Promotores de Salud program in Gallatin County

The internet has become an important resource for individuals to access health information as well as for healthcare organizations to disseminate information and to connect with patients and the public. Social networking sites (SNS) in particular, such as Facebook and Twitter, have also been used by community health centers, in Community Based Participatory Research contexts, and by Community Health Workers to interact with a diverse range of target populations. Latino and Hispanic populations have been shown to have high participation in SNSs such as Facebook and are likely to be open to using it in health-related contexts. A review of the literature on the use of SNS in Latino and Hispanic health promotion programs was conducted with the intention of informing the use of Facebook in a Promotores de Salud program in Gallatin County, Montana. Findings indicated that the widespread use of Facebook, and the ease with which content can be created by all participants increase the viability of Facebook as a tool for education, outreach and engagement with participants in a Promotores program. Potential disadvantages include a "digital divide" in access to internet and in online literacy that may still leave out the most vulnerable individuals, and federally funded program collaborators that have blocked Facebook on clinic campuses. These findings will help guide the implementation of a Facebook group to help Promotores de Salud share and access educational materials and increase connection with one another and with health professionals in a rural setting such as Montana.

Debra Kraner: Health & Human Development
Mentor: Selena Ahmed -- Health & Human Development
Impacts of Environmental and Management Factors on the Nutritional Quality of Mint, Spinach, Tomatoes, Basil and Pak Choi and Correlation with the Functional Quality of Chinese Medicinal Herbs

A major problem facing the Traditional Chinese Medicine (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. As TCM becomes more popular, the need for high-quality herbal products also increases. I am working with Dr. Ahmed of the MSU Food and Health Lab to examine how changes in environmental and agroecological management impact the functional quality of TCM herbs. Specifically, I have carried out five manipulative greenhouse experiments of mint, spinach, tomatoes, pak choi and basil using 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, and thus a higher functional quality. 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. Findings will be applied to provide guidelines for a validated procedure for future studies on functional quality and design a management program for medicinal herb farmers. There is still a large need for research in the study of the correlation between plant stress and functional quality.

Megan Peterson: Health & Human Development
Mentor: Kalli Decker -- Health & Human Development
A Longitudinal Study of Parent and Child Language During Play

Children's early language skills are related to numerous outcomes later in life, including socioeconomic status, unemployment, education level, and health outcomes. Language can be most easily learned between the ages of zero and three, and due to these major life implications it is important that we continue to research and understand language development during this time. Therefore, we conducted research to investigate children's early language skills and how this may be influenced based on parent-child interactions. Through this research 249 videos were collected and both children's and parents' language was transcribed to capture their back and forth spoken interactions during free play. We worked with a total of 78 families when children were 12, 18, 24, and 30 months of age. Through these videos we are investigating how children's and parents' use of language changes over time. Our investigation and findings focus on the total number of words used by parents and children at each age, as well as the unique number of vocabulary words, also known as richness of language, used by parents and children. We found that parents' total number of words used and the richness of their increased when their children were between 12 and 24 months of age, and then began to decrease at 30 months of age. We also found that children's total number of words used and the richness of their language also followed these same patterns between 12 and 24 months of age with increases over time, but they experienced a steeper pattern of growth between 24 and 30 months of age. It is possible that these trends demonstrate parents' sensitivity to their children's growing language skills, and when those skills begin to most rapidly increase, parents respond by talking less and listening more.

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James Rolin: Health & Human Development
Mentor: Florence Dunkel -- Plant Sciences & Plant Pathology
Creation of an Algorithm for the Standardization of Commercial Rearing, Processing, and Distribution of Acheta Domesticus for Human Consumption within the United States

Entomophagy is the eating of insects. As the human population of the world increases so does the demand for more food. Traditional animal protein sources take large amounts of resources and area for a relatively small actual yield when compared to that of insects. Unfortunately insect rearing in the US is quite new and does not have set industry standards nor economical models of production. My research aims to help solve the model issue by using both existing data and deriving new data all to be compiled in a computer driven model of every stage of production for food insects, namely the house cricket (*Acheta domesticus*).

Luke Shealy, Gretchen Groves: Health & Human Development
Mentor: Carmen Byker-Shanks -- Health & Human Development
Evaluating and Identifying Barriers to Participation of SNAP Recipients at Farmer's Markets

Many farmers' markets are authorized to accept Supplemental Nutrition Assistance Program (SNAP) benefits nationwide. Farmers' markets are a potential strategy to help low-income families access fresh fruits and vegetables. However, SNAP authorized farmer's markets are often underutilized. The purpose of this study is to identify barriers that discourage participation and propose solutions that may increase participation in the SNAP farmers' market program. SNAP recipients were recruited from one non-metro county in Montana. A mixed methods approach was used for this research. First, interviews were conducted with eight SNAP recipients who used the farmer's market and eight SNAP recipients who did not use the farmers' market. This qualitative data was used to inform a survey distributed to the wider community. Qualitative results indicate that the following barriers exist for SNAP recipients to shop at the farmers' market: lack of awareness, marketing and signage and lack of consistent EBT machine function. Preliminary survey results also indicate lack of awareness as a barrier. Potential solutions include increasing outreach efforts to create more effective marketing in order to spread awareness. SNAP beneficiaries do not use their benefits at the farmers' market because of a general lack of awareness of the program. To address this issue, farmers' markets should find ways to increase awareness and establish consistent venues of marketing. Other research has shown that access to high quality, fresh fruits and vegetables is limited in non-metro when compared to metro areas. These results may be applicable to efforts in other non-metro and metro areas to increase access to healthy foods and dietary quality for SNAP recipients.

Zachary Stern: Health & Human Development
Mentor: Lynn Ownes -- Health & Human Development
The Reward Factor for Preventative Treatment

Often following extended treatments that offer no substantial pain relief, patients are left frustrated, depressed, and narcotic addicted (Fordyce et al.,1967; Wargo 2016). T.E.N.S. therapy functions in a similar fashion to opioid prescription medications and Tylenol by blocking pain receptors from getting to the brain and inducing the release of opiates in the body (Basbaum & Fields 1978). The objective of this study was to identify the appeal of a mobile based form of T.E.N.S. therapy and E.M.S. A survey was created utilizing the tools from the website Survey Monkey and then dispersed through the social media outlets Facebook , Twitter, and Instagram. The goal was to measure the knowledge of electrical frequency as a pain relief option and the appeal of use and reuse if made available through a mobile phone app. Prior to the continuation of the rest survey participants were introduced to brief description of the what T.E.N.S. therapy and EMS are and how they benefit the individual. Then participants were asked a to answer a series of Likert scale statements and demographic questions. Each possible answer was given a corresponding number. Each answer given by participants was then averaged out to measure positive and negative appeal. The closer the number was to five the higher the positive appeal. The lower the average score the lower the appeal rating would be. Results validated a strong interest in an instant pain relief option brought about through mobile interface . This appeal was prevalent amongst various ages, regions , and education bases. Findings also brought to light the lack of knowledge that participants had regarding T.E.N.S. therapy or E.M.S. Confirming the appeal that a niche treatment option like T.E.N.S. therapy can enter into the medical market.

Rachel Stinson: Health & Human Development
Mentor: J. Mitchell Vaterlaus -- Health & Human Development
The lived experience of daily technology use in young adult married couples

This exploratory mixed methods research project aimed to examine the affects of technology on young-adult marriages. Ten couples (N=20) were surveyed and interviewed regarding their own personal technology use within the context of their marriage, the perceived impact this technology has had on their relationship, and their general opinions of how technology impacts the relationships of their peers.

Jennifer Mikkelson: Sustainable Food & Bioenergy
Mentor: William Stadwiser, Jill Holder -- INBRE, Gallatin Valley Food Bank
Story Mill Community Garden

The Montana INBRE program and Gallatin Valley Food Bank are exploring potential partnerships that would enable the implementation of a youth educational program at the Story Mill Community Garden. The questions guiding this project are as follows: In what ways can Gallatin Valley Food Bank best collaborate with local social service, community service, and/or corrections agencies to educate low-income, at-risk youth about gardening and nutritious food? Which potential partnerships might contribute the most towards achieving the teaching garden's long-term sustainability goals? Which potential partnerships might reach youth facing the greatest need for healthy food, gardening skills, and/or outdoor experiences? How might GVFB best utilize this research to inform future planning and grant applications?

Lydia Aman: Chemical & Biological Engineering
Mentor: Ellen Lauchnor -- Civil Engineering
Quantifying Ammonia Oxidation Kinetics of Nitrosomonas europaea with Competitive Inhibition

Nitrification is the process of converting ammonia (NH4) to nitrite (NO2-) and nitrate (NO3-) and is driven by microorganisms. Nitrification is used in wastewater treatment systems to reduce negative side effects of nitrogen pollutants in water. NH4 oxidation to NO2- is the first nitrification step. This project investigated the effect of inhibitory compounds on ammonia oxidation by the bacterium Nitrosomonas europaea (N. europaea). N. europaea is thoroughly studied ammonia oxidizing bacterium (AOB). Several studies indicate that nitrification of nitrogen in wastewater systems is inhibited by wastewater contaminants such as phenol. The ammonia monooxygenase enzyme (AMO) is responsible for oxidizing NH4. The nitrification inhibition is a result of the AMO enzyme oxidizing contaminants in wastewater instead of NH4. Phenol is representative of several aromatic compounds found in wastewater contaminants such as pharmaceuticals, fragrances, and antibiotics. The contaminants act as inhibitory compounds to the AMO enzyme reacting with NH4. This study measured reaction rates of N. europaea in the presence of different concentrations of phenol and NH4. Five batch tests were conducted with varying concentrations of NH4. Each test consisted of four sets of triplicates with 0, 5, 10, and 20 µM concentration of phenol. The samples were evaluated using nitrite assays. This data was used to evaluate initial rates of the reaction at varying NH4 concentrations. The method of initial rates was used to determine the enzyme kinetics; the results were used to compare the effect phenol concentration has on reaction rates. The results indicate that as phenol concentration increases, the reaction rate decreases. This kinetic model will be used to further understand nitrification in wastewater.

Jesse Arroyo: Mechanical & Industrial Engineering
Mentor: Cecily Ryan -- Mechanical & Industrial Engineering
Mechanical Properties of 3D Printed Bio-Plastics

This project explores the feasibility and effectiveness of 3D printing biopolymers and biopolymer blends (collectively termed bioplastics) to identify processing conditions that lead to desirable properties for bioplastic filaments, such as mechanical strength, tailorable ductility, and durability. This project also investigates the feasibility of incorporating natural materials, primarily short, plant-based fibers, into bioplastic extrusions and filament forming processes to create biocomposite filaments for 3D printing applications. We will present initial mechanical test results from these bioplastics and biocomposites, including poly(hydroxybutyrate-co-hydroxyvalerate)/short hemp fiber composites. One potential application for these materials is in rapid prototyping, including various plastic-based housings and supports used in the electronics industry. Bioplastics present a more environmentally sustainable alternative to plastics traditionally used in additive manufacturing, such as ABS, having similarities in strength and manufacturability to other commonly used petroleum-based thermoplastics.

Acknowledgements: Aaron Demro (MSU Graduate Student) - Mechanical & Industrial Engineering, Mathew Solle (MSU Graduate Student) - Mechanical & Industrial Engineering

Ashley Bertrand, Megan Weller: Computer Science
Mentor: Clem Izurieta, Gabe Rudy (Golden Helix) -- Computer Science
Variant Dashboard

Golden Helix offers data analysis software and predictive analytics used for finding genetic causes of disease and compound screening for drug discovery. They deliver industry-leading bioinformatics solutions for life science research and translational medicine. At present, Golden Helix does not have an interface that represents genomic variant information. The motivation for this project is to improve user experience in interpreting genetic variability through dashboard technology interfaces, thus allowing lab personnel and variant scientists to determine the pertinence of variants for individual patients. To develop the product, we will use an iterative life cycle and implement the Model-View-Controller design pattern, a technique commonly used for front-end desktop and web applications. The dashboard will be developed primarily in JavaScript, HTML, and CSS, with the use of other external tools including Highcharts. The final product will provide a web and desktop interface, displaying content in a web-view, supporting modularity, page resizing, and adaptability across viewing platforms. Users will be able to customize a dashboard according to which variants they would like to observe. Most importantly, the dashboard will interpret data and display it in an intuitive and readable manner. Clear presentation of genetic variability is a difficult problem, and our solution will make it easier for researchers to obtain the information they need rather than searching through raw data files. The dashboard we develop will show data pertinent to the variant and other information required for research and analysis.

Acknowledgements: Megan Weller (MSU Undergrad Student) - Computer Science

Taylor Blossom: Chemical & Biological Engineering
Mentor: Ross Carlson -- Chemical & Biological Engineering
Bio-fuel Production by Community Biofilm

The purpose of this project was to explore the structure of community biofilms and create a biofilm that could convert cellulose into biofuel. The three microorganisms that were studied were Clostridia phytofermentans, Escherichia coli, and Methanosarcina barkeri. C. phytofermentans is an anaerobic cellulose degrader which liberates glucose, E. coli, is a biofuel producing oxygen scavenger, and M. barkeri is an acetate utilizing methanogen that detoxifies byproducts. These microorganisms were first grown as monocultures before being grown as biofilms on plates. The plates were standardized so that only C. phytofermentans would be able to grow on them, and the other microorganisms were reliant upon the byproducts from C. phytofermentans. The primary challenge for this community growth was ensuring that the anaerobic C. phytofermentans and M. barkeri had sufficient growth to complete their respective purposes in the community, but were not exposed to oxygen. Once community growth was achieved, HPLC was used to quantify the concentrations of various media components and microorganism byproducts that were present. In addition, plate counts were performed on selective media for each organism to determine the concentration of colony forming units present. The information gained from HPLC and colony forming unit counts were used to adjust inoculum concentrations of each organism in the biofilm, as well as plate content, to maximize the biofuel producing capacity of the biofilm, and gain insight into the structure of the microbial community.

Wilson Britten, Colleen Rothe, Elizabeth Pennell: Computer Science
Mentor: Clemente Izurieta -- Computer Science
NuMo--A Better Diet a Better Life

Providing accurate nutritional information to an ever growing health conscious and mobile society has been identified as an area with significant commercial potential. The largest demographic in this category is ever connected through mobile devices, and as such, we are developing a mobile health application that addresses this need by providing accurate and customized nutritional information. Backed by experts in nutrition and research in a variety of healthy-eating mobile applications, we are developing NuMo. NuMo is a nutritional monitoring app for both iOS and Android devices that provides accurate, detailed nutrient information to users so that they can make informed eating decisions. The app's overarching goal is to empower users to investigate their own eating habits and find deficiencies in their diets. A user will be able to log daily food intake, save popular meals, and set personal nutrient intake goals. Using a database built by USDA research and our own supplementary provisions, the app will display personalized graphs of selected macronutrients and Omega 3/Omega 6 intake. These visuals, as well as personalized nutrient recommendations, will offer a clear picture to the user of how their diets can be improved.

Alexander Calderwood: Computer Science
Mentor: David Millman -- Computer Science
Applying domain-specific natural language understanding techniques to film

We report on our work involving adapting Natural Language Processing (NLP) tools, including subject-predicate-object triplet generation, to build a system capable of automatically testing if a given film or play passes the Bechdel-Wallace test, a test from feminist film theory. This test is passed when a film contains two or more females who discuss a topic other than a man. Despite efforts by researchers, no system or algorithm has yet been developed that can definitively state whether or a not a film has passed the test. Our system uses tools that have not yet been applied to this problem, thus expanding the body of knowledge and making new progress towards this goal.

Acknowledgements: David Millman (MSU Faculty Member) - Computer Science

Benjamin Carroll: Mechanical & Industrial Engineering
Mentor: Charles Kankelborg -- Physics
EUV Snapshot Imaging Spectrograph (ESIS) Baffle Design

The Extreme Ultra-Violet Snapshot Imaging Spectrograph (ESIS) is a solar camera scheduled to launch on board a sounding rocket in August 2018. ESIS images the sun over a large field of view in multiple spectral orders, allowing it to simultaneously collect spatial and spectral data. Since images are collected in specific wavelengths, any direct illumination of the CCD cameras from the sun would defeat the purpose of the experiment. Optical baffles are used to eliminate the potential for this to occur, as well as limit potential stray light reflecting onto the CCDs. Due to compact system design, variations in optical geometry, and numerous optical path crossings, designing an effective baffle system for ESIS presented several unique challenges. Using Z-Max ray-tracing and CREO Parametric modeling software we created an effective design using six flat baffles along the experiment's length.

Jacob Carter-Gibb: Civil Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering
Microfludic particles as a tool for monitoring oxygen levels in biofilms in magnetic resonance microscopy

Microfluidics is a rapidly growing field with many biological applications that have not yet been fully utilized. This project aims to create biologically compatible microparticles that, when used with nuclear magnetic resonance (NMR), will allow researches to monitor the oxygen during the growth of biofilms. The goal of this project will be to make double emulsions (drops within drops) of fluorinated oil encapsulated by a biologically compatible shell made of a hydrogel, such as agarose, that will serve as a surface for the biofilm to grow. To accomplish this, microfluidic devices will be used to create these particles quickly and in large numbers, at the rate of hundreds of thousands in minutes. A secondary goal will be to fine tune the devices to allow custom sizes of the agarose shells and the fluid encapsulated. Future research will include tuning these microparticles to better understand the diffusion of oxygen through biofilms as they grow, which will allow us to understand the role of oxygen in chronic wound biofilms. The hypothesis of this experiment is that the particles that we create for use in NMR will function better and provide a higher resolution than the polydisperse, or varying in droplet size, basic emulsion system currently being used.

Acknowledgements: Devin Figgins (MSU Graduate Student) - Chemical & Biological Engineering

Rachael Cohen: Chemical & Biological Engineering
Mentor: Stephanie McCalla -- Chemical & Biological Engineering
Separation of Nucleic Acids using pH

Blood-based biomarkers are critical to early diagnosis of diseases like cancer and Alzheimer's. These specific biomarkers of interest are nucleic acids called microRNA. However, they are both inefficient and costly to separate out of the blood and then amplify to a quantifiable amount. The focus of this project was to separate out microRNA based on their size, in order to effectively isolate the desired biomarkers. This was accomplished using a series of charged membranes functionalized with the amine groups of chitosan. The greater negative charge of larger DNA/ RNA causes it to travel slower through the chitosan membranes; similar to the how the size of a magnet affects its charge. A consistent baseline, or starting line, was created by having the first membrane functionalized with a higher concentration of chitosan. This baseline greatly increased the effectiveness of the nucleic acid separation by centralizing the initial binding of nucleic acids to a smaller and more precise area. Additionally there was a correlation of size to time, such that larger nucleic acids migrated slower. Future work would be to use fluorophores to test multiple sizes of nucleic acids at the same time, and to optimize the procedure for producing the higher concentration chitosan membranes.

Megan Danczyk: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
Experimental Results and Modeling of Thermal Energy Storage System

The inconsistent and unpredictable nature of sustainable energy sources is a major challenge which still needs to be managed. To address this issue and minimize energy loss in concentrated solar plants, thermal energy storage (TES) vessels are used to hold energy when the supply is higher than the demand. TES units work by storing the excess thermal energy in packed beds of varying materials. This research focuses on increasing the efficiency of packed bed TES units. The main objective was installing and commissioning the TES vessel. First, a system which met the physical thermal design constraints of the vessel was designed. Then, before assembly each piece of the system needed to be verified for proper functioning and is essential to the continued success of the lab. After confirming accurate behavior of the utilities and process control, a baseline test showing the thermal effects of 5 standard cubic feet per minute (SCFM) of 200°C air through the vessel and the losses when the system was reversed was recorded and analyzed. Additionally, using Star-CCM+ a more physically realistic model of the flow through the vessel using the discrete element method was created. The long term focal points were performing experiments with multi-component packed beds to find an optimum system for TES, and updating the discrete element method pore scale numerical model. A reliable, and more efficient, TES unit would save money for the energy companies, increase the supply of renewable energy power, and decrease the cost of sustainable energy sources.

Acknowledgements: Mohammad Mahdie (MSU Undergrad Student) - Mechanical & Industrial Engineering, Dinal Perera (MSU Undergrad Student) - Mechanical & Industrial Engineering

Ryan Darnell, Xuying Wang: Computer Science
Mentor: Clemente Izurieta -- Computer Science
K-12 Outreach Through Practical Software R&D in the Software Factory Environment

Teaching software development in environments that mimic industry practices is essential for teaching applicable real-word development skills. In addition, these kinds of delivery based projects engage students in meaningful design work that encourages clear, sustainable code. The Software Factory has provided such an environment to students at MSU since 2015. This creates a common platform for software businesses, entrepreneurship, and applied software development research. The Software Factory was first created by Dr. Jurgen Munch at the University of Helsinki in 2010. This project aimed to explore the effectiveness of such a setting for high school students with limited programming experience. Five students from Bozeman High School were selected to work in a team with two undergraduates with the goal of improving upon a Sorting Guide android application. This app was originally built during the previous summer project. In order to accomplish this goal, the students were additionally taught the tools and languages necessary to build an application. These students were exposed to Java, XML, Git, various sorting algorithms, and software development practices inside an industry setting. A demonstration of the students' work will be presented as well as a discussion on the benefits and challenges with this teaching method within the Software Factory.

Erica Eggleton: Chemical & Biological Engineering
Mentor: Ryan Anderson -- Chemical & Biological Engineering
Diffusion Layer Saturation Analysis of PEM Fuel Cells

The Diffusion Layer Saturation Analysis (DLSA) procedure previously developed by the Anderson lab has been used to investigate the effect of saturation on a Proton Exchange Membrane (PEM) fuel cell's performance by introducing a dry anode stream to reduce excess water via evaporation. This analysis correlates the averaged anode pressure drop signal within the PEM fuel cell to the exit relative humidity of the anode gas stream, which would normally require an expensive instrument to be measured. Knowing this relative humidity, saturation of the porous layers on the cathode side can also be estimated. This methodology is expanded to create a transient solver in MATLAB to find the change in saturation over time and quantify the water being removed from the porous layer by the anode channel stream. The protocol investigated utilizes a consistent ramp of the anode flow rate over various lengths of time. Multiple gas diffusion layer configurations are also investigated in order to analyze their individual contributions to the overall water transport resistance. By experimentally studying the correlation between saturation and fuel cell performance, important transport parameters are determined which can be used to validate previously published fuel cell models. DLSA is therefore shown to be a useful diagnostic and investigative tool for understanding and quantifying water transport in the PEM fuel cell and helping to make the technology more efficient and cost effective.

