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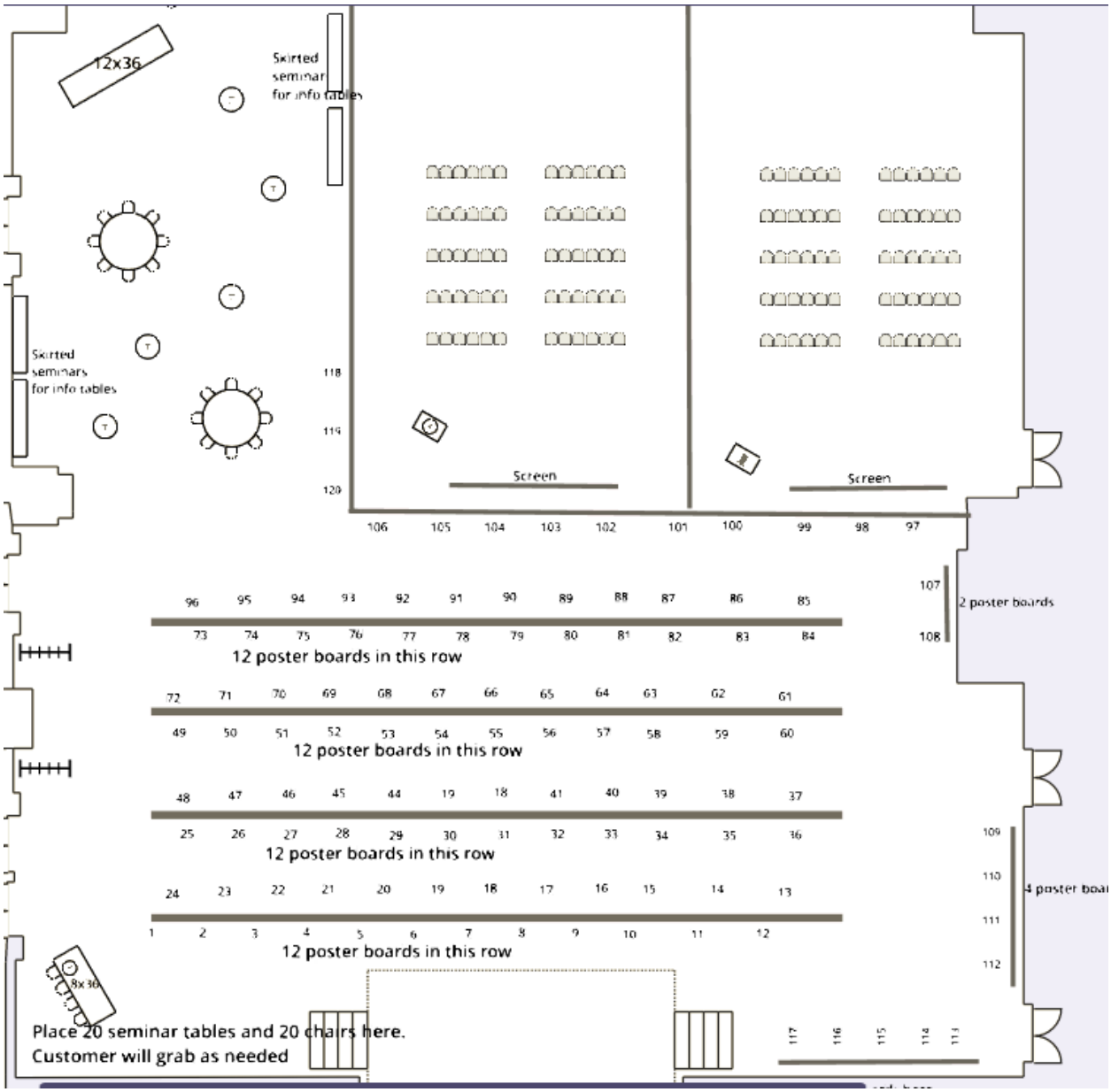
Conference Map