Acknowledgements: Logan Battrell (MSU Graduate Student) - Chemical & Biological Engineering, Megan English (MSU Undergrad Student) - Chemical & Biological Engineering

Megan English: Chemical & Biological Engineering
Mentor: Lisa Kirk -- Chemical & Biological Engineering
Application of MicroLab Resources in Rural Kenya Water Quality Testing

Presently, there is little recurrent water testing performed on boreholes in the Khwisero sub-district of Western Kenya. A lack of financial resources and the rural nature of the area hinders local testing capabilities. Many of the boreholes are the sole sources of clean water for communities, yet their chemical safety cannot be continually ensured. Colorimetric determination may be a solution to water analysis in non-traditional lab settings. The MicroLab analytical device could be a rugged spectrophotometer option to perform this testing. This presentation proposes a method to perform colorimetric field testing and compares collected results with available historical data. Metrics were taken for seven wells that were constructed at primary schools throughout the Khwisero sub-district. Field measurements of nutrients, metals, turbidity were taken using the MicroLab device and software. Furthermore, an additional field review of the MicroLab device identifies some of the device challenges and overall obstacles with rural water testing.

Zachary Frieling: Chemical & Biological Engineering
Mentor: Robin Gerlach -- Chemical & Biological Engineering
Urease inhibition, transport, and distribtution to better understand its subsurface behavior

Biomineralization is a capable technology being developed and researched today. Biomineralization is the formation of a precipitate, namely calcium carbonate, from a saturated solution that can be used to remediate toxic metals, plug small pores, seal fissures, and many more. Biomineralization has been used to seal wellbores, and shows promise in its ability to store supercritical CO2 and stop the leaking of methane from wells. The bacterium Sporosarcina pasteurii has been studied in depth as a source of biomineralization as it produces large amounts of the enzyme urease. This enzyme breaks down urea into ammonium and carbonate, and if calcium is present at sufficiently high concentrations calcium carbonate starts to precipitate inducing biomineralization. A eukaryotic source of enzyme, Jack bean, has also been studied, and shows potential in conjunction with the bacterial method. Inhibition studies were performed using Jack bean urease and chloride salts of copper, zinc, and cobalt to identify whether the enzyme might become inhibited for instance by replacement of the essential enzyme cofactor, nickel. It was found that copper and cobalt inhibited the enzyme more than zinc at low concentrations. The inhibition was found to be not significant enough to stop enzymatic activity in true subsurface applications where the concentrations of these metals are routinely very low. Additional research indicates that microbially induced calcium carbonate precipitation appears to create a much stronger seal than enzyme induced precipitation. Based on these findings, we are currently conducting column studies at 60°C using inactivated S. pasteurii as a source of urease. We will spatially map the distribution of calcium carbonate precipitates to optimize seal placement.

Acknowledgements: Arda Akyel (MSU Graduate Student) - Chemical & Biological Engineering, Adie Phillips (MSU Faculty Member) - Civil Engineering

Maia Grudzien: Civil Engineering
Mentor: Brittany Fasy -- Computer Science
Road Network Analysis

As infrastructure is rebuilt, or as new roads are being designed, safety should be at a top priority.
This project has been looking at understanding accident prone areas in a particular region, such as Montana, as well as larger cities like Seattle. As crash data was collected, maps were generated from the data and then layers were applied. Layers, or sorting factors, could include population density, clusters, city regions (i.e. sporting event complexes, shopping centers), etc. The goal of this project is to provide examples to engineers and city planners of safe and accident-prone roads and intersections, and in the long term, these data sets will be used to create better network comparison algorithms.

David Hamilton, Connor O'Leary, Yue Gong: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Remote Monitoring of Water Level in Storage Tanks via Radio Signal

Water storage is a critical issue in areas without regular rainfall. Storing water in tanks is particularly important for maintaining livestock, especially on ranches in eastern Montana. These tanks must be continually monitored because when they run low, the livestock may not have adequate water. A single ranch might use several water tanks spread across several miles, so the task of manually visiting each location and inspecting the water level can be very time-consuming and inefficient. If the task of monitoring the water level in these tanks were automated, this cost could be eliminated. At Bill Almy's ranch in eastern Montana, an automated system has already been implemented. A battery-powered device in the water tank sends a radio signal to a computer at the ranch headquarters, where the data is shown on a static web page. Unfortunately, this software has a deprecated interface, which is not optimized for mobile devices. It is also unsupported, and it frequently crashes. In this project, a new program was developed to receive and interpret radio packets, and a dynamic web page and phone application were designed to display the data.

Reece Hoskins: Civil Engineering
Mentor: Anders Larsson, Michael Reidy -- Civil Engineering, History & Philosophy
ECIV 101 Case Study Research and Development

Effective solutions to modern challenges in civil engineering, ranging from environmental change to gentrification, require engineers who engage with the political, societal and technological aspects of problems. As a first step in educating the holistic engineers that today's world requires, the Department of Civil Engineering is developing interdisciplinary case studies for use in a newly revamped Introduction to Civil Engineering course. The case studies developed use historical examples to explore the interactions between society, engineering and the material world, while introducing engineering methodologies in an applied example. The development of these studies requires extensive research and mentorship from both the Department of Civil Engineering and the Department of History. Background research was conducted into existing and pertinent civil engineering case studies as well as issues of note in the Bozeman community. Simultaneously, faculty mentors from both involved departments assisted in identifying six key topics that would be best communicated through a case study. Once the topics were identified, extensive background research was conducted to identify and highlight important points embodied by the case study. The case studies were then fully developed to include additional reading materials, discussion points, pedagogical frameworks and associated activities. A final portfolio will be developed containing the key ideas to be communicated, materials, exercises and discussions for use in the Introduction to Civil Engineering Class.

Matthew Johnson, Daniel Mills, David Kelly, Colton Marchwinski, Jonathan Dover, Colton Marchwinski: Electrical & Computer Engineering
Mentor: Brock LaMeres -- Electrical & Computer Engineering
RadSat-U

MSU researchers have been working for the past eight years on a computer system that is tolerant to ionizing radiation for space applications. In order to quantify the amount of radiation experienced by the computer, the RadSat-U team is developing a photovoltaic radiation sensor. RadSat-U, a 3U satellite designed to carry the radiation tolerant computer into space, is the ideal test platform. The experiment consists of a fully integrated solar cell and signal conditioning circuit designed to fit within RadSat-U. RadSat-U will then carry both the radiation tolerant computer and solar cell experiment into orbit where the space radiation environment will test the limitations of both systems. A full scale test will elevate this new technology to the highest NASA standard for emerging technology, allowing it be used in future missions.

Timothy Johnson: Chemical & Biological Engineering
Mentor: Jeffrey Heys -- Chemical & Biological Engineering
Gold nano rod hydrogel nanocomposite laser tissue welding

The original purpose of my research was to develop mathematical models of heat transfer and cell death and combine them into a model of Laser Tissue Welding (LTW) using collagen nanocomposite materials. LTW is an alternative to surgical sutures for repairing cuts and ruptures in tissues. Our LTW model uses collagen mixed with gold nanoparticles that convert light into heat. The application of laser light leads to a temporary phase change in the collagen from a gel to a viscous liquid and back into a gel that can seal a cut in the surrounding tissue. This topic interests me because as a student in Chemical Engineering, I will likely work with heat transfer and biological systems in many future projects. To develop the model, Dr. Jeff Heys and I utilized the Python programming language along with the FEniCS software library to solve the various partial differential equations and algebraic equations in the model. I combined two previously developed mathematical models: a bio-heat transfer model and a cell death model, and adapted them to work together in a single program so that individual variables can be optimized as efficiently as possible. Thus far, we have successfully integrated the two models into a single code that can predict the temperature of the nanocomposite and the surrounding tissue as well as predict the fraction of cells that are killed by elevated temperatures at different spatial locations. It is not yet possible to optimize system parameters, but is expected to be before May, 2017.

Audrey Jones: Civil Engineering
Mentor: Cahoon Joel -- Civil Engineering
Swimming Capabilities of Arctic Grayling

Arctic Grayling, Thymallus arcticus, is a fish species native to Montana. The last vestige of this Fish of Special Concern is found in the Big Hole River drainage in Montana. One reason for its decreased presence appears to be barriers to mobility. In order to facilitate mobility in streams with artificial barriers, such as low-head dams at irrigation diversions, one critical factor is the fish's swimming ability. In this study, fish were placed singly in a variable-flow swim chamber. The flow velocity was increased until the fish could no longer hold its position and was swept downstream by the current. The velocity at which this occurs is referred to as the sprint speed or Usprint. The US Fish and Wildlife Service Bozeman Fish Technology Center maintains a swim chamber and was host to this experiment. A group of forty fish, all hatchery-raised in a constant flow environment (artificial stream), was separated into two groups of twenty fish each. The first group, Cohort 1, was subjected to the experiment once per week for three consecutive weeks, beginning immediately after their removal from the artificial stream. The second group, Cohort 2, was tested one time in the swim chamber, sixteen weeks after removal from the artificial stream. Each fish was placed in the chamber at a flow of low velocity and then, at regular intervals, the flow was increased until the fish impinged on the screen at the back of the chamber. The average Usprint for both cohorts over all trials was 5.41 ft/s. Cohort 1 (all trials) had an average Usprint of 5.28 ft/s, and Cohort 2 had an average Usprint of 5.80 ft/s. There was not a significant difference in Usprint between the two cohorts. There was no apparent trend in Usprint between the successive trials using Cohort 1.

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Derek Judge: Electrical & Computer Engineering
Mentor: Anja Kunze -- Electrical & Computer Engineering
Height Reduction of Magnetic Elements to Accelerate Magnetic Element Chip Production

Mechanotransduction comprises the conversion of mechanical forces into a cellular event. It has been shown that cell polarity of cortical neurons can be influenced with the use of nanoscaled mechanical forces. These forces are created with the use of a magnetic gradient produced by the deformation of the magnetic field by micro-scale magnetic elements on a chip, and ferromagnetic nanoparticles or microparticles that are inserted into the cells. The purpose of my research is to optimize the placement and geometric shape of soft iron microstructures on chip, which we call magnetic elements, so that the elements can be shortened, reducing the amount of time to produce a chip, along with reducing the cost per chip. The rate for the 80/20 Nickel-Iron material that is currently being used for the magnetic elements is deposited as a constant rate of 1.6 Angstroms per second, so reducing the height is the best way to speed up production. To optimize the dimensions of the magnetic elements we developed a method to simulate the magnetic field gradient in a program called COMSOL, in order to see the force plot generated by the configuration. Based on static magnetic field simulations with an external 150mT magnetic field, we found that 4µm x 8µm x 6µm (length, width, height) magnetic element generates a magnetic flux gradient with peak values of .2 kg/(m*s^2*A) near the elements. Electroplating 80/20 Nickel-Iron on glass substrates confirmed a deposition rate of 1.2 Angstroms per second. Reducing the height of magnetic elements expedite the process of chip fabrication and increase material stability, allowing for more experiments to happen at a faster rate. Furthermore, an optimized design can allow the scaling down of the chip design, allowing for subcellular manipulation.

Acknowledgements: Dustin Blagg (MSU Undergrad Student) - Chemical & Biological Engineering

Kayla Keepseagle: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering
Learning Engineering through Research on Multidisciplinary Topics

Assisting graduate students has led to participation in diverse research projects, which enhanced comprehension of engineering concepts. The projects included differential pressure measurements in partially saturated porous media flows, growing of biofilms for magnetic resonance imaging analysis of oxygen distribution and particle size distribution during hydrate formation. Two-phase flow is common in hydrology and oil recovery. The objective of this research is to compute the pressure drop across a packed bed at varying flow rates. Previous research from collaborators in Norway concluded the pressure scaling for steady-state two-phase flow in porous media is proportional to the capillary number raised to a constant β. Capillary number is a dimensionless number that relates the viscous forces to the capillary force. It was observed at the low Ca regime the experimental data scaled at 0.55 and 0.96 in the high Ca regime. Biofilms are communities of microorganisms within self-secreted extracellular polymeric substance matrices. Oxygen concentration gradients impact biofilm growth and persistence in chronic wounds. In this project, 19F MR oximetry was used to measure bulk and spatially resolved oxygen profiles in the HFB agarose gel system. The data provides the means to test classic models of reaction and diffusion in biofilm systems. Hydrates are crystalline compounds that form when hydrocarbon and water molecules come into contact at low temperatures and high pressure. However, the process of hydrate formation is not well characterized. In this project, model hydrates are made using ice and cyclopentane by increasing the temperature from -20˚C to 1˚C. NMR measurements were used to determine the diffusion coefficients and droplet size distribution through Matlab.

Acknowledgements: Jeffrey Simkins (MSU Graduate Student) - Chemical & Biological Engineering, Linn Thrane (MSU Graduate Student) - Chemical & Biological Engineering, Sarah Codd (MSU Faculty Member) - Chemical & Biological Engineering

Whitney Kieffer: Chemical & Biological Engineering
Mentor: Ellen Lauchnor -- Civil Engineering
Sorption of Contaminants in Treatment Wetlands

Pharmaceuticals enter the environment through human and animal use and are present in a significant amount of surface water in the United States. Treatment wetlands are an alternative method of water treatment that offer many benefits including low energy and operational costs. The behavior of pharmaceuticals in treatment wetlands needs to be understood for effective treatment. This study looked into the adsorption of triclosan and sulfamethoxazole, two commonly occurring pharmaceuticals in surface water, onto the gravel bed of a treatment wetland. Adsorption of these compounds must be first understood to evaluate the contribution of other mechanisms such as plant uptake and degradation in the wetlands. A PVC column was filled with gravel with or without plant biomass to model a treatment wetland. Separate tests were run for both contaminants, during which media containing the contaminant was fed into the column and ran as a batch test for one week. The concentration of the contaminants in each sample were then determined using high pressure liquid chromatography. Over the course of a week, the concentration of triclosan was reduced by 94%, showing that it adsorbed readily to the gravel. The concentration of sulfamethoxazole did not change from the initial concentration throughout the experiment. Triclosan can be removed in significant quantities through adsorption to the gravel bed of treatment wetlands. However, sulfamethoxazole showed no ability to adsorb to the gravel. The ability of treatment wetlands to remove pharmaceuticals through sorption can contribute to overall removal in treatment wetlands, in addition to degradation.

Samantha Lucara: Mechanical & Industrial Engineering
Mentor: Roberta Amendola, Madisen McCleary (PhD student at MSU) -- Mechanical and Industrial Engineering
Investigation of the Effects of 5% Hydrogen Gas versus Pure Hydrogen Gas on the Reduction of a Solid Oxide Fuel Cell (SOFC) anode

The aim of this research is to compare the kinetics of the reduction process of an Aluminum Titanate (ALT) doped SOFC anode from oxidized state NiO/YSZ to cermet material Ni/YSZ when 5% hydrogen gas is used versus pure hydrogen. Previous research showed that ALT doped samples require a much higher reduction time when compared to the undoped material. Fully reduced anodes are needed to increase power efficiency in the fuel cell and high reduction times are not desired or suitable for industrial or civil applications. This research contributes to clarify the reduction mechanism and how it can be optimized.

Ryan Mason: Chemical & Biological Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
Carbide Derived Carbon Production at MSU

Carbide Derived Carbons (CDCs), are unique materials in that their porosity can be carefully tuned based upon the precursor carbide from which they are derived. CDCs have many potential applications in the fields of material science and engineering including, but not limited to: separations; fuel cells; supercapacitors; gas storage; and tribology. CDCs are commonly produced using halogenation (chlorine being the most commonly utilized halogen) at high temperature, in which the halogen reacts with non-carbon elements in the carbides to form volatile halide species. The reactive vaporization of non-carbon elements accounts for the regular porosity, which can be controlled by altering parameters such as initial carbide, reaction temperature, and halogen species. This poster reports efforts to synthesize and characterize CDCs using both conventional and novel synthesis approaches, with the aim of understanding relationships among CDC processing, structure, properties and performance, along with assessing commercial-scale production.

Acknowledgements: Emily Remington (MSU Graduate Student) - Chemical & Biological Engineering

Carter McIver: Mechanical & Industrial Engineering
Mentor: Randal Larimer, Berk Knighton (Professor at Borealis Lab) -- Electrical & Computer Engineering/MSGC, Chemistry & Biochemistry/MSGC
MSGC BOREALIS High Altitude Ballooning Project

This past fall I worked in the lab with Berk Knighton and Randy Larimer as an Undergraduate scholar. I assembled two new ground stations, which will help us track future launches and be at the ready in case of technical failure. I have also designed cases and other apparatuses that will be flown in the payloads. Specifically, cases for our IMU, (inertial measurement unit) which will be flown on the eclipse launch. These parts are designed on CAD software, then 3D printed and prototyped. We have been using SLA (Stereolithography) and FDM (Fused Deposition Modeling) printers. Besides this I worked on creating an instructional manual for the Ground Station and Fill Station. My hope is to have these available to new students, giving them an understanding of what a launch entails before going on one. Through working on these different projects, they gave me a greater understanding of the lab. I will be presenting on the ground station and the IMU case. I will cover a basic understanding of the High-Altitude Ballooning system and go into detail on the ground station. I would also like to have a smaller section on the process of creating the IMU case from design to prototyping.

Acknowledgements: Rhys Campbell (MSU Undergrad Student) - Mechanical & Industrial Engineering

Levi Merkel: Chemical & Biological Engineering
Mentor: Jennifer Brown -- Chemical & Biological Engineering
Rheological Study of Aging and pH Effects on Polymer-Particle Interactions

Rheological techniques were used to study the viscoelastic properties of aqueous carboxymethyl cellulose sodium salt (NaCMC) solutions containing graphene nanoparticles. NaCMC is a long-chain polymer molecule that ionizes when in aqueous solution. This results in a negative surface charge that forms hydrogen bonding sites. These interchain and intrachain sites are of particular interest as it has been shown that the addition of nanoparticles interact with them. Also, the presence of hydroxyl and hydronium ions in these solutions impacts the bonding sites in a different way; previous exploration has demonstrated that the interactions between the solvent and solute have pH dependence. Solutions with pH of 4.4, 6, 8.4, and 10 were analyzed in order to determine the impact of the pH on the formation of polymer-particle networks through changes in the viscoelastic properties. Rheological experiments were carried out using a TA Instruments AR-GR rheometer. Both flow and oscillatory experiments were performed on the samples, which measure viscosity and the viscoelastic storage and loss moduli respectively. The storage and loss moduli are measures of the amount of energy stored in the fluid and the energy dissipated. Viscosity was measured over a range of shear rates from 0.1-1000 s-1 as a function of time in peak hold tests to determine the transient behavior of the solutions, understand their susceptibility to hysteresis, and construct flowcurves of viscosity versus shear rate. The samples were also subjected to a strain sweep test to determine the linear viscoelastic region for each sample pH. From these results, an oscillatory experiment, or frequency sweep, was performed for frequencies from 0.1-100 Hz. These tests evaluated the strength of the polymer-particle network.

Acknowledgements: Julie Murretta (MSU Postdoc/Research Scientist)

Rostik Mertz: Computer Science
Mentor: Brendan Mumey, Brittany Fasy -- Computer Science
Bike Networking

I used networking techniques to represent the data that citi Bikes has collected and made public from New York, New York in 2013. By applying my knowledge of networks to this data I was able to graphically represent the data in such a way that it can be easily interpreted. With this I will determine if there is a need for new bike paths in New York based on common routes and destinations through the city. I will also be able to determine where it would be beneficial to place more bike rental locations.

Youra Moeun: Chemical & Biological Engineering
Mentor: James Wilking -- Center for Biofilm Engineering
Quantifying Pharmaceutical Composite Breakup Using Acoustic Methods

Pharmaceutical formulation is the process of combining a pharmaceutical active together with inactive excipients to produce a well-defined dissolution profile and dosage form of the active compound. For reasons of convenience, most pharmaceutical compounds are delivered orally. The human body will easily absorb water-soluble drugs through this method; however, nearly half of all new drugs are categorized as poorly water-soluble. Undissolved drugs never reach the bloodstream and are excreted, resulting in waste. To enhance the dissolution of poorly water-soluble drugs, we have developed a formulation composite of a water-soluble drug with silica nanoparticles. Strikingly, though the drug and silica do not dissolve rapidly in water, the composites break apart rapidly in water, leading to enhanced bioavailability. Our lab has previously used image analysis to follow the breakup of the composite, but this method is difficult to quantify. Here we present a new method, using an underwater microphone, known as a hydrophone, to gather acoustic information during composite breakup and use this information as a quantitative measure of breakup. We determined that this acoustic information can be quantified and have begun analyzing acoustic data using free acoustic analysis software. For example, the low frequency region of the spectrum appears to be associated with background noise, not fracture events; thus, the high frequency region is our primary focus. The high-amplitude occasional acoustic events represent major cracks in the sample, while the click trains represent more uniform breakup.

Acknowledgements: Emily Berglund (MSU Graduate Student) - Chemical & Biochemical Engineering

Nada Naser: Chemical & Biological Engineering
Mentor: Joseph Menicucci -- Chemical & Biological Engineering
Synthesis and Materials Testing of Selenium Nanoparticle-coated Bone Cement

Prosthetic joint infection (PJI) is one of the most critical complications following joint arthroplasty, causing up to 20% of arthroplasty failures. One approach to treat PJI is to embed antibiotics in bone cement. The goal of this project is to reduce the incidence of PJI by synthesizing selenium nanoparticles and embedding them into bone cement. We anticipate that, by coating bone cement with selenium nanoparticles, we may inhibit or prevent the formation of biofilms that are notoriously difficult to detect and treat. Our research plan is to first synthesize the selenium nanoparticles, characterize them, then embed them on the PMMA bone cement. We will do materials testing to examine the impact of embedding the nanoparticles, if any, on the structural integrity of the cement. We will also use a tape-adhesion test to determine the strength of adhesion of the selenium nanoparticles on the surface of bone cement. Finally, planktonic and drip-flow biofilm tests will be used to compare the bacterial growth and bacteria attachment rate on selenium-coated versus uncoated bone cement. This poster will update the progress of this project.

Jackson Negri: Chemical & Biological Engineering
Mentor: Stephanie McCalla -- Chemical & Biological Engineering
Decreasing the ratio non-specific to specicif miRNA amplification using a stem loop template

MicroRNA are small endogenous noncoding molecules of only 19-23 nucleotides in length. These tiny molecules play an important role in many processes in the human. Due to their limited length, miRNA sequences are very difficult to reliably detect and quantify. One possible detection method, exponential amplification reaction (EXPAR), is already being used for miRNA detection, viral DNA detection, and genomic DNA detection. The amplification process is specific and non-specific, the non-specific amplification makes it difficult to study the molecule of interest. More specific miRNA amplification would lead to a greater understanding of miRNA function in pathological processes would enable earlier disease diagnoses and potentially provide new therapies. On site diagnosis of miRNA for disease detection would be a breakthrough for biomedical research. One way to increase the specific rate of miRNA amplification is to use a stem loop template. The stem loop will help prevent the non-specific amplification of the molecule low, until the specific trigger molecule is present to initiate amplification. Altering enzyme, loop, dNTP, and magnesium concentrations were done to determine the best reaction environment. A matlab model was also created to model the reaction and determine how changing different concentrations affected the reaction.

Mackenzie O'Bleness, Lisa Peters: Computer Science
Mentor: Clemente Izurieta -- Computer Science
wFlow: Machine Learning Assisted Flowchart Generation Module for the wDesk Platform

wDesk, a financial services reporting platform created by Workiva, allows users to aggregate a wide variety of data about internal processes and requirements within the platform. Despite the presence of this data within wDesk, users still frequently use this same data outside of the platform to manually create process flow diagrams for reporting. In order to improve this workflow, Workiva partnered with the MSU Software Factory to create a module that will allow users to generate a flowchart from the existing data within the wDesk system that meets the high product standards of the company. This new module, called wFlow, was developed using Workiva's standard development practices and technologies. Following an agile development cycle, wFlow was implemented using Dart and React, and utilizes Workiva's publicly available front-end frameworks, w_module and w_flux. To optimize the generated flowcharts, the use of machine learning algorithms was explored for the purposes of creating a clear and readable graph layout without user oversight, when given only the data that comprises the nodes and connections of the graph. The integration of wFlow into the wDesk ecosystem will significantly improve the workflow of its users and open the door for further machine learning integration into Workiva products.

Barry O'Brien: Chemical & Biological Engineering
Mentor: Stephanie Wettstein -- Chemical & Biological Engineering
Adsorption Capacity of Various Hydrocarbons through Zeolite Structures as Determined by Breakthrough Experiments

The goal of this project is to develop adsorption isotherms for various hydrocarbons in zeolite structures. While zeolite structures have been known to be flexible, this research will focus on the effects of different molecules being adsorbed, and whether the expansion and contraction of the zeolite unit cell has an effect on adsorption capacity. The ability to manipulate the framework flexibility of a zeolite structure could lead to huge advances in catalysis and separation processes utilizing zeolite structures, particularly in the petrochemical industry. With possibly large advances in specific processes including, but not limited to: isomerization, hydrocracking, dewaxing, detergent building, and otherwise difficult gas separations. This research will focus primarily on the adsorption capacity of ZSM-5 zeolite with respect to n-hexane and 2-methylpentane hydrocarbons in pure and binary flow systems, in an effort to observe a potential framework flexibility in the zeolite structure. ZSM-5, n-hexane, and 2-methylpentane have been chosen due to the prevalence of relevant literature data. Experiments are still being conducted, however preliminary data has proven highly variable and inconclusive. Current and future efforts are to be directed at lowering the data variability, and improving the overall consistency of the results.

Justin O'Dea: Computer Science
Mentor: Britanny Fasy, David Millman -- Computer Science
Covariance in the Human Brain

The goal of this research is to better understand brain functions of individuals engaging in shared activities. The data that is collected from our research will better help us understand covariance in the human brain. We will compare participants' brain waves by using an Electroencephalography (EEG) which measures brain oscillations. The shared activities will range from reading a book, watching a video, or reciting text from a theater play. Covariance is measured by the joint inconsistency of two variables when they are at random. The brain oscillations of interest are known as Alpha, Beta, Theta, Delta, Gamma, and mu oscillations. Each oscillation is represented by various frequencies, which are measured in Hertz. To determine the different frequencies of the oscillations, subjects will be asked to take part in a shared activity. Subjects will perform multiple activities, and the data being produced from the subject's brain oscillations will be recorded by the EEG. After data has been recorded, researchers will examine which waves or collection of waves best capture covariance when people are sharing an experience. This research has the potential to broaden our understanding of the human brain, and may lead to future developments in the field.

Esther Oloff: Chemical & Biological Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering
Microfluidic techniques for encapsulating gastric organoids

We investigated the use of microfluidics, in which small volumes of fluid are precisely manipulated in a lab-on-a-chip device, to manipulate the growth of gastric organoids. 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 within Corning Matrigel Basement Membrane Matrix. We use specialized microfluidic devices to encapsulate these cells within different geometries, varying between 100-450 μm in diameter. The first technique is to make a thin PDMS film with an array of holes that is used like an "ice-cube tray" to make different 3D shapes. The second technique is to use a standard drop-making microfluidic device to form drops of Matrigel that encase cells. The viability of the cells were examined within the different geometries. By isolating and supporting a single human gastric epithelial cell within a Matrigel shape that can grow into an organoid, that organoid can be more easily analyzed, specialized, and transported. A potential application is to design and bioprint an organoid with ports, allowing easier introduction of drugs or removal of waste products from the organoid. Research is done under Connie Chang in the Center for Biofilm Engineering, in collaboration with Diane Bimczok in Microbiology and Immunology at Montana State University.

Caitlin Olson: Chemical & Biological Engineering
Mentor: Matthew Fields -- Other
Linking Microbial Biofilms to Nitrate Removal in Groundwater Sediments

A fundamental goal in the field of microbial ecology is to link the activity of specific microorganisms to processes occurring within an ecosystem. This project aims to identify the drivers of community structure and succession by identifying the metabolically active fraction of microbial communities from both pure and contaminated groundwater wells. The groundwater samples include a variety of contaminants, the most important of these for this experiment being nitrate. The use of four diverse wells in conjunction with enumeration and sequencing of transnationally active microorganisms, activity assays, and geochemical measurements will allow for the explanation of the mechanisms controlling for shaping community structure and function. Multiple assay comparisons will be used to achieve an accurate characterization of the active microbial communities in the samples, and will ultimately be applied to continuous sediment cores from pure and contaminated wells. A combination of methodological approaches will be used to evaluate the active fraction of microbial communities, as well as the associated rates of activity from the pure and contaminated wells. Biolog Microbial Identification System will be used to biochemically test and identify a broad range of bacteria. The visualization and sequencing of translationally active bacterial, archaeal, and denitrifying cells was studied by applying bioorthoganol non-canonical amino acid tagging (BONCAT). For contaminated wells large proportions of the community were identified as translationally active however, specific rates of activity were low. Total cell abundances ranged from 1.11-2.07 X 10^5 cells/mL with 73-84% of the community being transnationally active.

Madison Owens: Chemical & Biological Engineering
Mentor: James Wilking -- Chemical & Biological Engineering
Developing a Biocompatible Formulation for Stereolithographic 3D Printing

To determine how factors such as biofilm structure and microbial density affect the production of specific metabolites, and to address the mass transport and material property limitations inherent in naturally-formed biofilms, we propose to use stereolithography (SLA)-based 3D printing to construct biofilms with well-defined structures and properties. In this approach, a solid object is built up layer-by-layer from a liquid resin using a focused laser spot. Polymerization occurs at the laser focal point, which is raster scanned within the resin bath. Recently we have developed a biocompatible, water-based formulation for printing viscoelastic hydrogels using a commercial SLA 3D printer (Formlabs, Form 2). The formulation relies on free-radical polymerization of a polyethylene glycol-diacrylate (PEG-DA) monomer dissolved in water, which is initiated by a photoinitiator (LAP) responsive to 405 nm wavelength light. Microbes, such as A. sarcoides, Escherichia coli, Bacillus subtilis, and Pseudomonas aeruginosa, which are suspended in the liquid are entrapped in the PEG-DA hydrogel as it polymerizes and survive for extended periods of time. Moreover, PEG-DA provides a versatile platform for varying gel mechanics because parameters such as elastic modulus and toughness can be tuned by controlling the concentrations and ratios of divalent and trivalent PEG-DA monomers. This flexibility is important as the microbe-loaded hydrogels are not naturally-formed biofilms, and effort must be taken to determine how closely microbes embedded in our hydrogel replicate biofilm behavior. To do this, we must understand how parameters such as gel mechanics and chemical modification of the gel polymers impact gene expression.

Acknowledgements: Reha Abbasi (MSU Graduate Student) - Chemical & Biological Engineering, Aaron Benjamin (MSU Undergrad Student) - Mechanical & Industrial Engineering

William Pardis: Electrical & Computer Engineering
Mentor: David Long -- Chemistry & Biochemistry (Flathead Valley Community College)
Measuring Protons with Photons: An Optical pH Instrument for Large-Scale Monitoring of Ocean Acidification

pH, a measure of proton concentration, is a critical parameter impacting our global ocean ecology due to its governing nature in chemical equilibrium. Since the onset of the Industrial Revolution, A 0.1 drop in ocean pH has been measured off the coast of Hawaii. Many data sets suggest this is a result of a chemical exchange between Earth's atmosphere and its oceans. 30 to 40% of atmospheric carbon dioxide is absorbed by our oceans. Carbon dioxide reacts with water to produce carbonic acid, which decreases oceanic pH. The implications of this is not fully understood due to its large spatial dimensions. Usable technology exists to measure pH with sufficient accuracy and precision, but is very expensive and therefore inaccessible to the general public. We developed an indicator-based pH photometer for in-the-field measurements that is easily assembled, inexpensive, handheld, and runs off of a cell phone allowing for web linked geo-referenced data. Five of these instruments were taken and tested in the South Pacific during a student study abroad trip. The instrument proved to be useful for in-field scientific inquiry and competitive relative to other instruments of its class at a fraction of the cost. The photometer, nicknamed the "pHyter", is currently undergoing field testing by the National Oceanic and Atmospheric Administration and lab tests by Sunburst Sensors, a national leader in this technology based in Missoula, MT. A citizen's science effort distributing pHyters on coastlines around the world would surpass the size of this issue and begin a better understanding of this important change in our global system.

Daniel Peters: Chemical & Biological Engineering
Mentor: Robin Gerlach -- Chemical & Biological Engineering
Characterizing Algae Growth and Biomass Composition under Autotrophic, Mixotrophic and Heterotrophic Conditions

The algal research group at the Center for Biofilm Engineering has a library of over 100 algal cultures, for most of which the metabolic pathways are not known. By growing each culture under phototrophic, heterotrophic, and mixotrophic conditions on a small scale, we have been able to determine which pathways each organism is capable of utilizing. Upon completion of a larger scale experiment, information about a select organism's nutrient uptake, growth, and composition will be analyzed to gain a rigorous understanding of the growth under each metabolic condition. Due to the plentiful organic carbon and often light limited conditions present in wastewater, algae that is capable of growth using multiple metabolic pathways are uniquely suited to these conditions and are of particular value in exploitation and even remediation of this otherwise low value waste stream.

Acknowledgements: Matthew Jackson (MSU Graduate Student) - Chemical & Biological Engineering

George Platt: Chemical & Biological Engineering
Mentor: Robin Gerlach -- Chemical & Biological Engineering
Attempting to identify the sources of microbial methane production from coal

As the world begins to transition away from high-emissions fossil fuels, natural gas has become increasingly relevant. One natural gas reserve is found in subsurface coal seams, known as coalbed methane (CBM). Biogenic methane production occurs in anoxic environments where microorganisms catalyze the conversion of coal to methane through fermentation and methanogenesis. This study focuses on the upstream biogeochemical processes that promote the degradation of the coal matrix into bioavailable organic intermediates. A series of solid-liquid extractions were performed with coal from the Powder River Basin (PRB) using methanol, dichloromethane, and water in various treatments and sequences. The residual coal from the extractions was used in anaerobic bioreactors inoculated with a native microbial consortium from the PRB to assess and quantify the variation in methane production via Gas Chromatography (GC). Additionally, the liquid fraction of the extracts were analyzed using Gas Chromatography–Mass Spectrometry (GC-MS) and the bioreactor contents were analyzed using Fluorescence Excitation-Emission Matrix Spectroscopy (EEMS) to assess their chemical composition and fluorescent signatures. While the bioreactors produced limited amounts of methane compared to previous CBM studies, the EEMS analysis showed that the bioreactor contents experienced a shift in fluorescent signatures indicating potential biotic and abiotic chemical conversion of the coal. Dissolved inorganic and organic carbon measurements showed significant differences between treatments, indicating that the coal pre-treatment affected the biogeochemical processes necessary for coal conversion. Ultimately, this study provided insight into the organic intermediates that are bioavailable for coal conversion.

Acknowledgements: Katie Davis (MSU Graduate Student) - Chemical & Biological Engineering, Heidi Smith (MSU Postdoc/Research Scientist) - Center for Biofilm Engineering

Shawna Pratt: Chemical & Biological Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering
Monitoring single-cell bacterial growth using drop-based microfluidics

Drop-based microfluidics is a technology by which monodisperse water-in-oil emulsions are created through the manipulation of fluids in a microfluidic device. The resulting drops act as individual, contained environments that can carry biological cargo; in the case of this study, the cargo is single Pseudomonas aeruginosa bacterial cells. Here, the growth of two strains of P. aeruginosa, wild type and a mutant hibernation promotion factor knockout strain, Δhpf, was monitored using specially developed microfluidic drop incubation technology. The Δhpf gene helps cells to successfully enter dormancy when undergoing starvation. Here we have developed an incubation technique that utilizes a uniquely engineered microfluidic device to hold drops in a set position and prevent drop evaporation for the duration of a 24 hr growth period. This technique allows for the growth of individual cells to be monitored, meaning that insights such as the heterogeneity of cell growth are lost to bulk data. During the growth period, drops are continually imaged through confocal technology to determine changes in fluorescence output, which reflects cell growth. This technique demonstrates the ability to monitor the growth of single cells to produce growth curves for each individual cell. In this study the developed microfluidic incubation technology facilitates a deeper investigation of the demographics of growth between the two strains explored, and allows for probing the heterogeneity of bacterial populations at a single cell level.

Acknowledgements: Tatsuya Akiyama (MSU Graduate Student) - Microbiology & Immunology, Geoffrey Zath (MSU Graduate Student) - Chemical & Biological Engineering, Kerry Williams (MSU Postdoc/Research Scientist) - Microbiology & Immunology, Michael Franklin (MSU Faculty Member) - Microbiology & Immunology

Dominik Pruss, James Soddy, Brandon Busby: Computer Science
Mentor: Hunter Llyod, Clemente Izurieta -- Computer Science
Charging Station and Automated Docking for Tangobots

As the size and number of motorized robots under the Computer Science Department increases, so does the time and manpower required to maintain the robots. The purpose of this project is to design and build a prototype charging station for Tangobots, the newest generation of robots being introduced to the Computer Science Department. This will enable the Tangobots to charge themselves, saving significant manual effort by operators. Currently the only way to charge the Tangobots is to manually charge each battery independently after removal from the device. In this project we will design and create a charging station that is easily mounted by the Tangobots. We will also create an API that will be implemented by the Tangobots, which will monitor the current battery level and determine when to navigate to a charging station, dock with a charging station, and charge its battery with little to no user assistance.

Acknowledgements: James Soddy (MSU Undergrad Student) - Computer Science, Brandon Busby (MSU Undergrad Student) - Computer Science

Jeana Ratcliff: Civil Engineering
Mentor: Kathryn Plymesser, Stuart Challender -- Civil Engineering, Earth Sciences
Drinking Water Resources in Western Kenya

The aim of this study was to investigate and characterize existing drinking water resources in the Khwisero sub-county area of western Kenya, with the goal of informing future water resource decisions made by the Montana State University chapter of Engineers without Borders (EWB@MSU), local stakeholders, and government officials. Data collection was performed using handheld GPS systems, and scope was narrowed during the study period to an area surrounding the Eshibinga community. Data collected included recording of location, condition, perceived potability, and accessibility of existing surface and groundwater drinking water sources (excluding rainwater catchment systems). The collected information was analyzed using GIS systems to create maps which provide visual and quantitative understanding of local conditions. These tools can be used to increase understanding of spatial distribution and functionality of local systems, and to influence decision making for future water supply projects. Research results will be shared with the EWB@MSU water development team and relevant stakeholders in Khwisero. These findings may be used to reduce redundancy in local water supply projects and to increase collaboration and understanding between Khwiseran community and government entities and EWB@MSU project teams in future water development projects and decision making.

Dean Ricker: Chemical & Biological Engineering
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
Does aquaporin 3b affect the number and or characteristics of calcium waves in the neural plate of Xenopus laevis embryos?

Does aquaporin 3b affect the number and or characteristics of calcium waves in the neural plate of Xenopus laevis embryos? Aquaporin 3b (Aqp3b) is a water channel protein that is expressed in two lines of cells along the edges of the neural plate. The neural plate then rolls up into the neural tube through a process called neural tube closure. The neural tube is the precursor to the entire central nervous system. When aqp3b expression is inhibited, neural tube closure does not occur. My hypothesis is that neural tube closure is orchestrated by calcium waves triggered by Aqp3b. In order to test my hypothesis, I inject three different groups of albino Xenopus laevis embryos at the four cell stage. One group, the control, is injected with a tracer (Rhodamine Dextran) and GCaMP6 mRNA that is translated into a protein that fluoresces in the presence of calcium. A second group, the test group, is injected with the tracer, GCaMP6, and aqp3b morpholino oligonucleotide (aqp3b MO), which inhibits translation of aqp3b mRNA. The final group, the second control is injected with tracer, GCaMP6, and a modified aqp3b MO that does not inhibit translation. This second control tests whether it is the presence of an MO or the inhibition of expression that affects calcium waves. The embryos are then allowed to develop to neurula stage, at which point a microscope camera is used to take a time lapse of them. Thus far, my efforts in this project have been to learn the necessary techniques and gain a qualitative understanding of the characteristics of calcium waves from the imaging I have done so far. Going forward I will be collecting more images of calcium activity in each of the three groups and developing a method for analyzing the data.

Acknowledgements: Dylan LeBlanc (MSU Postdoc/Research Scientist) - Cell Biology & Neuroscience, Jenifer Forecki (MSU Postdoc/Research Scientist) - Cell Biology & Neuroscience

Tanner Robison: Chemical & Biological Engineering
Mentor: Jovanka Voyich -- Microbiology & Immunology
Identifying specific extracellular residues of the sensory kinase SaeS important in the recognition and response to hydrogen peroxide in Staphylococcus aureus.

The Staphylococcus aureus (S. aureus) exoprotein secretion system (SaeR/S) is a two-component protein system within Staphylococcus aureus that has been linked to this pathogen's ability to survive within human neutrophils (polymorphonuclear leukocytes or PMNs). Prior studies have shown that an extracellular (EC) loop, consisting of nine amino acid residues on SaeS, is vital for S. aureus to sense and respond to extracellular stimuli--specifically components of human PMNs. Additionally, γ-hemolysin (hlgA) is a predominant virulence factor that targets immune and red blood cells. This toxin has been shown to be regulated by SaeR/S. New hlgA-GFP S. aureus cell strains--including point mutations of the residues on the EC loop--have been developed in order to study the role of each residue in S. aureus survival. All strains contained a plasmid on which the hlgA gene was linked with the GFP reporter. The current study sought to analyze the activity of these strains in the presence of hydrogen peroxide, a predominant reactive oxygen species produced by neutrophils. GFP fluorescence following transcription of hlgA was measured using spectrophotometry. This method was used to investigate the expression of hlgA following S. aureus incubation (up-to 6 hours) with non-lethal to lethal doses of hydrogen peroxide. Experimental findings suggest that the hlgA-GFP reporter may not be sensitive enough to definitively show differences in hlgA expression in wild-type and in SaeS EC point mutation S. aureus strains following exposure to hydrogen peroxide. While high concentrations of hydrogen peroxide did negatively impact cellular growth early on, GFP concentrations were not significant enough at those time points to distinguish differences in

Joel Seeley: Mechanical & Industrial Engineering
Mentor: Stephen Sofie -- Mechanical & Industrial Engineering
Sintering by diffusion promoting grain growth of yttria doped Co304

Sintering is a phenomenon driven by diffusion. As such, the energy required to move an atom or ion from one position to another, the activation energy, is fundamental in understanding sintering. In this work, the activation energy of densification and the activation energy of grain growth of 8·mol% yttria with 0.0, 0.5, 1.0, and 2.5·mol% Co_3O_4 were estimated from two-stage sintering experiments where sample length change was measured with dilatometry, and grain size was measured with scanning electron microscopy images. Sintering performance, and dopant effects on crystal structure, as measured by XRD, are presented. Activation energy estimates were then used to empirically estimate, and identify with curve-fitting the unknown function of density from the Wang and Raj activation energy equation; a literature standard in the estimation energy of activation energy of diffusion.

Acknowledgements: Clay Hunt (MSU Graduate Student) - Mechanical & Industrial Engineering

Hayley Smith: Computer Science
Mentor: Brittany Fasy, Roger Fischer (Gallatin College) -- Computer Science, Mathematics
Storytelling: Computer Science for American Indians in the Middle Grades

Computer Science is rarely taught in the high schools, and even less likely to be taught in a middle school. However, research suggests that students decide if they will continue in STEM by the end of 8th grade. Students have a natural ability to tell stories, especially the students from tribal communities who use stories to express themselves. ALICE is developed to be an easy to learn programming software that uses 3D graphics to provide instantaneous results to the user. This research project will develop curriculum using ALICE to teach computational thinking and computer science to middle school students by embedding storytelling activities into the Indian Education for All standards currently implemented across the state of Montana. To increase effects of these research, a website will also be developed to provide the community information about the project, research results and the lessons developed.

Abigale Snortland: Mechanical & Industrial Engineering
Mentor: Amendola Roberta, Madisen McCleary (PhD Student at MSU) -- Mechanical & Industrial Engineering
Investigation of Aluminum Titanate Doped Solid Oxide Fuel Cell Anodes

Developing new ways to obtain sufficient energy away from coal and oil production is a pressing challenge of today. Fuel cells are one viable option for facing this problem and have a great potential to change how energy is produced in the future. It is important to focus on reliability and longevity in design without sacrificing efficiency of the cell and is largely the focus of this project. The addition of ALT to Ni-YSZ has been found to improve the desired properties for the anode and finding the optimal amount to add is the core of this project. In order to be practical for commercial implementation, a new procedure needs to be developed to create samples of roughly 0.5mm thick. This is a reduction in size from the 2mm thick samples tested in the past and is important since a difference in thickness can have a large effect on the material properties and performance of the anode and especially its ability to provide enough strength and support to the rest of the fuel cell. At first, it was attempted to simply cut down on the amount of powder used for each sample and continue with the previous pressing procedure. It was discovered that roughly .5 grams of ceramic powder was the lower limit to what would provide a viable sample. After sintering, these samples were still too thick for the application. Future work will involve the testing and developing of a tape casting procedure that should allow for the creation of thin viable samples for testing.

Derek Snyder: Civil Engineering
Mentor: Greg Pederson -- Ecologist (USGS)
The Role of Humans and Climate in Historic Fire Activity on Tribal Forests of Northwestern Montana

Over the past several millennia, the severity of fires in mixed-conifer forests has varied greatly. Human interaction with these forest ecosystems has likely had an effect on this. In the past, the Salish and Kootenai tribes conducted seasonal burns south of Flathead Lake. Recently, the Confederated Tribes have taken measures of fire suppression. This project uses fire history data from one area of historically high human burning activity and another area that has been mainly isolated from human activity. Over the summer, I began the project as a Montana Institute on Ecosystems undergraduate researcher collecting data. This data was collected by taking tree-core samples from the root collar of trees, noting fire scars on trees, and measuring the diameter. The samples are now being analyzed and cross-dated to model fire history. Comparing fire regime data from each of these areas may reveal the effect of human activity on fire severity. The ultimate goal is to use this information to inform future forestry management of the historical drivers of mixed-severity fires in the mixed-conifer forests of the tribal lands of the Northern Rocky Mountains.

Aaron Splady: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Wagon: The Social Media Wish List

There are many online shopping websites that allow you to create wish lists. These have a very large shortcoming in that they are website specific. Wagon aims to be a consumer-focused site to allow people to easily share any item they are interested in with their friends. It is centered around each user having different lists with varying degrees of privacy. Users will be able view their own lists, the lists of their friends, and public lists. If a user would like to buy an item for another user, they will be able to click on a link that will direct them to the product page. The goal of Wagon is to streamline online gift shopping so that users can spend less time shopping online and give gifts that are exactly what the recipient desires.

Travis Stone: Computer Science
Mentor: Clemente Izurieta -- Computer Science
The Paranoid Writer's Vault

For writers, collecting, organizing and securing one's work can be challenging. There are, of course, tools that writers can use that are already readily available, but these tools rarely meet all the needs of a writer and are never tailor-made to a writer's specific needs. To address this shortcoming, I created a system that could handle all of the various tasks needed in order to better organize and secure a writer's work. The system can be divided into three sections; an online file storage and database server, a web based text editor, and a note-taking android application. The server's operating system is Ubuntu and hosts a database that organizes notes by date, genre, type (ex. Lines, morals, themes, etc.), and whether they are associated with an ongoing project or are independent. The server also hosts a website that contains a text editor for editing documents hosted on the server. The editor only has a few functions (bold, italics, plus others) as implementing a text editor to the standard of Microsoft Word, for example, is not necessary in the context of this project. The android application is designed to take notes and quickly organize them into the appropriate folder or database. Possible future improvements to the system might include adding several additional servers to host all the data on a cloud network, as well as integrating a remote command system that will be able to accept and then execute certain commands.

Anna Teintze: Mechanical & Industrial Engineering
Mentor: Charles Kankelborg -- Physics
A Wider View: Fetching Explosions on the Sun!

My goal was to redesign an instrument payload from a prior experiment for a rocket on a parabolic journey to capture images of the sun's surface. Most spectrograph pictures of the sun are taken through a narrow slit which then is moved incrementally across the surface of the sun as the images are taken. The issue with this approach is that over time, the surface of the sun is changing as the slit moves. Therefore, the beginning, middle and end of an event on the surface may all be captured in different areas of the event as the slit moves. To solve this, MOSES experiment takes a broader approach, capturing a spectrograph picture of the entire surface of the sun at once, thus eliminating the need for incremental movement altogether. Since this experiment's previous voyage, some new accommodations needed to be made. The baffles, which block excess light entering the end of the payload, needed redesigning in order to accommodate the new liquid nitrogen layout. Also, the harnessing cables and the electronics needed rearranging to fit in the new layout, mirrored to its previously occupied side of the I-beam payload, which is now home to an instrument for a different experiment. This required a fresh design of the liquid nitrogen cooling to all the systems and new housings, in order to protect the fragile optical equipment from the sun's rays.

Ryan Thompson, Tyler Wright: Computer Science
Mentor: Clem Izurieta -- Computer Science
Visualizing Point Clouds in Virtual Reality

As the field of virtual reality (VR) continues to grow and expand, there is an ever-increasing need for VR applications and programs. This project is sponsored by Blackmore Sensor and Analytics under the Software Factory program. The main objective is to take LIDAR-created point clouds and shift them into a VR environment. Once these points are in a VR setting, a user can then navigate the space and view the point cloud from any angle, height, and/or distance, thus allowing technicians to observe potential latent sampling errors or to simply grant users a videogame experience in VR environments. In order to achieve this goal, the point cloud must first be loaded into Unity, a game engine that provides application development for VR devices. Once the points are in a Scene, a user is granted the ability to navigate the VR space by way of a physics capsule, a movement system, a simple menu, and a cross-hair component. In the future, we plan on computing meshes for these VR environments, therefore granting the user a simulated physical world with realistic collision detection.

Acknowledgements: Tyler Wright (MSU Undergrad Student) - Computer Science

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

As the field of Topological Data Analysis (TDA) continues to grow and develop, there are an increasing amount of applications that lend themselves towards this 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 past been observed. 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. This allows for the scope to be narrowed to these smaller, computational 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. In order to best sample this data set, two methods will be used: cubical decomposition and a random "cookie-cutter" approach. The number and size of the cubes and "cookies" will be varied to ensure that all aspects of the set are captured. The diagrams that will then be created for each region are able to be compared and contrasted, revealing the spatial nature that is inherently present in these celestial manifolds.

Angus Tomlinson: Computer Science
Mentor: Brittany Fasy, David Millman -- Computer Science
An Investigation of Musical Structure with Persistent Homology

While topological data analysis (TDA) is seldom used in natural language processing, TDA techniques have been even more rarely applied to the realm of music. Therefore, we are seeking to understand the topological structure of music with persistent homology, a TDA tool for measuring the persistence of simplicial complex filtrations. Borrowing a “bag of words” technique from natural language processing, we are converting measures in a song to “bag of notes” vectors. From these vectors, we will produce Vietoris-Rips filtrations of the songs and analyze the resulting filtrations with persistent homology. Using this approach, we hypothesize that we will be able to define an inverse relationship between a song's underlying persistence and its constituent notes. This inverse topological descriptor could be used to highlight structural components of a song that would not be evident by merely observing a song's notes. This tool would be quite useful to topologists and musicians alike, and would lay the foundation for future research on the structure of music.

John Trapp, Tyler Mattioli, Jason Sanders: Computer Science
Mentor: Clemente Izurieta -- Computer Science
Blueprints MSU: The Game

The transition between high school and college can be a daunting experience for many students. The problem with traditional college prep is that it is expensive because of the high demand on resources. It requires dedicated staff at every high school or a roaming team of specialists. The cost for implementing these programs are simply too high for most school systems. To mitigate costs, and to help improve the transition to college life, the Montana State University School of Computing has partnered with the College of Education to design and build a mobile application to help high school students answer important questions they may have and also to learn about the formal and informal societal roles and regulations of university life. Before the involvement of the School of Computing, the Blueprints team traveled to high schools in the area seeking questions and concerns about college. They catalogued approximately 450 unique questions. This project involves the review of the questions gathered during prior activities and produce a game that is able to answer them adequately. To create our game, we used GameMaker, a software suite designed for making games. Overall, the Blueprints game will address these formal and informal societal roles and help provide high school students a look into the complexities of university life and to remove the apprehension of living alone. In the future we plan to conduct studies on its effectiveness, then we will release it to high schools to get both their feedback, and hopefully their students: ready to tackle their university tenure.

Acknowledgements: Tyler Mattioli (MSU Undergrad Student) - Computer Science, Jason Sanders (MSU Undergrad Student) - Computer Science, Tricia Seifert (MSU Faculty Member) - Education

Paige Tunby: Civil Engineering
Mentor: Mark Skidmore -- Earth Sciences
Assessing microbial nitrite oxidation from subglacial sediments

It has been shown that microbial communities are active at temperatures close to freezing (0-1˚C) in subglacial systems. These microorganisms are an integral part of the biogeochemical cycles that take place in subglacial environments and it has been argued that they may play a significant role in global biogeochemical cycles on glacial-interglacial timescales. Previous research at Robertson Glacier, Canada has shown that its subglacial sediments harbor diverse assemblages of potential nitrifying and nitrate reducing organisms. My research project has focused on an aspect of the aerobic portion of the nitrogen cycle in subglacial systems. I set up enrichment cultures for nitrite oxidizers at 4˚C, close in situ subglacial temperatures, using subglacial sediments from Roberson Glacier. Conversion of the added nitrite to nitrate in the biotic experiments and no change in the unamended control experiments demonstrated microbial nitrite oxidation. Multiple transfers of the enrichment culture were then undertaken to try and obtain a pure culture. The activity, through nitrite oxidation and cell biomass of these latter 4oC enrichments was measured, and showed activity but without significant increases in biomass. Ongoing work is focused on determining the identity of the nitrite oxidizing organism or organisms in the enrichments.

Kelly Walls: Mechanical & Industrial Engineering
Mentor: Paul Gannon -- Chemical & Biological Engineering
Surface Characterization Techniques in Materials Research and Development

Materials characterization allows for a better understanding of the relationships among the processing, structure, properties and performance of advanced materials and is vital in industrial research and development. Modern industries rely on several surface analysis techniques, including scanning electron microscopy (SEM), energy-dispersive x-ray spectroscopy (EDS), x-ray photoelectron spectroscopy (XPS), and x-ray diffraction (XRD). Each surface analysis technique has unique functionalities, capabilities, advantages and limitations. In this presentation, the function and operation of SEM/EDS, XPS, and XRD will be discussed alongside examples of their use in high-tech materials research and development.

Acknowledgements: Josh Aller (MSU Postdoc/Research Scientist) - Mechanical & Industrial Engineering

Seth Whiteside: Mechanical & Industrial Engineering
Mentor: Mark Owkes -- Mechanical & Industrial Engineering
Modeling the Effects of Warm Buildings on Fluid Flow in Cities

This research seeks to understand how heat transferred from warm buildings effects the fluid flow in cities. The motivation for this research is to understand how this alteration in flow would affect particle dispersion in cities. The goal for this research is to effectively use computational fluid dynamics to model test cases. With the data obtained, project collaborators will be able to design experiments to validate the outcomes of the simulations done using Star CCM+. Initial results showed that a simplified building with a high thermal conductivity was capable of transferring a substantial amount of heat to the fluid flowing past it. Further analysis remains to be done to quantify the effect of this heat on the fluid flow. The remainder of this research will focus on quantifying the effects of heat transfer as well as exploring and simulating more complex buildings and arrangements.

Mark Young: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering
Rheological Characterization of HPMCAS in Various Solvents

The purpose of this study was to rheologically characterize solutions by changing the concentration of hydroxypropyl methylcellulose acetate succinate (HPMCAS) dissolved in a variety of solvents, including acetone, methanol, and an acetone and water mixture. HPMCAS is a synthetic polymer derived from cellulose, it has found high interest in the pharmaceutical industry where it heavily used in the formation of spray-dried dispersion's. The characterization of the rheological properties of these solutions is of interest to better understand how the solvent choice and the polymer concentration impact the spray-dried dispersion. Polymer solutions exhibit critical concentrations of overlap and entanglement that correlate to when the polymer chains in solution begin to overlap with other chains and when polymers chains begin to entangle with other chains in the solution. When polymer chains overlap with each other a network forms in the solution, this leads to an increased viscosity as well as viscoelastic behavior that can be observed and characterized. Steady state flow tests, strain sweeps, and frequency sweeps were performed to observe the rheological properties of these polymer solutions. Overlap and entanglement concentrations were found for solutions with the solvents of Acetone, Methanol and an acetone and water mixture. The viscoelasticity of these solutions was then analyzed at polymer concentrations between and above these critical concentrations.

Emma Kashian: Environmental Studies
Mentor: Florence Dunkel – Plant Sciences & Plant Pathology
Mass Rearing House Crickets in Rural Mali

Subsistence farmers in rural Mali commonly have a strict grain diet which can result in deficiencies in vitamin B12, certain amino acids such as lysine and tryptophan. House crickets, Acheta domesticus, a species found wild in village homes in Mali have been found to be a complete source of fat, protein, vitamins, and essential amino acids. We tested the viability of mass rearing Acheta domesticus in rural Mali by developing cricket feeds for chickens with materials locally available to Malians. We defined success by measuring cricket fecundity and survivorship in laboratory bioassays. Treatments with 4 replicates were: a) feeding crickets a combination of ground millet and fresh zucchini fruit; and b) feeding crickets with a combination of ground millet, ground dried zucchini seeds, and fresh zucchini fruit. Data were analyzed with a simple and multiple comparison of means. Control crickets were fed Fluker Farm high calcium cricket food, and distilled water. From our three repeats, we deducted that sustainable locally sourced foods in rural Mali can provide a suitable diet for mass rearing house crickets.

Isak Petersen: Anthropology, History
Mentor: Florence Dukel – Plant Sciences & Plant Pathology
Encouragement of Knowledge Sharing Regarding Malaria

I worked with individuals in Sanambele, Mali, in order to determine if they were interested in sharing their knowledge of malaria prevention with neighboring villages. Malaria is the number one cause of death for children under the age of five in Sub-Saharan Africa. The class I worked with has had success in eliminating malaria in the village of Sanambele, which has been nearly malaria free since 2009. Now, the biggest threat to that status is the potential for malaria to be reintroduced to Sanambele from the surrounding villages. The course uses a methodology that places aims to reduce the colonizing effects that are present in nearly every "international aid" organization. The "holistic method", as it is called, aims to have the community direct all work that is done. This is so that the presuppositions of researchers do not place a burden on the desires of the community. For my part, I talked often with several individuals who live in and around Sanambele through email and Skype. I also spent countless hours studying relevant literature in order to see if other institutions have had success with similar methods of international cooperation.

Josh Carter: Mechanical Engineering & Microbiology
Mentor: Blake Wiedenheft – Microbiology & Immunology
Structure Reveals Mechanisms of Viral Suppressors that Intercept a CRISPR RNA-Guided Surveillance Complex

Genetic conflict between viruses and their hosts drives evolution and genetic innovation. Prokaryotes evolved CRISPR-mediated adaptive immune systems for protection from viral infection, and viruses have evolved diverse anti-CRISPR (Acr) proteins that subvert these immune systems. The adaptive immune system in Pseudomonas aeruginosa (type I-F) relies on a 350 kDa CRISPR RNA (crRNA)-guided surveillance complex (Csy complex) to bind foreign DNA and recruit a trans-acting nuclease for target degradation. Here, we report that the cryo-electron microscopy (cryo-EM) structure of the Csy complex bound to two different Acr proteins, AcrF1 and AcrF2, at an average resolution of 3.4 A˚. The structure explains the molecular mechanism for immune system suppression, and structure-guided mutations show that the Acr proteins bind to residues essential for crRNA-mediated detection of DNA. Collectively, these data provide a snapshot of an ongoing molecular arms race between viral suppressors and the immune system they target.

Acknowledgements: Connor Hoffman (MSU Undergraduate Student) - Chemical Engineering

Tim Gauthier: Mechanical & Industrial Engineering
Mentor: Eric Johnson -- Mechanical & Industrial Engineering
Active Pitch Control for Cross-Flow Water Turbines

Cross-flow water turbines (CFTs) are complex devices that, while studied extensively, have seen little implementation relative to the conventional horizontal-axis (wind) turbine. This research intends to prove that active pitch control (APC) methodology can significantly improve performance of CFTs. Computational fluid dynamics (CFD) simulation will provide the design space to determine an optimal control configuration, while experiments will be conducted in the future to validate simulation results. Preliminary investigation suggests that passive pitch control (APC) can increase coefficient of power of the CFT, which represents rotor output and is therefore a main indicator of improved performance. However, PPC estimates the overall flow field by a simple mathematical relation that only takes into account turbine radius and velocity. APC provides the ability to measure the flow field during simulation, giving the ability to specify exact values for more accurate control and take into account the dynamic fluctuations of each turbine blade. The model is a straight-bladed CFT with three cambered blades and a radius of 0.108, along with dimensions from the Civil Engineering water flume. A proportional-integral (PI) controller is used in tandem with two-dimensional CFD to drive blade rotation rate. Individual blade moments are selected as input parameters and each blade is controlled separately based on fixed-pitch moment data. Initial results show improved performance due to a wider positive torque bucket and a higher starting pitch angle per revolution.

Niall Clancy: Fish & Wildlife Ecology
Mentor: Lindsey Albertson – Ecology
Unique emergence patterns of salmonflies (Pteronarnys californica) on the Fallatin and Madison Rivers of Montana

The salmonfly (*Pteronarcys californica)* is one of the most iconic invertebrates in western North America. *Pteronarcys* is a large aquatic stonefly (Order Plecoptera) that spends the larval portion of its lifecycle within gravels on the riverbed. *Pteronarcys* then emerges from the water in spectacular, synchronized hatches in early summer to live the adult portion of its lifecycle in the terrestrial, riparian habitat. Both the Gallatin and Madison Rivers of southwestern Montana have hatches that are closely followed by trout anglers. However, there is a perception among the fly fishing community that salmonfly numbers have significantly decreased over the past few decades. We collected salmonfly exuviae during the hatches on the Gallatin and upper Madison Rivers and recorded the date of emergence, proportion of males and females, and several environmental variables including water temperature, amount of suspended solids, and substrate size. Our results indicate that the peak emergence on the Madison River occurred in a predictable sequence from site to site along the downstream to upstream longitudinal profile. The Gallatin River showed no such pattern, instead exhibiting a relatively consistent hatch timing across all sites at similar times. It is currently unclear as to what is driving this difference in emergence pattern but anecdotal evidence suggests temperature, hydrology, and geomorphology may all play a role. Testing these hypotheses is the subject of ongoing work.

Acknowledgements: Heidi Anderson (MSU Graduate Student) - Biological Sciences

Nina Paris: Chemistry & Biochemistry
Mentor: Brian Bothner -- Chemistry & Biochemistry
Further Investigation of How and Why the Lipid Bilayer Composition of Escherichia coli (E. coli) Differs in Aerobic and Anaerobic Environments

Escherichia coli (E. coli) is a highly studied bacterium because it is easy to grow and can grow in aerobic and anaerobic conditions. E. coli cells are surrounded by a lipid bilayer to help facilitate what can enter and leave the cell and to help protect it from the environment. Lipids are very sensitive to energy levels in a cell and therefore can give insight into metabolic stress in cells. Last summer I determined that the lipid composition of E. coli lipid membranes is different when grown in aerobic versus anaerobic conditions. Experiments since then have been done and it has been determined that the lipid composition changes quickly once E. coli cells are transitioned from aerobic to anaerobic environments. This shows that lipid synthesis and metabolism of the lipid bilayer of E. coli is affected by whether oxygen is available.

Acknowledgements: Molly Lukes (MSU Undergrad Student) - Chemistry & Biochemistry

Noah Archer: Physics
Mentor: Hugo Schmidt, Tim Tu (Fu Jen Catholic University) -- Physics
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 (Bi1/2Na1/2O3)0.925(BaTiO3)0.075 doped with Manganese (Mn) which in amounts up to 2% increases the depolarization temperature, above which the piezoelectric property is lost.

Juliana Beauchene: Microbiology & Immunology
Mentor: Jodi Hedges -- Microbiology & Immunology
Mouse TLR4 vs. Human TLR4

The overall goal of the project is to understand the immune response of Toll-like receptor 4 (TLR4) in mice that express the human TLR4 gene compared to mice with the mouse TLR4 gene. Research concerning TLR4 has high potential to lead to the modification and transformation of vaccines we use today. The hypothesis is that human TLR4 has an amplified TRIF-biased response compared to mouse TLR4. A TRIF biased response is optimal in vaccine production because the TRIF adaptor protein has minimal inflammatory response. The moving target of creating vaccines on ever changing viruses is a challenge. TLR4 research has the potential to create vast improvements in vaccines we use today and improve biomedical and public health.

Katherine Budeski: Chemistry & Biochemistry
Mentor: Brian Bothner -- Chemistry & Biochemistry
Identification of Biomarkers for Tumor Development in the Liver using Bovine Serum Albumin as a Molecular Sensor

Analyzing biological fluids using untargeted metabolomics has proved challenging because it is time-consuming and, at times, inconclusive. As an alternative method, the Bothner Lab has established the use of the protein bovine serum albumin (BSA) as a molecular sensor to differentiate complex biological solutions. Serum albumin is the most abundant protein in mammalian blood, where it transports lipids, hormones and drugs. The natural role of BSA as a carrier protein inspired the Bothner Lab to test this proteins' ability to bind a wide variety of small molecules with a goal of targeted metabolite extractions from complex biological samples. This method has been coined the protein sensor assay (PSA). A new set of methods has been developed to perform metabolite extractions using the PSA on serum collected from mice with induced liver cancer from the Schmidt Lab at Montana State University. The Schmidt Lab has done much work to identify the key steps in biochemical pathways like oxidative stress in mice with induced cancer. In this project I have used the PSA together with liquid chromatography mass spectrometry and statistical analyses to identify biomarkers for tumor development in mouse serum. In the future, the PSA may be used to speed up analysis and improve confidence in disease diagnostics.

Acknowledgements: Timothy Hamerly (University of Florida) – Infectious Diseases & Pathology, Rachel Rawle (MSU Graduate Student) - Microbiology & Immunology, Ed Schmidt (MSU Faculty Member) - Microbiology & Immunology

Katherine Chamberlain: Physics
Mentor: Nicolas Yunes -- Physics
Gravitational Wave Tests of Modified Gravity with Future Space and Ground-based Detectors

The result of some of the most energetic and violent events in the universe, known as Gravitational Waves, are constantly propagating through space-time. These waves were first directly detected in September of 2015, and plans are moving forward to improve and expand the gravitational wave detectors that already exist. In particular, a design for a space-based gravitational wave detector has been submitted to the European Space Agency, with hopes that such a detector could be operational in two decades. Additionally, plans for upgrades to current gravitational wave facilities, as well as plans for new more advanced facilities, have been proposed. These future ground-based detectors will have an improved sensitivity to gravitational wave signals over ten times the sensitivity of current detectors. Using the projected sensitivity curves for the proposed instruments, both space- and ground-based, we took a theory-agnostic approach to determine how well modified theories of gravity could be tested with these future generation detectors. We have found that a combination of future ground-based and space-based detectors will provide drastically better constraints than current gravitational wave detectors can alone.

Jacob Corpron: Cell Biology & Neuroscience
Mentor: Doug Kominsky -- Microbiology & Immunology
Tryptophan Metabolites and Their Role in IL10-R1 Expression

Within the gut lives a diverse microbial flora. Intestinal epithelial cells (IEC) need to maintain a functional barrier in order to protect the body from this antigenic luminal environment. The immune system's inflammatory response to invasion of antigens in the IEC layer can lead to disruption and damage to the mucosal lining. This compromises the barrier function of the epithelium, resulting in an increase of bacterial diffusion across the intestinal epithelia as well as an increase in inflammation. Regulatory T cells (Treg) can mediate the pro-inflammatory response through the signaling of the cytokine interleukin-10. Il-10 and its receptor IL-10R1 play key roles in suppressing inflammation resulting from a disruption of intestinal epithelial homeostasis and epithelial barrier. Recent research has shown the activation of the aryl hydrocarbon pathway induces IL-10R1 IECs. There is currently a gap in our knowledge regarding the specific tryptophan metabolites implicated in the upregulation IL10-R1 in intestinal epithelial cells via the aryl hydrocarbon receptor pathway. Based on previous findings, we hypothesize that specific tryptophan metabolites including indole-3-carboxaldehyde (IAl), indole-3-proprionate (IPr) and indole-3-acetic acid (IAa) upregulate IL-10R expression through the AhR pathway in intestinal epithelial cells.

Acknowledgements: Brittany Jenkins (MSU Graduate Student) - Microbiology & Immunology

Tanner Cox: Ecology
Mentor: Lindsey Albertson -- Ecology
Springtime migration by Mountain Whitefish: A journey for food?

Mountain Whitefish (Prosopium williamsoni) are native to the entire state of Montana. The Smith River basin, in central Montana, encompasses numerous tributaries with little fragmentation. Recent studies have observed Mountain Whitefish traveling long distances through the watershed during peak spring runoff. The cause for these movements is not well understood. Thus the objectives of this study are 1) to describe the benthic macroinvertebrate community structure 2) to describe dietary requirements of Mountain Whitefish and 3) compare Mountain Whitefish diets and non-native Rainbow Trout diets (Oncorhynchus mykiss) in the Smith River and Sheep Creek. Benthic samples from both Smith River and Sheep Creek indicate large diversity in potential food items. Mountain Whitefish diets are diverse including numerous benthic macroinvertebrate families whereas Rainbow Trout diets are less diverse encompassing fewer families per diet. Ephemeroptera families have dominated diets of both species. Thus potential competition between the native Mountain Whitefish and non-native Rainbow Trout is plausible in areas of high fish abundance and limited common prey items.

Acknowledgements: Addie Dutton (MSU Graduate Student) - Ecology, Lindsey Albertson (MSU Faculty Member) - Ecology, Michael Lance (MSU Graduate Student) - Ecology

Peter Crawford-Kahrl: Mathematical Sciences
Mentor: Tomas Gedeon, Bree Cummins -- Mathematical Sciences
Characterization of continuous bounded ordinary differential equations across all parameter choices for regulatory networks

The characterization of the long-term dynamical behavior of the solutions to a class of ordinary differential equations (ODEs) with continuous components that transition between constant threshold values has significant applications to the understanding of regulatory networks associated with both gene regulation and neural network behavior. In particular, sigmoid models are realistic representations of regulation events in regulatory networks, but being non-linear, solutions cannot be found analytically in general. We investigated the dynamics of a class of functions that transition continuously from one constant threshold value to another, by dividing phase space into a finite number of rectangular “boxes”, and analyzing the “flow” of trajectories from one box to another, which previous work has done on discontinuous “switching” models of regulatory networks. We present an algorithm that unambiguously assigns directions of flow from box to box for the general bounded continuous system, which can be used to create a “domain graph” of phase space. We also present a mapping of the Morse decompositions of the domain graph of the switching system to the Morse graph of the corresponding bounded continuous system's domain graph. By partitioning parameter space into a finite number of semi-algebraic sets, our work allows for the complete characterization of the the overall dynamics of any given regulatory network's respective model over all possible parameter choices, which is a paradigm shift in the analysis of dynamical systems.

Helen Dailey: Earth Sciences
Mentor: David Varricchio -- Earth Sciences
Assessing Eggshell Pigment Fossilization Potential with Artificial Aging

Modern bird eggs are unique from those of reptiles in that they may be naturally pigmented; recently, evidence was found to support the presence of pigment in fossilized dinosaur eggs. The purpose of this study is to determine the likelihood of pigment preservation in eggshell that has undergone fossilization. Two aspects of the fossilization history of eggshell are considered: pre- and post-burial conditions. Pre-burial conditions include exposure to sunlight and meteoric water. Sunlight is simulated using a UV lamp with a peak wavelength of approximately 370nm. Meteoric water is simulated using dry ice in distilled water to produce carbonic acid. Post-burial conditions consist of either extremely high temperatures or lower, typical to geological reality temperatures. Emu eggs are used to test the preservation potential of biliverdin, the pigment responsible for blue-green coloration. Brown chicken eggs are used to test the preservation potential of protoporphyrin IX, the pigment responsible for brown coloration. White chicken eggs are used as a control. Preservation potential is assessed by comparing the presence of pigment in unaltered eggshell to the presence in eggshell altered either by only pre-burial conditions or by both pre- and post-burial conditions. This is done using high performance liquid chromatography (HPLC) and histological thin-sectioning. HPLC provides chemical identification of the presence of pigments. Histology provides visual comparison between conditions including both coloration and structural changes. Results will aid in ascribing color to fossilized eggshell and may allow for additional learning in the area of dinosaur reproduction.

Colin Delaney, Dario Scotto: Physics
Mentor: Alan Criag -- Physics
Electron Trapping Techniques

Montana State University has never trapped electrons. Our research employs two different trapping methods to constrain and cool particles. The first is a Magneto Optic Trap (MOT); it employs two opposing solenoids coupled with a Doppler laser cooling to spatially constrain atoms to a large region. The next is a Circular Radio-Frequency Quadrupole (CRFQ) trap; it uses an oscillating electric quadrupole in a loop that traps ions in a tightly confined orbit. The combination of these traps can allow sympathetic cooling between the atomic-buffered gas of a MOT and ions in the CRFQ. Instead of ions, we seek to tune our trap for electrons. This technique could be used to study the quantum hall effect, or Bose-Einstein condensate, among other phenomena. My research presents different design configurations implementing combinations of MOT and CRFQ Traps and simulating trade-offs of their performance parameters to contain and cool ions. Variations such as the rotation of the quadrupole loops and their cross sectional shape, diameter and field strength of the anti-Helmholtz coil combined with laser amplitude and detuning from atomic resonance will be explored and tabulated.

Acknowledgements: Dario Scotto (MSU Undergrad Student) - Physics

Jacklyn Deppmeier: Physics
Mentor: Sachiko Tsuruta -- Physics
Non-Standard Neutron Star Cooling Using a Quark Model

Neutron stars are extremely dense objects that are created during star deaths. They typically follow either a "standard" cooling process, or a faster "non-standard" cooling process. Non-standard cooling is caused by the presence of exotic particles such as pions, quarks, or hyperons in the core. This poster focuses on non-standard cooling using a quark core model. Cooling curves were created using a neutron star thermal evolution code modified to account for cores made of exotic particles. These models can be compared to previous models and experimental data to learn more about actual cooling behavior.

Acknowledgements: Marcus Teter (PhD), Andrew Liebmann (MSU Postdoc/Research Scientist) - Physics

Sabrina Dinkel: Microbiology & Immunology
Mentor: Ronald June -- Mechanical & Industrial Engineering
Targeted joint therapy using TAT peptides in Osteoarthritic cartilage

Osteoarthritis (OA) is a debilitating disease that affects millions of Americans each year. It is characterized as a loss cartilage, the smooth tissue lining human joints. Currently, there is no cure for OA and the only treatment is an invasive and painful knee or hip replacement. Due to this, there is a need for a novel drug therapy to be developed. The objective of this study is to characterize the diffusion and uptake of TAT Protein Transduction Domain (TAT-PTD), a positively charged, small peptide. TAT-PTD has been tested in FDA clinical trials and has been shown to be a safe and effective drug delivery vehicle. We hypothesize the charge difference between positively charged TAT-PTD and negatively charged cartilage will increase the efficacy of drug delivery to cartilage. In this study, samples of OA cartilage were placed into a solution containing fluorescently labeled TAT peptides. I expect the study will show limited results because there is a diminished negative charge in OA cartilage due to the loss of negatively charged proteins. This will then decrease the attractive force between the TAT-PTD and cartilage. Multiple other studies have also had the same results. These studies have found that positively charged molecules have a decreased uptake in OA affected cartilage. Therefore, similar results could be expected in this OA model system. The impact of this data is to better understand how positive charge can affect the efficacy of drug delivery to OA cartilage. In addition, the data provides information on how positively charged molecules could be used to enhance drug delivery.

Acknowledgements: Sarah Mailhiot (MSU Graduate Student) - Mechanical & Industrial Engineering

Will Dumm: Mathematical Sciences
Mentor: Bree Cummins, Tomas Gedeon -- Mathematical Sciences
Modeling disease transmission: Incorporating family cliques in exponential random graphs

Disease transmission is most commonly modeled using compartmental ordinary differential equations or agent based models, both of which have notable drawbacks. Compartmental models permit theoretical results, but they rely on the false assumption that populations mix homogeneously. Agent based models account for the fact that populations are not homogeneously mixed, but are computational models and do not lend themselves to the derivation of theoretical results. A third, more recent approach in which equations governing disease transmission are imposed over a social network attempts to combine the strengths of both model types. The social network utilized represents individuals as nodes and contact between those individuals as edges. This technique accounts for the complexities of social structure while permitting the derivation of theoretical results. Many network models exist which approximate the properties of real-world social networks, but these widely ignore important local network structures such as family units. Therefore, their use in the modeling of disease transmission ignores important mechanisms of disease propagation. A new class of networks which more closely represents real-world social structures would be useful in modeling disease transmission through populations. This project aims to adapt exponential random graph models, a general class of network model which accounts for certain local structures, to specify the existence of family cliques of all sizes. An important characteristic of real world social networks is that each individual belongs to some family clique. We expect the inclusion of this property to change the dynamics of epidemic spread on a network and potentially to allow for more accurate modeling of epidemics.

Lauren Dupuis: Chemistry & Biochemistry
Mentor: Connie Chang, Sharon Neufeldt -- Center for Biofilm Engineering, Chemistry & Biochemistry
Krytox-PEG Triblock Copolymer Surfactant Synthesis and Modification

Microfluidics devices can form water-in-oil microscale emulsions, which can be used in medical applications such as high-throughput single cell assays. However, a biologically compatible surfactant must be used to keep the drops stable. The surfactant cannot interact with the biological agents within drops being tested for these applications. The surfactant that was synthesized for high-throughput biological assaying in the Chang lab is a polyether diamine polymer with two perfluorinated polyethers attached on each end of the diamine to create a triblock copolymer. The synthesis involves converting an alcohol to an acid chloride on the perfluorinated polyether that will then react with the amine groups on the end of the polyether diamine to create the triblock. The different batches of this surfactant went through a testing process to be sure that they were stable enough to undergo the experimental testing needed for the applications. Drops were formed with 1.5% surfactant in oil, tested for stability over three days, incubated for a day, thermal-cycled under PCR and an NMR spectrum was taken to look for purity. After being able to create this original surfactant polymer, the goal of this project is to create a new surfactant with a similar chemical synthesis that will be able to cross-link and create a hard shell around the drop.

Acknowledgements: Geoffrey Zath (MSU Graduate Student) - Center for Biofilm Engineering

Maria Clara Fernandes Martins: Microbiology & Immunology
Mentor: Eric Boyd -- Microbiology & Immunology
Metabolic preferences of a chemoautotrophic thermophilic microorganism

High-temperature chemotrophic hot springs in Yellowstone National Park are inhabited by microorganisms that subsist on varied substrates supplied primarily by water-rock interactions. Hydrogen oxidation is a particularly important metabolism for many such microorganisms and helps fuel chemoautotrophic growth. Hydrogen-oxidizing microorganisms (hydrogenotrophs) living in YNP are capable of coupling this activity to the reduction of oxidants, including oxygen and ferric iron. We've observed seemingly contradictory metabolic preferences carried out by a chemoautotrophic, thermophilic, hydrogenotroph in the 'Roadside East' hot spring (pH 3.0, 82.4°C). Sediment-associated communities from the source of this spring are dominated by a species of Metallosphaera (80% of the total community) which has the genomic potential for hydrogen oxidation with [NiFe]-hydrogenases. Additionally, we have shown the ability of this organism to oxidize hydrogen in laboratory cultures. However, net microbial hydrogen oxidation is not measured in situ in this spring, but we can observe the presence of iron oxides in this spring. The Metallosphaera species present in this community is seemingly conducting iron oxidation coupled with oxygen reduction instead of hydrogen oxidation, a process which yields less energy. Here I present preliminary work aimed at investigating why this microorganism is using iron oxidation instead of hydrogen oxidation, with both metabolisms requiring oxygen, often limited in hot springs. Results will be discussed in light of the ability of a putative Metallosphaera isolate from Roadside East to conduct both metabolisms. Further, results will be discussed from laboratory competition experiments determining metabolic preferences when both iron and hydrogen are available.

Acknowledgements: Melody Lindsay (MSU Graduate Student) - Microbiology & Immunology

Brittney Forsman: Microbiology & Immunology
Mentor: Blake Wiedenheft -- Microbiology & Immunology
The Evolution and Mechanisms of Type 1 CRISPR Systems

Bacteria and Archaea have adaptive RNA-guided immune systems called CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)-Cas (CRISPR associated) that provide protection against invading genetic elements. There are currently five reported CRISPR types comprised of at least nineteen subtypes that encode for a different crRNA-guided surveillance complex. The Type 1-E system of Escherichia coli relies on a surveillance complex called Cascade (CRISPR-Associated Complex for Antiviral Defense) and a nuclease/helicase, Cas3. Similarly, the Type 1-F system of Pseudomonas aeruginosa relies on a surveillance complex called Csy (CRISPR system yersinia) and the trans-acting nuclease, Cas2/3. The Type 1-F system is unique, because it contains a fusion of the Cas2 and Cas3 proteins into a single polypeptide. In most Type 1 systems, Cas2 and Cas3 are separate proteins that are involved in adaptation and interference, respectively. When the surveillance complex of a Type 1 system binds to target DNA, it recruits the nuclease to degrade the invader DNA. My aim is to determine if the Cas2/3 protein from P. aeruginosa can complement the activity of Cas3 from E. coli.

Hailey Gelzer: Ecology
Mentor: Wyatt Cross, Eric Scholl (PhD student at MSU) -- Ecology
Estimating the spatial extent of Pallid Sturgeon (Scaphirhynchus albus) foraging in large rivers: matching fish movement with macroinvertebrate resource availability

Large-river fish continue to decline around the world due to anthropogenic activities. In order to successfully restore these fish, management approaches need to understand how much available food exists to sustain population levels. Many imperiled fish in large rivers move considerable distances, requiring estimates of food availability at corresponding spatial extents, yet few studies have attempted to "match" these two scales. The objective of my study was to compile and analyze movement data of a federally endangered fish that are native to large rivers in Montana, the Pallid Sturgeon (Scaphirhynchus albus). Ultimately, these movement estimates will be used in a larger study that combines habitat quantification, macroinvertebrate structure and production estimates, and Pallid Sturgeon movement distributions to quantify food availability to hatchery-raised juvenile Pallid Sturgeon. To determine the spatial extent of Pallid Sturgeon foraging, I conducted an online literature review and compile papers of Pallid Sturgeon movement from a variety of North American Rivers. Following the literature review, I obtained unpublished data of Pallid Sturgeon movement from the upper Missouri and lower Yellowstone Rivers from state (Montana Fish Wildlife and Parks) and federal (United States Geological Survey, United States Fish and Wildlife Service) agencies. Matching Pallid Sturgeon movement with the extent of their resource base provides insight into whether large river ecosystems in Montana can support current restoration activities designed to bolster declining populations.

Acknowledgements: Christopher Guy (MSU Faculty Member) - Ecology

William Griffiths: Environmental Studies
Mentor: Mark Fiege -- History & Philosophy
Our Last Cast: The Future of Fly Fishing in the American West

Anglers need to understand the future of global environmental change and its consequences for freshwater fisheries. The urgency of the impacts we face is not as accessible to guides, outfitters and anglers as it needs to be. This spring I have conducted a literature review of climate science and fisheries ecology, and I have interviewed climate scientists, fisheries ecologists, guides, and outfitters about the Yellowstone and Madison Rivers. The culmination of my project this spring - one chapter of a short book - explains the future effects of climate change on the social, economic and ecological aspects of fly fishing communities on the Yellowstone and Madison. My goal is to fill a pressing need to convey these concepts so we can prepare and react more effectively to the current environmental crisis.

Fiona Grubin: Psychology
Mentor: Monica Skewes -- Psychology
Students of Color at Montana State University: Racial Microaggressions and Protective Factors

Racial microaggressions impact the lives and health of ethnic minorities in the U.S. every day, and college students of color are no exception. Research shows that students of color at predominantly and historically White universities such as MSU experience microaggressions and a more isolated campus climate than their majority-group peers. Perceived discrimination among students of color has been shown to be significantly associated with increased rates of anxiety, depression, and alcohol problems (Blume et al., 2014; Skewes & Blume, 2016), with potentially harmful implications for academic achievement. Despite these challenges, college students of color are resilient and possess protective factors that help them successfully navigate university environments. The present study reports preliminary findings from an ongoing undergraduate research project examining protective factors that might buffer the effects of microaggressions and promote healthy coping among college students of color. The study sample will consist of 50 MSU students who self-identify as ethnic minorities and volunteer to complete a battery of self-report questionnaires about their experiences with microaggressions, mental health, and substance use behavior. Potential protective factors examined in the survey include self-efficacy, authenticity, positive emotions, social support, spirituality, self-esteem, self-compassion, and approach-based coping styles. SPSS will be used to analyze data and explore associations and interactions among hypothesized protective factors and microaggressions, mental health symptoms, and alcohol outcomes. Results will be summarized and discussed along with future research suggestions and interventions to encourage and cultivate protection from microaggressions on campus.

Annette Harnish: Microbiology & Immunology
Mentor: Eric Boyd -- Microbiology & Immunology
Temporal Dynamics of Microbial Communities in Four Yellowstone National Park Hot Springs

The microbial communities of Yellowstone National Park (YNP) thermal features have been well-characterized, and have provided a wealth of information about thermophilic microbial community ecology. However, there has been little study of how these communities change in composition over time. The objective of this project is to use culture-independent methods to characterize the microbial community composition of four acidic YNP hot springs with weekly sampling over a six-month sampling period spanning multiple seasons. Analyses will be conducted using high-throughput 16S rRNA sequencing to determine community composition and quantitative PCR to determine population abundances in tandem with geochemical analyses, in order to assess how and why microbial communities respond to spring geochemical fluctuations over time. In addition to the three springs sampled continuously over six months, emphasis will be placed on microbial community succession in a newly formed hot spring that appeared during the course of sampling to provide insight into the establishment and succession of thermal feature microbial communities. I hypothesize that seasonal variances in climatic factors, especially precipitation, will have a pronounced impact upon hot spring communities due to the mixing of surface waters with subsurface hydrothermal waters. Preliminary molecular and geochemical results will be presented in context of temporal dynamics of the system.

Acknowledgements: Daniel Colman (MSU Postdoc/Research Scientist) - Microbiology & Immunology, Melody Lindsay (MSU Graduate Student) - Microbiology & Immunology, Max Amenabar (MSU Graduate Student) - Microbiology & Immunology, Matthew Stott (Wairakei Research Centre)

Michelle Hicks: Mathematical Sciences
Mentor: Laura Hildreth -- Mathematical Sciences
The Relationship Between Refugee Resettlement Patterns and Crime Rates

This analysis researches the empirical relationship between refugee resettlement and crime rates across various counties in the United States during the period 2005-2015. Using crime data from the FBI Data Collections and refugee resettlement pattern data from the Department of Justice, this analysis looks at the incidence of crime, both locally (at the county level) and nationally. The analysis then controls for unemployment, population, state GDP, percentage of youth, education level, and year. In this analysis, a difference-in-differences regression model is used to determine whether any increase in crime is due to refugee resettlement or merely part of a national trend. Upon preliminary (yet inconclusive) analysis it appears that these results may concur with previous research in that fluctuations in crime rates are not due to refugees, with the exception perhaps of petty theft.

Adam Holeman: Mathematical Sciences
Mentor: Kevin Wildrick -- Mathematical Sciences
Existence of Lipschitz Continuous Maps onto Flap Spaces

A metric space is a collection of objects together with a notion of distance between these objects. Functions between metric spaces which only distort the distance between any two given points by at most a multiplicative factor can be shown to preserve many other geometric properties of the spaces, including notions of dimension, topology, and 'flatness'. Recently, metric spaces have been discovered which exhibit these invariants of euclidean space, yet any function between the spaces must necessarily distort distances beyond a multiplicative constant. The purpose of this project is to investigate the existence of a weaker relationship between euclidean space and metric spaces satisfying these invariants. We begin by introducing a method by which new metric spaces may be generated from euclidean space by attaching discs to the plane. The metric spaces resulting from this process are called flap spaces. We then continue to explain the existence of Lipschitz surjections onto flap spaces in special cases.

Annie Holland: History & Philosophy
Mentor: Molly Todd -- History & Philosophy
The Evolving Identity of the Salvadoran Woman: A Narrative of Strength, Survival, and Feminism

Salvadoran women were directly involved in political action leading up to the civil war which plagued El Salvador from 1979 until 1992. Grassroots women's movements claimed the streets of El Salvador as their battleground; women hosted marches, sit-ins, hunger strikes, and public speeches to condemn the atrocities committed by the Salvadoran government. The dawn of civil war and high numbers of male fatalities forced the opposition guerrilla movement, Farabundo Martí National Liberation Front to enlist women into various roles. The FMLN promised liberty and equality for women within the movement and in the aftermath of war. However, postwar statistics indicate feminicide and domestic violence are rising yearly in El Salvador. This research project reveals the nuance and complexity of the lives of Salvadoran women in the prewar, wartime, and postwar periods and the failure of the Salvadoran government to protect its female citizens. The high level of violence and murder of women in the postwar years leads to the core question of this research: what did the Salvadoran civil war achieve for women?

Zane Huttinga: Mathematical Sciences
Mentor: Tomas Gedeon, Bree Cummins -- Mathematical Sciences
Global Dynamics of Extensions of Switching Models for Biological Systems

I present results related to a certain class of models called switching systems. For the past several decades these models have often been used to study biological systems. Part of my work involves placing a bound on the size of the parameter space of these models. This is an important result in regard to computation of the coarse global dynamics of switching systems, a key part of my mentors' research. In addition, I present results on a modification to the switching system. We seek such modifications because the switching model is incapable of accounting for the actions of all biochemicals in a given system; in particular, the model can represent proteins or mRNA but not both. Since fall 2015 I have studied an extension of this model which includes linear variables representing intermediaries between those of the switching system. This allows the extension to model both proteins and mRNA. I have proved many key results for this extension, in particular that my mentors' current methods for computing the switching system's coarse global dynamics carry over directly to the extension. In addition, the extension in general exhibits additional dynamic behavior not seen in the switching system.

Nathan Hyatt: Physics
Mentor: Dave Klumpar -- Physics
Spatial Scale and Energy Characterization of Electron Microbursts

The FIREBIRD mission involves two small satellites called cubeSats which detect energetic electrons that are ejected into the atmosphere from the layer of energized particles, held by the earth's magnetic field, known as the Van Allen radiation belt. (FIREBIRD is an acronym for Focused Investigations of Relativistic Electron Burst Intensity, Range, and Dynamics). Electrons are ejected from the sun during periods of high activity, and can be trapped in the earth's magnetic field, but regions of electrons precipitating into the atmosphere, called electron microbursts, have been theorized to be originating in these trapped regions. The FIREBIRD mission aims to gather data about the electrons energies and locations of precipitation to understand the cause of this phenomena. Characterization of the regional size and energies of electron precipitation, in conjunction with data from missions investigating potential causes, can provide insight into how these electron microbursts are produced. This phenomenon directly concerns any space science application, and many more scientific fields, because electron microburst can be hazardous to spacecraft and electrical systems on earth. Working on a complex interdisciplinary project such as FIREBIRD requires a lot of collaboration between team members. This presentation will be designed to educate all members of the team on the physics involved in making a detection, and to explain possible causes of electron microbursts.

Micah Johnson: Physics
Mentor: Charles Kankelborg -- Physics
Optical Alignment of ESIS and MOSES

The Extreme-Ultraviolet Snapshot Imaging Spectrograph (ESIS) is a new instrument to be carried on a sounding rocket to collect spectral solar data in August of 2018. In the summer of 2016, I developed, tested, and confirmed methods essential to the optical alignment of the ESIS instrument. The ESIS instrument works by imaging the first order of the incoming light. This is accomplished using extreme ultraviolet (EUV) diffraction gratings. I worked with the ESIS team to develop an instrument for the alignment of the EUV diffraction gratings. The EUV gratings cannot be aligned using EUV unfortunately due to absorption of the light in air. Instead, the alignment must be transferred from gratings specified to work in visible light (VIS) to the EUV gratings. If the EUV gratings are put in the exact same place as the aligned VIS gratings, we will be able to detect the solar spectrum of interest. My research was directed towards developing a technique for defining how in space a surface was oriented in order to verify the EUV gratings are in the same place as the VIS gratings, and therefore will be aligned. Of the systems tested, confocal microscopy, an optical technique that involves curve fitting the intensity response of light reflected off a surface, like the grating's surface, was found to meet the required specifications. Various confocal microscopy systems were tested, and eventually I built a system that allows precision to .00015 inches with 98% confidence. The fabrication of the instrument, further testing, and actual alignment of ESIS will continue into the summer of 2017.

Kevin Jones: Ecology
Mentor: Chris Organ -- Earth Sciences
The Evolution of Human Pregnancy

Humans have a greater risk of complications and death during childbirth than any other primate. The obstetrical dilemma is a hypothesis that attempts to explain this fact. It suggests that human gestation time is shortened compared with other primate species due to a constraint between the size of the maternal pelvis and the fetus' head. This hypothesis implies that humans are exceptional among primates because humans are born early -- a consequence of our large brains and bipedal posture. Previous studies supporting this hypothesis have not considered human reproductive traits within the comparative framework of primate biology and evolution. To address this hypothesis, we are collecting reproductive trait data (gestation length, adult and neonate body mass, etc.) in 100 primate species. We are applying phylogenetic generalized least squares models to analyze how these traits evolve. We expect that the results will clarify how the obstetrical dilemma has or has not shaped human evolution.

Zoie Kaupish, Caleb Stair: Microbiology & Immunology
Mentor: Deborah Keil, Jean Pfau -- Microbiology & Immunology
Arizona Amphibole Asbestos Induces Autoimmunity and Fibrosis in Mice

Asbestos is a well-known carcinogen that contributes to autoimmunity and other health consequences. Libby Amphibole (LA) asbestos was a contaminant of vermiculite mined near Libby MT for decades, leading to asbestos diseases not only in mine workers, but in the entire community. Amphibole asbestos fibers in Arizona (AzA) have recently been discovered, but their health impact is unknown. The goal of this study was to determine whether these environmental fibers induce autoimmune and fibrotic responses at a very low dosage. Seven months after exposure, blood, urine and lungs were collected from mice. Serum was used to determine autoantibody (ANA) levels and T helper cytokine responses. Urine was used to measure protein excretion, suggesting kidney involvement. Results revealed ANA levels were statistically significant with positive results with AzA. Also, all three Th-17 cytokines were shown to have increased levels in treated mice that were statistically significant above controls. Urine analysis indicated significant amounts of excreted proteins by treated mice. Using the right lungs, a Total Collagen Assay was performed to determine the presence of fibrosis. The results determined a statistically significant increase in treated mice. Therefore, our results show that the AzA poses a serious health risk, even in small doses.

Acknowledgements: Caleb Stair (MSU Undergrad Student) - Microbiology & Immunology, Zoie Kaupish (MSU Undergrad Student)

Courtney Kellogg: Political Science
Mentor: David Parker -- Political Science
Parliamentary Perceptions: Constituency impressions of allowance allocation

This research aims to understand the relationship between Members of Parliament and their constituents. Using Richard Fenno's theory of home styles as a foundation for the study, we looked for a significant relationship between how a Member of Parliament allocates his or her resources in order to build a specific home style and if that home style is being perceived by the constituents. The home style that was focused on in this study was the constituent servant. Previous research has shown that by visiting the district, spending time on casework, and meeting with constituents, a perception is built among constituents that their representative works for the constituents and embodies their beliefs and values (Fenno 1978; Cain, Ferejohn, and Fiorina 1987). The Independent Parliamentary Authority and the 2015 British Election Study were utilized to understand the expenditures of Members of Parliament and the perceptions of constituents have of their members. We specifically focus on the costs associated with holding surgeries and the positive relation with the reputation of being a constituent servant.

Ashley Kerkaert: Psychology
Mentor: Ian Handley -- Psychology
Gender Bias in STEM

There is growing evidence for gender bias in science, technology, engineering, and mathematics (STEM) fields that disfavors women. For example, women are disproportionally underrepresented as invited speakers at conferences, and their work is generally cited less often than comparably productive male scholars. Even more, Handley et al. (2015) discovered there was actually a gender bias in the way individuals evaluated the scientific evidence that demonstrates gender bias in STEM. In one experiment, for example, men evaluated research abstracts containing evidence for gender bias in STEM less favorably than did women, whereas the opposite evaluations occurred for abstracts containing evidence for no gender bias. Handley et al. offered 2 likely reasons for their effects. First, it is possible that men view evidence of a gender-bias that benefits men less favorably than women because admitting to this privilege would pose a risk of losing such privilege. This idea fits well with social identity theory, which suggests that group status contributes to self-esteem. Thus, strengthening a person's self-esteem prior to receiving such threatening information might reduce this defensiveness, and thus reduce the bias. Another possible explanation regards expectations; quite simply, people like information that fits with their expectations. Assuming women expect research to find a gender bias, whereas men might not, women might evaluate evidence showing this bias more favorably, and men might evaluate evidence that does not show a gender bias more favorably. The current research directly tests these possibilities, and the design, results, and conclusions from this research are detailed.

Trisheena Kills Pretty Enemy: Microbiology & Immunology
Mentor: Seth Walk -- Microbiology & Immunology
Molecular Epidemiology of Clostridium difficile infection

Clostridium difficile is the most commonly acquired nosocomial pathogen in the United States. Of all patients on antibiotics, 10-25% will develop *C. difficile* infection (CDI) and some of these may develop a severe complication, known as pseudomembranous colitis. The overall goal of this project was to understand *C. difficile* epidemiology at the Bozeman Deaconess Hospital (BDH). Prompt detection of pathogenic strains with molecular biology techniques can aid in the rapid intervention of CDI cases. In this project, we were given de-identified specimens (stool samples) from patients who were suspected to have CDI. Specimens were plated onto selective media and presumptive single colonies of *C. difficile* were isolated. I verified through PCR that isolates were indeed *C. difficile* and that they carried genes encoding for at least one of the *C. difficile* toxins, TcdA and TcdB. I also helped differentiate between strains using PCR ribotyping, which is a general genotyping method for *C. difficile*. However, the presence/absence of toxin genes and PCR ribotyping are not highly discriminant methods to differentiate between strains. To do so, I used a technique called multi-locus variable-number tandem-repeat analysis (MLVA) to detect sub-groups within individual PCR ribotypes. Due to inconsistent results with MLVA, we then used a technique called High Resolution Melt Curve Analysis (HRMCA) to differentiate between strains. A fluorescent dsDNA dye, called SYBER green, was included in the initial PCR and was detected when released from the melting DNA. Using HRMCA, we could quickly and accurately discriminate between strains of the same PCR ribotype.

Seth Koller: Physics
Mentor: Alan Craig
Optical Trapping: Techniques and Applications

Optical traps are important tools for studies in many fields including biophysics, medicine, chemistry, and more. This study explains the physics of optical trapping, designs and design constraints, specific applications of optical traps, and potential for new implementations. Once the phenomenon is understood, it will be straightforward to visualize the various possible designs depending on the intended use for the trap. There are many different ways in which an optical trap can be built and used; one example that will be discussed thoroughly is bioanalysis using optical traps, which allows for the comparison of genetically identical cells. With invention comes the potential for innovation and improvement, especially as technology progresses; therefore, the study will be finalized with a brief discussion of the future of optical traps.

Amanda Kotila: Physics
Mentor: Joe Shaw-- Electrical & Computer Engineering, Physics
Testing of Dome-Style Infrared Cloud Imager

This study details the comparison of data from the recently-completed dome-style infrared cloud imager (dome ICI) with data from the traditional infrared cloud imagers (ICIs.) The dome ICI can view the entire sky horizon with one camera that views the sky as reflected off of a metal dome, as opposed to traditional ICIs which use a fisheye lens to view the sky horizon. This greatly reduces ICI costs; the single camera mounted to the dome ICI can be 1/10 the cost of a fisheye lens, while being better weatherproofed for continuous imaging, and post-collection data processing can be done straightforwardly using Matlab software. A direct comparison of images acquired by the dome ICI and the traditional infrared cloud images shows qualitative agreement between images collected by the two instruments. Due to its affordable camera, straightforward setup, and low maintenance costs, it will be a useful tool at all levels of imaging research.

Natali Kragh: Earth Sciences
Mentor: Jean Dixon -- Earth Sciences
Examining Isotope Scavenging Efficiency of Various Wet Depositional Processes in the Rocky Mountains

In the study of geomorphology, it is critical to understand how sediment moves and deposits within a landscape. The transfer of mass can speak volumes about landscape formation and degradation over time, along with the agents of change driving that movement. Some of the most effective tracers used to record these transfers are radiogenic isotopes delivered to earth's surface by precipitation. These nuclides include naturally occurring Be-7, meteoric Be-10, Pb-210, as well as Cs-137, a by-product of nuclear testing. These isotopes are all delivered to earth's surfaces via wet and dry deposition (i.e. rainfall/snow and dust.) However, few studies have been conducted concerning which types of precipitation are most efficient at scavenging these isotopes and bringing them to surface. Previous studies have also not addressed how proportionate isotope delivery is against precipitation amounts. Since September 2016, precipitation samples have been collected, filtered with a cation exchange resin, and analyzed in a germanium crystal gamma spectrometer to identify isotopic signatures. Testing the ratios of Pb-210 in varying precipitation types has given an insight into the scavenging efficiency for fallout nuclides in wet deposition processes. These results will give future insight to current erosion and deposition regimes, and be potentially applicable to future studies concerning paleoclimate and erosion in the Rocky Mountains.

Alexander Krenzler: Physics
Mentor: Dana Longcope -- Physics
Measuring Magnetic Reconnection using X-Ray and EUV Images

A great deal has been learned about the many phenomena driven by the Sun, but one that has remained an enigma is that of magnetic reconnection, the physical process in highly conducting plasmas in which the magnetic fields are rearranged and magnetic energy is converted to kinetic energy, thermal energy, and particle acceleration. It is known qualitatively that magnetic reconnection is fundamental in the formation of coronal loops and the production of solar flares, but much of the quantitative side is unclear. In this research, X-Ray and extreme ultraviolet images are obtained from regions identified to contain examples of magnetic reconnection. From these images, a series of cutouts to zoom in on the active emergence in each image are made. From these cutouts, coronal loops that display magnetic reconnection are identified, and quantitative values of magnetic flux transfer are obtained using an existing modelling code for coronal loops. The modelling parameters include the coronal densities of the loops and voltage drops from the original region to the newly emerged one. These values for voltage are quite large and are around 109 V. Using this knowledge, it should be possible to determine rate and strength of future solar eruptions.

Ian LaCroix: Chemistry & Biochemistry
Mentor: Tomas Gedeon -- Mathematical Sciences
Real Time Metabolomics and Applied Dynamics

Metabolite Extraction Chip Mass Spectrometry (MEC-MS) is an emerging technique that allows near real-time monitoring of complex fluids. Here, we show that MEC-MS can be used to monitor the metabolism of an E. coli culture grown in a chemostat bioreactor. Periodic samples of live E. coli cells were automatically pulsed through the MEC-MS, over the course of twenty-four hours. The significance of the data produced by MEC-MS was that; it provided a continuous description of how the metabolic profile of E. coli changed during the sample period. This type of data has previously lacked in metabolomics studies. We used the data to develop a continuous model of differential equations, with the goal to explain the dynamics of metabolism in E. coli. The next step will include; using MEC-MS to monitor E. coli under oxidative stress conditions, and then to analyze the metabolic dynamics. With an aim to detect biomarkers of oxidative stress in a predictive fashion. Future work will include; application of this methodology to the analysis of human biofluids in order to detect novel biomarkers of disease.

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Gabrielle Law: Chemistry & Biochemistry
Mentor: Matthew Taylor -- Microbiology & Immunology
Assessing evolutionary pressure on Herpes Simplex Virus Type 1 genomes during infection and spread

This project will quantify evolutionary pressure, through mutation and selection, of herpes simplex virus type 1 (HSV-1) during replication and spread. HSV-1 infection involves replication and spread in neurons, in part contributing to HSV-1 as the leading cause of viral encephalitis in developed countries. HSV-1 is a dsDNA virus with an accordingly low point mutation rate. Yet a high level of viral genome diversity has been observed across populations. Viral diversity is produced through the combined effects of evolutionary pressure and selection on HSV-1 genomes. We are establishing methods to quantify viral population diversity and the effects of evolutionary pressure on HSV-1 genomes. We quantified inter-viral genomic recombination using a marker transfer assay to understand the impact of selection pressures, such as neuron replication, on viral diversity. The marker transfer assay utilized two unique, comparably fit viral isolates with genetically distant fluorescent protein expressing cassettes to co-infect cells. We scored viral progeny as either parent or recombinant based on marker expression as a percentile of the population. We adapted the marker transfer assay for both in vitro and in vivo HSV-1 infections. We utilized the HSV murine eye model to quantify the effect of spread and replication in neurons on viral populations. Understanding how HSV responds to antiviral selections during replication and spread will enhance current treatment for herpes infection and provide insight for vaccine developments.

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Savanah Leidholt: Ecology
Mentor: Sara Waller -- History & Philosophy
What Does the Fox Say? A Comparison of Rural and Urban Red Fox Vocalizations

The Red Fox (Vulpes vulpes) has the widest geographical range of any carnivore in the world; it can be found in much of the Northern Hemisphere and Australia. The Red Fox is a generalist predator that can live in a very wide range of habitats from deserts, arctic tundra, grasslands, and urban environments. Fox populations in urban areas are typically high. The average density of urban foxes is 2-12 adults/km2 (whereas rural fox populations tend to be 0.2-2.7 adult foxes/km2. With this information in mind, my goal was to compare fox communication patterns in rural and urban areas. A review of the scientific literature on fox vocalizations reveals that most studies focus on long range communication, vocalizations selected for tameness or aggressiveness, and ontogeny of vocalizations. Few studies have been done on how red fox vocalizations are affected by urban environments. Thus less is known about the topic. Using the RAVEN interactive sound analysis software, fox calls were collected over a four-month period around known fox locations. From this data, I was able to find what time of day the foxes were more likely to call and compare the types of calls heard at each site. Fox locations were carefully chosen to represent rural and urban areas. One location was close to Montana State University with high traffic and many new developments. The other site was located several miles away from town in a farming community. I recorded some calls given off at each site and identified the types of calls made on a day to day basis. As urban areas are denser and foxes are territorial, it is predicted that a greater population of foxes in a smaller area will decrease the amount and diversity of calls made likewise foxes in rural areas will be more vocal.

Oscar Machado: Cell Biology & Neuroscience
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
Determining the Place of Aqp3b in Noncanonical Wnt Signaling

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 aquaporin3b (aqp3b) prevents convergent extension of the mesoderm and that aqp3b acts through noncanonical Wnt signaling. Wnt signaling is a key signaling 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/Ca2+ pathway and that it acts upstream of the cytoplasmic Wnt signaling pathway member Disheveled (Dsh). The Frizzled7 (fzd7) membrane receptor is part of the noncanonical Wnt/Ca2+ pathway and also acts upstream of Disheveled (Dsh). I will test, whether in this signaling cascade, aqp3b acts upstream or downstream of fzd7. Thus, I will test whether fzd7 activates aqp3b, if aqp3b activates Fzd7, or if aqp3b is bypassed and fzd7 activates disheveled. When fzd7 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 + fzd7, or PKC-GFP + fzd7 +aqp3bMO (morpholino oligonucleotide, which inhibits aqp3b) into two-cell Xenopus embryos and examine under a fluorescence microscope whether the PKC is bound to the membrane (active Wnt signaling: PKC + fzd7 injection or if aqp3b acts upstream of fzd7) or remains in the cytoplasm (no Wnt signaling: PKC injected alone or if aqp3b acts downstream of fzd7). With this procedure the place of aqp3b within the Wnt/Ca2+ signaling pathway will be determined.

Devin McGlamery: Chemistry & Biochemistry
Mentor: Devin McGlamery -- Chemistry & Biochemistry
A Divergent Synthesis of Spongistatin

Since the dawn of organic chemistry, natural products have long been coveted for their remarkable complexity as well as unmatched bio-activities. Spongistatin is one such natural product possessing activity against human melanoma with a GI50 value of just 25 pM. In addition to medicinal potential, spongistatin is an intriguing synthetic puzzle, containing a multitude of intricate stereocenters as well as two spiroketal subunits that join the A,B and C,D ring systems forming the spitoketal moiety's of the molecule. Spongistatin's two spiroketals exist as two stereoisomers, the axial-axial (A,B) and the axial-equatorial (C,D). The axial-axial spiroketal is favored due to stabilization via the double anomeric effect, whereupon the ring system is stabilized by lengthening of the C-O bond by $n \rightarrow \sigma^*$ donation. However due to poor orbital overlap the axial-equatorial stereoisomer does not benefit from double stabilization. The Cook group has developed a divergent synthesis of highly substituted spiroketals via an ortholactone allylsilane fragment coupling reaction which proceeds through a Sakauri type mechanism. To make this more applicable to spongistatin we aim to develop methodology around less rigid frameworks (scheme 1). We have so far focused on the synthesis of cyclic ortholactones from the C4 unsubstituted dihydropyran, via an oxidative catalytic nucleopalladation reaction. Regretfully the cyclic nature of the molecule provides an increase in stability that prevents the operation of the previously developed spiroketalization conditions (scheme 1). To combat this, recent work has focused on generation of methoxy or ethoxy substituted ortholactones, in order to generate the C4 unsubstituted spiroketals (scheme 2).

Meridith Miska, Erin Shervey: Earth Sciences
Mentor: David Mogk, Dean Adams, Josh DeWeese -- Earth Sciences, Art
Clay Identification using X-Ray Diffraction and Scanning Electron Microscope in "Wild Clay Project"

In an initiative with the International Wild Clay Research Project (IWCRP), the MSU Art Department and Earth Science Department are collaborating to apply mineralogical studies to native clays of Montana and Minnesota. Bulk mineralogical analysis was done through X-ray Powder Diffraction (XRD) and scanning electron microscope (SEM) techniques. Analysis of oriented clay mounts created using USGS guidelines found that the primary clay in the samples was illite. The minerals associated with this group included muscovite, biotite, microcline, anorthite, and albite. Quartz was found throughout most of the 14 samples. In addition to spot analyses, the SEM was used to analyze fired and glazed clay disks to determine the depth of glaze penetration and compositional or structural changes to the clays after being baked. The results of this study will be applied to the ongoing research done for the IWCRP as well as being applied directly to ceramics classes at Montana State University. The IWCRP hopes to encourage the use of local clay and to advance sustainable practices in ceramic arts. The data collected with this project will be used to serve as a foundation for a database about wild clays. The information in this database will allow artists to find a clay that is local, sustainable, and suitable for their ceramics. Further collaboration for the project is expected in the future, with the possibility of joint field trips between art and earth science students to study the places where these clays have been harvested.

Eric Mitchell: Physics
Mentor: Zeb Barber -- Physics
Turbulence Characterization via Coherent LIDAR Techniques

The purpose of this research is to use coherent Frequency Modulated Continuous Wave (FMCW) light detection and ranging (LIDAR) for the characterization of turbulence in the atmosphere. This application allows for sensitive measurements of the wave front fluctuations induced by turbulence. The high sensitivity of this method, allows for data collection for sampling distances ranging from 50-100 meters. From this extended data range, the relative turbulence strength between the target and the detector could be determined by implementation of the Kolmogorov's theory of turbulence. The relative turbulence strength values range from $3x10^{-17}$ - $3x10^{-13}$ $m^{-2/3}$ depending on altitude. This is a proof of concept demonstration and has applications in long range coherent imaging including synthetic aperture lidar (SAL).

Pete Mitchell: Chemistry & Biochemistry
Mentor: Mark Quinn, Igor Schepetkin, Liliya Kirpotina -- Microbiology & Immunology
Regulating T-cell Responses: Screening and Characterization of Possible Kinase Inhibitors in Ex vivo/In vitro Models

Protein phosphorylation is a key component of T-Cell Receptor (TCR) signaling pathways. Upon activation of a TCR, protein kinases, such as Lck, phosphorylate proteins downstream of the cascade, which results in recruitment of scaffold and adaptor proteins. Transcription factors are modulated following this cascade, which may lead to proliferation and production of cytokines as part of an immune response to the activation of TCR mediated signal transduction. However, when the transcriptional regulation goes awry in lymphocytes, immune dysfunction can occur. Over- or auto-reactive lymphocytes resulting from intracellular pathway disruptions can lead to disorders, such as chronic inflammation, diabetes, and cancer. One approach to manage immune dysfunction is by targeting the deregulated activation of protein kinases and their cascades. The objective of this project is to screen selected sesquiterpene lactones (SLs) for anti-proliferative activity and low cytotoxic effects, followed by characterizing of any affected protein kinases in murine and human models. Cells were pre-treated with a compound for 20 minutes, activated with anti-CD3/CD28, and then T-cell proliferative assays or ELISA were employed. From our experimentation, Erk1/2 was shown to have dose-dependent phosphorylation and was used to gauge other SLs for Erk1/2 selectivity. Additionally, the mechanism of the Erk1/2-SL interaction (estafiatine) was investigated. The data are still preliminary and more experiments are needed to draw conclusions, in particular to the mechanism.

Jonathan Murtaugh: Physics
Mentor: John Sample -- Physics
The Light and Fast Terrestrial Gamma Ray Recorder

Terrestrial Gamma-ray Flashes (TGFs) are sub millisecond bursts of radiation from lightning flashes. The accelerated electrons in a lightning strike produce gamma-rays with energies up to tens of MeV, which are potentially harmful to aircrafts and flight crews. The Light and Fast TGF Recorder (LAFTR) is a device flown on a high-altitude weather balloon that will be able to provide data that will be used to reconcile competing TGF formation models through its unprecedented ability to count a high number of photons per event. In particular, LAFTR will reconcile the relativistic feedback and lightning leader tip formation models of TGFs. LAFTR will also be able to acquire data that will be able to confirm theoretical TGF distributions in inland North America, which currently predicts that TGFs should be relatively scarce in Montana. The competing formation models and LAFTR's ability to reconcile the competing models will be outlined.

Michelle Narayan: Cell Biology & Neuroscience
Mentor: Michael Franklin -- Microbiology & Immunology
Characterization of Pseudomonas aeruginosa Antibiotic Resistance to Polymyxin

Polymyxin B is a cationic peptide antibiotic that has efficacy at killing the opportunistic pathogen, Pseudomonas aeruginosa. However, the efficacy of polymyxin B is reduced at high calcium concentrations, which are characteristic of in vivo environments. The goal of this study is to identify P. aeruginosa genes that impart calcium-dependent polymyxin B resistance. In previous research, a series of P. aeruginosa mutant strains was obtained that had increased sensitivity to polymyxin B when cultured at high calcium concentration. Some of the mutants have been complemented with P. aeruginosa DNA that restores polymyxin B sensitivity, and these genes have been sequenced. Sequence analysis has shown that the genes that effect resistance are ones that have not yet been identified previously, and unexpectedly are not related to lipopolysaccharide modification, as been shown in other research. In this project, I used a microtiter plate assay and antibiotic disk diffusion assays to determine the minimum inhibitory concentration (MIC) of the wild-type strain, the mutant strains, and the complemented strains, at low and high calcium concentrations. Unlike prior results using e-strip diffusion assays, the MIC results do not show a significant difference between the strains cultured differing calcium concentration. In future studies, I will modify the MIC methodology and perform e-strip analysis to determine if the difference observed here from prior studies are a result of differing methodologies for determining MICs.

Robert Nerem: Physics
Mentor: Rufus Cone -- Physics
Development of Low-Cost Scanning Fabry-Perot Interferometers to Characterize High-resolution Laser Systems

Scanning Fabry-Perot Interferometers (SFPI's) are a very useful tool for characterizing high-resolution laser systems. SFPI's use optical interference effects to probe the frequency spectrum of the laser light, requiring special components that are specific to the wavelength (color) of the laser. Consequently, it is necessary to have multiple SFPI's to characterize the wide variety of lasers used in an optical spectroscopy research lab; this can be prohibitively expensive if one uses standard commercially available SFPI's. With this motivation, we investigated a low-cost modular design using standard optical components to span the entire visible and near-infrared spectrum. An initial SFPI was built and tested for use with a new tunable external cavity diode laser system operating at a wavelength of 690 nm for the study of Cr3+ ions in ruby and alexandrite optical crystals. Our new SFPI enabled the diode laser system to be evaluated and optimized by observing the effects of the laser cavity alignment and tuning on the laser's frequency spectrum revealed by the SFPI. The performance and properties of our prototype SFPI have led to optimization of the design and construction. The finesse (spectral resolution) and frequency stability of the SFPI compares favorably to the performance of more expensive commercial interferometers. Additionally, the effects of environmental acoustic noise on the SFPI were studied, demonstrating that the cavity design is robust and stable. Guided by our results on this system, we are currently constructing several additional SFPI's at wavelengths of 405 nm and 980 nm for use with other new laser systems in the laboratory.

Kyle Olson: Physics
Mentor: Rufus Cone, Charles Thiel -- Physics
Non-radiative relaxation of rare-earth ions through coupling to hydrogen and deuterium impurities in crystals

Thulium-doped lithium niobate is a leading candidate for implementation of quantum information and signal processing systems. The wide absorption profile and exceptionally large oscillator strength are ideal for high-bandwidth and frequency-multiplexed applications. In many of these applications, optical waveguides allow chip-scale integration of optical elements. A popular method for fabricating waveguides in LiNbO3 is to diffuse hydrogen into the crystal; however, hydrogen can affect the optical properties of other ions, such as thulium, leading to unwanted non-radiative relaxation and heating effects. To determine the effect of hydrogen impurities on thulium-doped LiNbO3 crystals, we in-diffused thulium ions into the surface of LiNbO3 wafers and studied the fluorescence of the 3H4 - 3H6 Tm3+ transition for varying concentrations of hydrogen. Controlled amounts of hydrogen were added to the LiNbO3 wafers using proton exchange methods and the change in the thulium fluorescence lifetime was measured using pulsed laser excitation. Results suggest a very strong short-range interaction between thulium and hydrogen, causing rapid non-radiative relaxation for thulium near hydrogen and a reduction in lifetime by orders of magnitude. In contrast, there is no observable effect on thulium that is further from the hydrogen. Consequently, while increasing hydrogen levels reduces the fraction of thulium with long lifetimes needed for quantum and classical signal processing, the lifetimes of the remaining unaffected ions are still suitable for these applications. Results suggest that the fabrication of waveguides in thulium-doped LiNbO3 by proton exchange methods may be a viable approach for quantum and classical information applications over some ranges of hydrogen concentrations.

Acknowledgements: Aaron Marsh (MSU Graduate Student) - Physics, Tino Woodburn (MSU Graduate Student) - Physics

Rita Park: Microbiology & Immunology
Mentor: Margaux Mesle, Adrienne Phillips, Matthew Fields -- Center for Biofilm Engineering
Effect of coal particle size on microbial methanogenesis in the presence of oxygen

This project is a sub-experiment within the DOE-funded Microbially Enhanced Coal Bed Methane (MECBM) project, which studies methanogenesis in shallow coal beds of the Powder River Basin (PRB) located in southwestern Montana. The proposed research will observe the effects of coal particle size on: (1) methane production yield, (2) microbial diversity, (3) dissolved oxygen (DO) concentration in the coal bed methane (CBM) water, and (4) bioavailability of organics from the coal. Microbial CBM has a strong potential as an energy resource worldwide, but the exploitation of production wells with oxygenated surface waters may impact in situ microbial diversity and thus the methanogenic potential of coal beds. This experiment will provide further information on the oxygen-scavenging capacity of coal particles in CBM water, and subsequent impact on the anaerobic microbial methanogenesis. Cultures containing coal and CBM water from the PRB coal beds will be set up in triplicate glass bottles sealed with a rubber septum to allow for regular sampling. Coal of 2 particle sizes will be obtained with sieves: small ($0.075 < 0 < 0.85$ mm) and large ($18.3 < 0 < 28.3$ mm). These cultures will be treated with a methane-producing inoculum from a PRB coal bed; coal degradation and methane production will be monitored over time. This experiment will evaluate methanogenesis rates as a function of coal particle size and of subsequent DO levels in the CBM water. Results will provide a better understanding of the subsurface energy potential of MECBM.

Brenden Pelkie: Earth Sciences
Mentor: Edward Adams -- Civil Engineering
Validation of a capacitance probe for use in detecting solid-liquid phase change of water in a snowpack

A method for measuring the liquid water content of a snow sample is important to research of snow melt mechanisms and has implications for avalanche and water supply forecasting. Currently, there is no reliable and easily applicable method to measure the presence of liquid water in a snow sample. This project tests the hypothesis that the presence of liquid water in a snow sample has a larger influence on the sample's capacitance than other factors. Other main factors that influence the capacitance of snow are temperature, density, and grain structure. This project uses a capacitance probe manufactured by Capacitec. The probe measures the dielectric properties of a small section of snow within a sample, representative of several grains. Preliminary results show that the probe does detect the appearance of liquid water in a sample. This is seen as a sharp drop in probe values when snow melts, at 0°C. Results from this project will be used in the design and implementation of a sensor array, which will be used to study melt-freeze fronts in a snow sample.

Cailey Philmon: Ecology
Mentor: Lindsey Albertson -- Ecology
Establishing a Model Relating Non-Destructive Measurements of Growth to Biomass

Calculating aquatic macroinvertebrate biomass and growth rate is essential to understanding a multitude of ecological questions. Non-destructive methods of measuring growth are needed for long-term and continuous measurements. We compared three standard methods for quantifying organismal growth in order to determine the quantitative relationship between volumetric displacement (VD), body length, and ash-free dry mass (AFDM). AFDM measurements, although the most precise measurement of body size, require killing the organism, whereas VD and body length can be used with live organisms, and continuous growth rates for each individual could be calculated. 45 Salmonfly larva (Pteronarcys californica) were collected at three sites along the Gallatin River in southwestern Montana. Through direct measurements, statistical calculations, and by establishing a model relating non-destructive measurements of growth to biomass, future studies will be able to accurately record growth of the same individual over time, rather than reducing population numbers and diversity.

Acknowledgements: Heidi Anderson (MSU Graduate Student) - Ecology

Mark Poston: Mathematical Sciences
Mentor: Ryan Grady -- Mathematical Sciences
Zeta Functions and the Prime Number Theorem on Dynatomic Curves

This project uses zeta functions, functions that describe the behavior of different systems that involve counting things, to determine an analog of the Prime Number Theorem (PNT) for dynatomic curves. Specifically, the properties of the particular zeta function related to dynatomic curves. The Riemann Zeta function describes the behavior of prime numbers. The properties of this zeta function are used heavily in the proof of the PNT, the same is true for this setting. Since the zeta function associated with dynatomic curves has not been studied nearly as much as many other zeta functions, this project required making some calculations with this zeta function. Using the results, important properties of the zeta function were determined. An analog of the PNT will be formulated with the proof coming from the previously derived properties of the zeta function.

Caitlyn Richter: Political Science
Mentor: David Parker -- Political Science
Mixed Member Electoral Systems, Holding Government to Account, and Representational Styles in the Scottish Parliament

We tackle the question of the effectiveness of ministers' questions and the role institutional structures play in how members chose to utilize them to hold government to account and craft a representational style. We qualitatively and quantitatively analyze written questions for the geographic region of concern (national or local), the topic of concern, and the tone in which the question or motions are stated. Written and oral questions represent a different level of commitment on the part of the MSP, as one requires that they be at the parliament in person while the other does not. Leveraging this difference, we can examine whether members pursue different governing and reputational goals with each question type. We also examine whether constituency and regional members pursue different representational strategies with written and oral questions. Finally, we evaluate who holds government to account and assess the effectiveness of their endeavors.

Magdalena Russell: Cell Biology & Neuroscience
Mentor: Frances Lefcort -- Cell Biology & Neuroscience
Therapeutics for rescue of Ikbkap deficient dorsal root ganglia neurons: An In-vitro Approach

The Lefcort lab has developed a mouse model that recapitulates the hallmarks of Familial Dysautonomia by conditionally deleting the IKAP protein from neural crest cells, which gives rise to the neurons and glial cells of the peripheral nervous system, via the Wnt1-cre driver. The mouse shows significant reductions in neuronal number in the dorsal root, sympathetic, and parasympathetic ganglia. As such, it provides an excellent model system for determining the function of IKAP in embryonic development and for mimicking the Familial Dysautonomia found in humans. This research projects aims to assess the neuroprotective effects of two different drugs, Metformin and the GSK2606414 PERK inhibitor, on the Ikbkap deficient dorsal root ganglia (DRG) neurons within this mouse model. The ultimate goal of this study is to identify and target new cell signalling pathways and their neuroprotective potential as they relate to Familial Dysautonomia. An absolute cure for the disease is improbable due to the widespread devastation it causes. However, determining a mechanism to rescue neuronal death could lead to valuable therapeutic approaches and new rescue strategies that could eventually be used to increase the quality of life and overall lifespan in the mice and, eventually, in humans.

Liam Scott: Chemistry & Biochemistry
Mentor: Brian Bothner -- Chemistry & Biochemistry
Metabalomics Profiles of Ciproflaxacin Treated Staphylococcus aureus and Acinetobacter baumannii Biofilms

Many bacterial organisms have the ability to form complex conglomerations of cells known as biofilms. It is important to understand this stage of bacterial life because it facilitates colonization and persistence in environments not suitable for planktonic cells. For example, biofilm structures grant an inherent resistance to antibiotic agents, a trait that is particularly concerning for infectious bacteria such as Staphylococcus aureus and Acinetobacter baumannii. With bacterial organisms such as these displaying powerful resistance to antibiotics, it is becoming ever more critical to understand biofilm structures, along with the inherent antibiotic resistance that they provide. To begin to understand these structures, many researchers have turned to analysis of the metabolomic profiles of bacterial species, and how those profiles differ between planktonic cells and biofilm conglomerations. In this project, it is proposed that the metabolomic profiles of S. aureus and A. baumannii will differ significantly between not only their free floating and biofilm states, but also in their antibiotic treated biofilm states. As such, I will work to combine an external metabolite analysis conducted using gas chromatography mass spectrometry (GCMS), with an internal metabolite analysis conducted using liquid chromatography mass spectrometry (LCMS), to create metabolomic profiles of each variant of these bacteria listed above. With this data, it will be possible to elucidate the biochemical pathways critical to S. aureus and A. baumannii biofilm antibiotic resistance. On a larger scale, this information will be critical in the pursuit of sensitizing S. aureus and A. baumannii to modern antibiotics.

Acknowledgements: Jackson Toth, Phillip Stewart (MSU Faculty Member) - Chemical & Biological Engineering

Kaitlyn See: Microbiology & Immunology
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
How Aqp3b Influences Convergent Extension Through Noncanonical Wnt Signaling

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

Acknowledgements: Christa Merzdorf (MSU Undergrad Student) - Cell Biology & Neuroscience

Marisa Sewell: Cell Biology & Neuroscience
Mentor: Diane Bimczok -- Microbiology & Immunology
CD103 regulation in human dendritic cells using retinoic acid in the gastric microenvironmnet

CD103 (αE integrin) is an important marker for dendritic cells (DCs) in the human mucosa. Iliev et. al (2016) showed that CD103+ DCs display tolerogenic behavior in the human gut and induce Treg cell development. However, not much is known about the regulation of its expression, though it is widely used as a delineator of DC populations. Previous work in my group shows that retinoic acid (RA) and toll-like receptor agonists contribute to the regulation of CD103 expression in human DCs (Roe et al, 2016). We postulate that CD103 functions to initiate DC binding to gastric epithelium, possibly to E-cadherin, in order to allow for antigen sampling through tight junctions by DC dendrites. Additionally, previous research in this lab has concerned the identification of gastric stromal factors using gastric stroma- conditioned media (SCM), which is a model for the gastric microenvironment. I have shown that gastric stromal factors are responsible for suppressing dendritic cell maturation in Helicobacter pylori infection. We have thus confirmed SCM-derived immunoregulatory factors as a suitable model for generating dendritic cells with a tolerogenic mucosal phenotype. Here, we've confirmed that (RA) induces CD103 expression in peripheral-blood monocyte derived dendritic cells (MoDCs). Additionally, we show that the addition of SCM increases the extracellular expression of CD103 in both RA and non RA treated conditions. Lastly, I show that intracellular concentrations of CD103 in the presence of SCM are lower than extracellular concentrations, whereas CD103 is predominantly located in the cytoplasm in the absence of SCM, indicating that SCM may be a catalyst for initiating redistribution of CD103 to the cell membrane.

Acknowledgements: Mandi Roe (MSU Graduate Student) - Microbiology & Immunology

Veronika Shchepetkina: Cell Biology & Neuroscience
Mentor: Frances Lefcort -- Cell Biology & Neuroscience
Investigation of the nervous system 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 Ikbkap gene, resulting in a decreased amount of the IKAP protein. FD patients experience symptoms such as decreased sensitivity to pain or temperature, dysfunction of the autonomic nervous system, incoordination, hypotonia, various dysfunctions of the organs, and even death. In addition, FD patients experience progressive blindness due to the loss of retinal nerve fiber layer. In order to study the role of IKAP in the retina, we developed the retina-specific Ikbkap conditional knockout (CKO) mouse model. We used this model to quantify retinal ganglion cells in the retinal nerve fiber and found decreased cell numbers in the mutant mouse at different ages. Data from our lab has revealed evidence of CNS deficits in mice with FD, such as behavioral alteration, a reduction in specific neuronal populations, reduction in spinal motor neuron innervation, and alteration in cortical morphology. In order to further investigate the implications of FD on the CNS, we generated another mouse model (Tuba1α) in which Ikbkap is deleted in all neurons. Our data show that both adult and embryonic Tuba1α mice have enlarged lateral ventricles in the brain, a symptom occurring in other degenerative and developmental disorders. We used this mouse model to investigate proprioceptive and nociceptive neurons in the embryonic DRG in order to compare development in the DRG to the brain. Neither population was altered in the mutant mouse, suggesting that these cell types are resilient to the disease during embryogenesis.

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Nathan Sickler: Microbiology & Immunology
Mentor: Jamie Sherman, Hannah Estabrooks -- Plant Sciences & Plant Pathology
Beta-glucans and Anthocyanins in Barley for Human Food

β-glucans and anthocyanins hold nutritional value and are present at relatively high concentrations in barley. Purple, blue, and black barley were tested for the sake of improving beer and feed production. With the use of reagents and spectrophotometry, it was possible to measure the concentrations of each line of barley. Anthocyanin pigments because of antioxidant activity protect from many illnesses, such as cardiovascular disease. β-glucans can assist with human illnesses such as cancer and diabetes. A pH diffusion method was used in order to extract anthocyanins from ground barley. The obvious sign of the presence of anthocyanins was a pink-reddish haze in an acidic solution. β-glucans concentrations were measured in a photometric analyzer. There were significant differences between purple, blue, and black barley concentrations. Results showed increased concentrations of anthocyanins and β-glucans in purple and blue barley where black barley lacked in these nutritional qualities. Quantitative concentrations were compared to qualitative picture scans of each barley line to examine the colors of the seed coat. It was determined that select purple and blue barley had the highest concentrations of anthocyanins and β-glucans. Crossing these lines with low protein lines would introduce the idea of producing beer with added health benefits. Future research would be done to ensure anthocyanin and β-glucan molecules would be present through a malting process.

Taylor Simpson: Ecology
Mentor: Jia Hu -- Ecology
The Effects of Rocky Mountain Juniper Encroachment on Stream Water Availability

Juniper encroachment has been occurring in rangelands across the western United States since the 1800's. This has largely been due to the introduction of livestock and fire suppression that began in the 1800's. A more recent factor in juniper encroachment is of course climate change. Woody plants experience an increase in growth as a result of increased levels of CO2 and juniper is no exception to this. As a result of all of these factors, juniper is widespread in many rangelands and is now encroaching on riparian areas in rangeland streams. Ted Turner has taken a special interest in stream conservation with Turner Enterprises investing significant money into protection, restoration, and conservation of trout streams on his many ranches. Turner Enterprises is concerned that encroaching juniper in the riparian area along streams on the Snowcrest Ranch is having an adverse effect on stream water. There is concern that this will then effect stream and fishery health. This study examined the water source of the rocky mountain juniper using oxygen isotopes to determine if they were in fact using stream water as a primary water source. This was then compared to a natural riparian plant, the willow, a species whose growth the ranch is promoting. This research is still ongoing, but preliminary results from Willow Creek on Snowcrest Ranch did not show that juniper was tapping into stream water as the primary water source and that there was no clear distinction in water use between Rocky Mountain Juniper and Willow.

Kori Smyser: Chemistry & Biochemistry
Mentor: Erik Grumstrup -- Chemistry & Biochemistry
Growth of ZnTe Nanowires for Observation with Femtosecond Pump-Probe Microscopy

In an effort to contribute to the search for alternative fuel sources, we propose to examine the excited state behavior of piezoelectric ZnTe nanowires, which have applications as mechanical energy harvesters. Our initial work has focused on designing a replicable synthesis for chemical vapor deposition (CVD) growth of uniform ZnTe nanowires. With success, we now begin an ultrafast spectroscopic study of the carrier dynamics in ZnTe nanowires.

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Karen Stengel: Cell Biology & Neuroscience
Mentor: Susy Kohout -- Cell Biology & Neuroscience
Characterization and Comparison of Vertebrate Voltage Sensing Phosphatases

The voltage sensing phosphatase (VSP) is a transmembrane protein which regulates the phosphatidylinositol phosphate (PIP) signaling pathway in a voltage dependent manner. The membrane potential is an important signal in normal cellular processes controlling neuronal signaling, muscle contractions, and immune responses while PIPs regulate many different processes in the cell, including membrane trafficking, promoting cell death, and cell growth. When either pathway is compromised, many serious diseases can occur, including autism, epilepsy, and cancer.Interestingly, VSP has been found to be expressed in non-small cell carcinoma and hepatobiliary cancers, suggesting it may also play a role in cancer and could indicate an unexplored role of voltage in cancer cell propagation. The majority of VSP research has focused on the tunicate Ciona intestinalis (sea squirt) species of the protein (Ci-VSP) and very little is known about the vertebrate VSPs. I have been studying the vertebrate VSP species Gallus gallus (chicken, Gg-VSP) and Danio rerio (zebrafish, Dr-VSP) in order to compare the functions of these vertebrate species to Ci-VSP, focusing on the 210 and 212 equivalent sites of Ci-VSP. Dr-VSP has been successfully mutated for voltage clamp fluorometry (VCF) experiments. VCF is a technique that allows us to monitor protein motions through a fluorescent tag on the VSP, all in a live cell. Several of the Dr-VSP mutations have expressed and display voltage-dependent fluorescence changes that vary from the equivalent Ci-VSP mutation suggesting that the different species of VSP do not all function similarly. The rest of the vertebrate species being studied are still being mutated to include labeling sites.

Kevin Surya, Isabelle Brenes: Earth Sciences
Mentor: David Varricchio, Chris Organ -- Earth Sciences
Pelvic Sexual Dimorphism in Modern Birds (Aves: Neornithes) and Its Evolutionary Relationship with Relative Egg Size

Pelvic evolution from non-avian to avian dinosaurs (modern birds) is often assessed biomechanically, with functions ranging from weight-carrying, ventilation, and locomotion/flight. Recently, reproduction has been hypothesized to have constrained and shaped pelvic morphology along this lineage. Opening of the pelvis by separating the pubes is thought to have allowed an increase in relative egg size and changes in the egg shape. Since reproductive ability would be advantageous for females, pelvic dimorphism may have evolved in this group. Pelvic dimorphism and its correlation with reproduction in non-avian reptiles and mammals have been extensively studied, but not in modern birds. We are currently investigating pelvic size dimorphism using a multiple regression on representative species from the major group of modern birds (n=30). This will test if there is a significant difference in pelvis dimensions between sexes after accounting for body size. We will also use phylogenetic regression to test for a correlation between dimorphism and relative egg size. Completion of this study will not only result in a better understanding of how the avian pelvis evolved, but also of how sexual selection modifies skeletal anatomy. It is possible that the outcomes of this research will produce a reliable method for determining the sex of extinct dinosaurs, which has been a major hurdle to paleobiological research.

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Rachel Ulrich: Mathematical Sciences
Mentor: Greenwood Mark -- Mathematical Sciences
Reconstructing suicide vs. elevation datasets and related analyses

Dr. Mark Greenwood has authored a locally published textbook for STAT 217 – an intermediate statistics course offered at MSU – and is interested in incorporating an exploration of data on county suicide rates and a possible connection to elevation. Both elevation and suicide rate information are publicly available, but researchers using these data sets have not published a holistic dataset incorporating the multiple sources from which this information stems. I plan to recreate a dataset focusing on the potential relationship between altitude and suicide rates in the contiguous United States based upon two well-publicized articles. In addition to providing a thought-provoking textbook example, this dataset and exact methods for reconstruction will be submitted to MSU's Scholarworks and made available as a public geospatial dataset on ArcGIS Online, allowing other researchers interested in these data access to an easily analyzed version. A comparison of results will serve as a verification of methods, possibly allowing me to improve upon these methods in future research.

Lazaro Vinola Lopez: Earth Sciences
Mentor: David Varricchio, Ross MacPhee -- Earth Sciences, American Museum of Natural History
Fossil record of the Rock Iguana genus Cyclura (Family: Iguanidae) in Cuba: implications for its systematics, paleoecology, and paleodistribution

The West Indies is one of the areas with highest biodiversity and number of endanger species in our planet. Circumscribed to this area is the genus of Rock Iguanas, Cyclura. For very long time, it has been study to understand dispersion and speciation models that take place on islands. New fossils remains from three Quaternary deposit in western Cuba have shown the presence of an unknown giant species of Cyclura that coexisted with the living specie Cyclura nubila. Morphological comparison with another eight species from the Antilles and histologic comparison between this C. sp. and fossils and modern remain of C. nubila is used to determinate the taxonomic status of the specie. Interspecific competition, extirpation, extinction and response to human modification of both taxa in Cuba, has further implication for the conservation of the other species, most of them under critical status of conservation.

Greer Wagner: Sociology and Anthropology
Mentor: Colter Ellis, Kelly Knight -- Sociology and Anthropology
Vicarious Victimization: An Overview of Prevelance, Predictors, Symptoms and Outcomes

Conversations around vicarious trauma, secondary traumatic stress, burnout, compassion fatigue and/or vicarious victimization have taken place in victim service provider occupations since the 1990s. Overall, the focus has primarily been retroactive and hypothetical in nature, which fails to address how, why, and to what degree these phenomena affect individuals who regularly work with victimized people. Current literature in this area focuses on four key categories: 1) prevalence of the problem, 2) predictors, 3) symptoms and medicalization, and 4) outcomes/interventions. The purpose of examining hundreds of articles in each of these areas was to produce an Oxford bibliography. This document will serve as a comprehensive overview of the research and aid in future researcher's exploration of where innovation is most needed.

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Theodore Warthen: Cell Biology & Neuroscience
Mentor: Christa Merzdorf -- Cell Biology & Neuroscience
Gap junctions in the development of the nervous system

Gap junctions are intercellular ion channels composed of two intermembrane protein complexes called connexons, which are bound together forming an intercellular pore. These pores then allow for passive transport of small molecules and ions. Calcium along with other ions that move through these gap junctions are known to be involved in intercellular communication. We hypothesize that intercellular signaling through gap junctions helps begin, direct, and end developmental processes such as convergent extension in the embryonic stages of gastrulation and neurulation. I have begun to determine at which stages gap junction proteins (connexins) are expressed. To do this cDNA (DNA reverse transcribed from RNA isolated from blastula, gastrula and neurula Xenopus laevis embryos) was used as a template for PCR with primers specific to each connexin. The PCR products were analyzed by gel electrophoresis (the primers had been tested previously and were known to be functional). By using this form of PCR we were able to determine what genes were expressed at what stages. The connexin 46 and connexin 43.4 genes were found to be expressed at stages 18 and 20 (late neurula and early tailbud), while connexin 30 was found to be expressed at stages 12-20 (late gastrula through early tailbud). There were several connexin genes, which were not expressed at the stages that were tested. The next step is to determine the expression patterns of the expressed genes through in situ hybridization of gastrula and neurula Xenopus embryos.

Laura Evans: University Studies
Mentor: William Steidwiser, Laura Evans -- INBRE
How can the Gallatin Valley Lactation Program utilize Department of Family Services home-visit data to analyze breastfeeding rates for at-risk families?

Research was conducted by examining already-existing, deidentified data sets concerning breast feeding data from the Montana Department of Family Services and information from Home Visiting, which is part of Gallatin City County Health Department. The data contained the number of referrals to the Department of Family Services, and information from Home Services. This data was gathered and combined into one data set in order to evaluate the possible correlation between breastfeeding rates and at-risk families. For the purposes of this study at-risk is defined as tobacco users, parents with mental illness, and drug use. The data sets were not publicly available, but were given on request. There are no restrictions on the data sets. This research will provide the basis of a grant proposal needed by the Lactation Education Program. The main focus of this research is to examine the possible correlations between the rates of breastfeeding over six months and the number of children referred to the Department of Family Services. The reason the rates are examined over six months is because it has been shown that the benefits of breastfeeding only show up after this period of time with sustained breastfeeding. Although, the breastfeeding rates of Gallatin County are the highest in Montana, they are not sustained. A meta-literature review was also conducted to gather the major findings concerning breastfeeding rates and the behavior described above that can classify a family as at-risk. Once completed the Lactation Education Program hopes to use the findings to support their grant writing efforts. Their grant will be used to institute programs that will hopefully reduce the number of children referred to the Department of Family Services by increasing the rates of breastfeeding.

Morgan Paolini: Biochemistry (Montana Tech)
Mentor: Katie Hailer -- Chemistry and Geochemistry (Montana Tech)
Analyzing the Effects of Treating Human Lung Cell Tissue with a Low-Level Chronic Metal Mixture

In 1983, Butte, Montana was designated a Superfund site due to the impact of over a century of mining activity. A recent study was conducted analyzing the accumulation of 36 elements in the hair and 11 elements in the blood of Butte residents as opposed to a control population, as well as an analysis of the soil and air of the Butte area. Elevated levels of several metals, including Cu, Mn, and As, were found in the hair, blood, soil, and air. The focus of this study was on the elevated metals in the air, arsenic and manganese. Previous studies have shown that elevated levels of metals, such as Pb, As, and Mn, can evoke serious health effects such as neurodegenerative diseases and cancers. In order to investigate the toxicity of airborne metal ions on Butte residents, this study replicated the environmental exposure of the airborne metals found in the human study, and evaluated the biological response of normal lung cells. To do this, human lung cell tissue (BEAS-2B) was treated with a low-level chronic metal mixture of either $NaAsO_2$, $MnCl_2{\cdot}4H_2O$, or a mixture of the two metals. Following metal exposure, the cell cultures were assessed with XTT cell viability assays measuring cell viability based on mitochondrial respiration and gene array plates measuring genetic changes. The results of these tests are expected to provide preliminary knowledge regarding the health impacts of low-level chronic metal exposure effects on human lung cells.

Sowmya Sudhakar: Mechanical Engineering (Montana Tech)
Mentor: Jack L. Skinner -- Mechanical Engineering (Montana Tech)
Generating Antimicrobial Surfaces with Electrospinning Methods

The health care industry is constantly working to improve methods for maintaining environmental hygiene in our everyday lives. In school cafeterias, for example, plastic trays are decontaminated on a daily basis with sanitizing spray. This sanitation method is ineffective for complete removal of all bacterial contaminants. As one alternative to current methods, the use of specific polymer surfaces equipped with integrated patterns has proved to be a highly effective deterrent for bacterial adherence and growth compared to controls. Patterned polymer surfaces were fabricated using a highly efficient and relatively simple nanoimprint lithography method. Staphylococcus aureus is one type of bacteria commonly found in the nose, respiratory tract, and skin. Mycobacterium tuberculosis is another prime example of potentially hazardous bacterium that can thrive actively inside the human body. The alarming aspect of both Staphylococcus aureus and Mycobacterium tuberculosis bacterium species is their rapid increase in resistance to modern pharmaceuticals over the last 50 years (Centers for Disease Control and Prevention, 2013). The Centers for Disease Control and Prevention has estimated that increased drug resistance has cost the public billions of dollars and taken millions of lives. It is therefore imperative that alternatives to traditional antibacterial methods be explored. Electrospinning is a highly-recognized fabrication method utilized for its cost-efficient production of ultrafine fibers that can be produced with ease. The ultrafine fibers produced from electrospinning range in size from the nano to micro-scale and have beneficial qualities such as flexible structural morphology characteristics, high surface area, and the ability to manipulate mechanical properties. Antimicrobial polymer surfaces were made with a combination of electrospinning, electroplating, and nanoimprint lithography. The fabrication process and results from bacterial plaque counts will be presented.

Aiden Amtmann: Applied Health and Safety Sciences (Montana Tech)
Mentor: Bill Spath -- Applied Health and Safety Sciences (Montana Tech)
Injury Patterns among Skiers and Snowboarders at a Mid-Size Ski Resort

The purpose of this research project is to determine the injuries, injury rates and injury patterns of skiers and snowboarders at a mid-size Montana ski resort. This research may help gather information vital to developing policies and equipment that may help improve safety and injury rates among snow sports enthusiasts. For this project, 161 incident reports from the Ski Patrol Department at Discovery Ski Area were obtained. Each incident report was sorted through to gather information such as; skier/snowboarder, ability, gender, trail difficulty, probable injury, anatomical location of injury, etc. The data concluded that males were more commonly injured than females. Snowboarder injuries were predominantly male (76%), also these males were younger (ages 13-18) and of beginner level. Snowboarders were more likely to have injuries to their shoulders, wrists, and head. On the other hand, skiers had a sweeping majority of knee injuries. Skiers aged 6-12 and 46 and over had the most injuries. Both skiers and snowboarders obtained a majority of possible sprain/strains, with possible fractures following. Also, most incidents occurred during morning hours and on beginner level trails. Replication of this research could provide more information for safety guidelines and protocols for Ski Patrol personnel.

Brittnee Crane: Biochemistry (Montana Tech)
Mentor: Joel W. Graff -- Biological Sciences (Montana Tech)
TRIMmunity and MAGE Interactions

Interferon (IFN)-β is involved in immune responses against viral infections. Some TRIM proteins, such as TRIM5 and TRIM22, are IFN-stimulated genes (ISGs) since their expression levels increases in response to IFNβ-intitiated signaling and, interestingly, have been shown to have direct and indirect antiviral activities, respectively. In a recent transciptomic analysis of polarized macrophages, we found that TRIM31 was specifically upregulated in response to INFβ 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 antigen gene (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 TRIM31 interaction partners. Co-localization studies will follow. 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.

Angie Pancost: Biological Sciences (Montana Tech)
Mentor: Stella Capoccia -- Biological sciences (Montana Tech)
Analysis of Correlations Between Low Resting Heart Rate, Personality Tendencies, and Decision Making

Low resting heart rate has been found as a prevalent biological marker for personality tendencies along the antisocial spectrum. Additional characteristics that emerge along the antisocial spectrum include superficial charm, grandiose sense of self-worth, stimulation seeking, and a lack of empathy for others. Studies suggest that this lack of empathy could play a role in jury decisions. This research examines possible correlations between people's resting heart rates, personality tendencies, and decisions made on court cases. We hypothesize that low resting heart rate will correlate to high prevalence of the three researched personality traits as well as less empathetic decision making in the court case analysis. In order to test the hypothesis, we ran a social survey that collected data on low-resting heart rates, personality traits, and evaluations of court cases. We focused on three main personality tendencies seen in the antisocial personality disorder spectrum: callousness, deceitfulness, and thrill seeking. The court cases selected were particularly difficult scenarios that hinged on perspective. Our goal was to examine the degree to which low resting heart rates, personality traits, and extreme sentencing showed a statistical relationship. Understanding the ways in which biomarkers affect decision making could benefit the legal system tremendously.

Winter Kempainnen, Teal Taylor: Biological Sciences (Montana Tech)
Mentor: Joel Graff -- Biological Sciences
Generation of Human Monocytic-Activating Leishmanial Parasites

Macrophages and other monocyte-derived cells are used by the immune system in response to environmental stimuli and the polarized effect of the response can have beneficial or detrimental outcomes in different settings. This project evaluates the efficiency of the specific transgenic *Leishmania tarentolae* to activate human macrophages and, if successful, the parasites could be used for macrophage-activating therapeutics for infected hosts. We hypothesize that nonpathogenic *L. tarentolae* expressing human cytokines from transgenes, will activate human macrophages in a consistent and controllable manner. DNA recombination methods were used to clone hIFNG and hGM-CSF into plasmid vectors capable of recombining with the highly repetitive ribosomal RNA locus of leishmanial parasites. In addition, fluorescent protein-coding genes were cloned into the plasmid vectors as a marker of successful genomic integration. Current efforts are focused on optimizing the efficiency of generating transgenic *L. tarentolae*. In addition to the potential of these transgenic parasites for use as macrophage-activating therapeutics, it is possible through cross protection for these parasites to be used as vaccines against the pathogenic forms of this neglected tropical disease.

Lydia Dupuis, Luke Domanico: Biological Science (Montana Tech)
Mentor: Joel Graff -- Biological Sciences (Montana Tech)
Targeted Deletion of IFNγ- and GM-CSF-Activated STAT Proteins

Various CRISPR-Cas systems act as adaptive immune system in the archaeal and bacterial domains. These systems utilize captured fragments of foreign genetic sequences to enable the prokaryote to defend against specific threats such as viral genomes. The CRISPR associated proteins (Cas), when expressed along with short segment of guide RNA (gRNA), are able to be used as tools for editing genomes with exquisite precision across all domains of life. Here, we created tools designed to employ CRISPR-Cas technology to target genes that code for STAT1 and STAT5A/B proteins and hypothesize that the resulting STAT knockout cells will be unable to adequately respond to transgenic leishmanial parasites expressing recombinant human IFNγ and GM-CSF, respectively. STAT1 and STAT5A oligonucleotide duplexes were successfully cloned into the pSpCas9(BB)-2A-EGFP plasmid at the tandem BbsI restriction sites. HEK293 cells were successfully transfected with the pSpCas9(STAT1)-2A-EGFP and pSpCas9(STAT5A)-2A-EGFP plasmids as demonstrated by EGFP expression in these cells. Monoclonal strains of HEK293 cells are being screened for unresponsiveness to STAT pathway-activating stimuli. Upon confirmation of successful gRNA-directed Cas9 mutations in STAT genes, lentiviral vectors containing these gRNA-encoding sequences will be used to similarly mutate human monocytic cell lines as an important tool for characterizing human IFNγ- and GM-CSF-expressing leishmanial parasite-mediated monocytic cell activation.

Lorrie Capjohn: Business, Science (Chief Dull Knife College)
Mentor: Dianna Hooker -- Mathematics (Chief Dull Knife College)
West Nile Virus 2016

The Goal of the West Nile Research on the Northern Cheyenne Reservation is to find the presence of the WNV. There are many steps to take in getting some answers. The first step is trapping and identifying the mosquitos that are carriers of the West Nile Virus, the Culex Tarsalis and Culex Pipien. Once the identification is done we move to extract the RNA from the sample mosquitos. We then prepare the RNA samples for the PCR machine to detect the presence or absence of the West Nile Virus. One of the unique things about Lame Deer is we are a “hot spot” for Culex Pipiens which are rare in other parts of the state. About half of every sample of mosquitos we collect is Culex Pipiens.

Dannette Spottes Horse, Lana Wagner: Social Work and Criminal Justice (Blackfeet Community College)
Mentor: Jim Kipp -- Math and Science (Blackfeet Community College)
A Mixed-Methods Community Investigation of Trauma and Depression Incidence within an Indigenous Population

American Indians experience some of the highest health disparities in the nation per ethnicity, to include lower life expectancy and disproportionate stress, poverty, discrimination in the delivery of health services, poor social conditions, and cultural differences. Increased frequency and intensity of prolonged stress has been related to susceptibility of infection and autoimmune and chronic disease. This inquiry seeks to define the relationship between stress biomarkers, infection, and disease. A primary piece of this investigation is the potential connection between salivary cortisol, trauma, and negative health experiences. This was measured by both quantitative blood and saliva samples compared with the qualitative self-report survey called the Adverse Childhood Experiences (ACE) with the aim of exposing the increased occurrence of chronic disease and infection frequency as well as adverse life conditions community participants were experiencing. Enzyme-linked immunenosorbant assay (ELISA) was used to establish salivary cortisol levels in 110 recruited participants, determining if they exhibited elevated levels of stress. This research further explored additional stress biomarkers such as c-reactive protein and immunoglobin A (IgA). The purpose of this work is to provide information to educate individuals in the management of stress to improve quality of life. We found that there was significant correlation between trauma and depression, though no correlational significance between salivary cortisol, C-reactive protein, nor immunoglobin-A with trauma.

Acknowledgements: Lana Wagner, Betty Matthews-Henderson, Billy Jo Kipp, and Delores Hoyt

Raser Powell: Biology (Flathead Valley Community College)
Mentor: Mirabai McCarthy, Ruth Wrightsman -- Plant Biology, Biology (Flathead Valley Community College)
Antibiotic Potential of Flathead Fungi and Flora

Widespread overuse of antibiotics in medical and agricultural industries has resulted in extensive antibiotic resistance at the global level, which poses an immediate threat to human health. The most commonly used antibiotics are currently synthesized from fungi & bacteria, yet other organisms such as lichens, bryophytes and pteridophytes have sparked scientific interest as potential sources of antimicrobial compounds, but only a small fraction of species have been tested. The overarching goal of our research is to determine whether locally occurring fungi, lichens, bryophytes, and pteridophytes have antibiotic potential against several pathogenic bacteria. One-hundred-and-ten plant and fungal specimens were collected, identified, dried and deposited in the FVCC herbarium. Samples were later prepared for antibiotic analyses using ethanol extractions and tested using the Kirby-Bauer disk diffusion method. Extractions from 9 different lichen, 3 bryophytes, and 1 pteridophyte species inhibited growth of *Staphylococcus epidermidis,* but none inhibited that of *E. coli*. Our continued research in this area will involve testing extractions from additional fungal, plant and lichen species against these bacteria, and combining various extracts to determine whether we can produce more synergistically effective antibiotics.

Terydon Hall, Scott Ollinger: Metabolic Research Lab (Blackfeet Community College)
Mentor: Jim Kipp -- Math & Science Department
Combining both Qualitative and Qualitative Measures

This project investigates serum levels of cortisol within a federally recognized tribe. Cortisol, a steroid hormone, is produced and released via adrenal gland function. Relevant to this study, cortisol can be detrimental to humans, as it directly suppresses immune function and thereby increases disease susceptibility. Historically, incidence of chronic disease is markedly higher within Native American populations, than other ethnicities. This mixed-methods study, combining both quantitative and qualitative measures, seeks to determine whether this federally recognized tribe experiences prolonged high-stress events via serum sample and analysis. A further goal of this investigation is to ascertain whether or not stress levels are related to increased infection vulnerability and chronic disease, via a participant self-report survey.

Acknowledgements: Betty Matthews (Blackfeet Community College), Delores Hoyt (Blackfeet Community College)

Jerry Racine, Colbi Kipp: Secondary Education (Blackfeet Community College)
Mentor: Jim Kipp -- Math & Science Department
The link between serum cortisol levels within an American Indian community

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, Native American communities suffer from various stress disorders related to generational trauma, mental, and substance abuse. This has resulted in increased frequency of infectious disease, autoimmune disease and various cancers. Native American 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 by comparison of self – reported depression amongst various bio-markers and socio-economic factors. This project fully began in the summer of 2015, canvassing local students and members of the community to engage in this project. Each participant was asked to complete a survey, and donate blood and saliva samples for direct cortisol testing. Analysis was performed of serum and saliva samples for direct cortisol testing. Analysis was performed on serum and saliva samples via Enzyme-linked Immunosorbent assays (ELISA). The assay is performed and analyzed to see the direct link of specific antigens or antibodies attaching to the surface of certain wells, within the ELISA test, to view cortisol levels within the system.

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