Topical Sessions – SUB Ballroom C

April 13, 2018

HEALTH & HUMAN DEVELOPMENT 9:00 am – 10:30 am

Messengers for Health uses a community-based participatory research approach and involves members of the Apsáalooke (Crow) Nation and Montana State University faculty and students. In 2013, project partners decided to focus on helping community members with chronic illness (CI) improve their self-care. In 2016, we received a grant from the National Institutes of Health to develop and implement a randomized controlled intervention trial of a program with 200 members of the Apsáalooke community. The resulting program is titled Báa nnilah, which translates to advice or instructions for life that are received from others. The program method is centered on Crow cultural strengths and includes 7 group meetings (gatherings) led by community members (mentors) who are doing well managing their CI. The program encourages and supports Apsáalooke people with CIs to take positive steps to manage their illness, to support each other, and to be an advocate for themselves to improve their health while staying true to Apsáalooke traditions and values. The different panel presenters will provide an overview of the Báa nnilah program and describe the specific parts of the program for which they are responsible including participant recruitment and retention into the program, development of program content such as working in a positive manner with healthcare providers, mentor training and support, and program evaluation.

Moderators: Shannen Keene, Rae Howe Birdhat – Health & Human Development
Mentor: Suzanne Held

Undergraduate Panel Members:

- **Rae Birdhat-Howe: Community Health**
- **Brianna Bull Shows: Microbiology**
- **Laurel Fimbel: Community Health**
- **Shannen Keene: Community Health**
- **Sami Mohl: Cell Biology & Neuroscience**
- **Mikayla Pitts: Community Health**
- **Coleen Trottier: Pre-Medical Certificate**

McNair Scholars Program 11:00 am- 12:30 pm

The essence of the McNair Scholars Program (MSP) at MSU is to successfully combine faculty mentoring, undergraduate research, and academic support services for students who are preparing themselves for success in graduate school and whose families have not traditionally participated in post-secondary education. One important preparatory aspect of the program is to provide opportunities for scholars to share their research and creative projects at regional & national conferences such as today. The collection of projects previews the diversity of interests, as students in the MSP range from art history to environmental science.

11:00 – Amber Yates, Elementary Education (Mentors – Megan Wickstrom)
Title: Mathematical Modelling: Analyzing Students' Notions of Mathematics in Primary Education

11:15 – Lauren Dupuis, Chemistry (Mentor – Matthew Cook)
Title: A Convergent Synthesis of Diazonamide A

11:30 – Nicolette (Alex) Green, Psychology (Mentor – Matthew Vess)
Title: True Self Alienation and Mind Wandering: The Relationship

11:45 – Savanah Leidholt, Biological Sciences (Mentor – David Willey, Tom Shultz)
Title: Variation in Genetic Composition of O. annularis and O. franksi and their Symbionts by Depth

12:00 – Betheny "Birdie" Kushner, Philosophy (Mentor – Kristen Intemann)
Title: Alleviating the Suffering Incurred by Causal Determinism and Other Disorders

12:15 – Uriel Menalled, Sustainable Food and Bioenergy Systems (Mentor – Timothy Seipel)
Title: Understaidnign the Interaction of Crop Management System and Crop Identity on Biologically Mediated Plant – Soil Feedbacks

Acknowledgement: This research is funded in part by the US Dept. of Education McNair Scholars Program, grant #P21A130148.

Macroevolution: The Fellowship of the Tree 1:00 pm- 2:30 pm

"Nothing in biology makes sense except in the light of evolution." This 1973 quote from evolutionary biologist, Theodosius Dobzhansky, is truer than ever before. Researchers since have taken evolutionary theory to new realms of understanding, explaining everything from the vast diversity of organismal forms to how cancer develops and spreads within the human body. The MSU Macroevolution Lab aims to carry the torch of evolutionary theory to better understand our world. Our research applies computational methods to test hypotheses concerning cellular, genomic, organismal, and cultural evolution.

Given that this theme is interdisciplinary – consisting of a wide variety of subjects, including cellular and organismal biology, genomics, paleontology, and anthropology – it opens the door for new ideas and collaborations from the MSU community.

Moderators: Chris Organ, Kevin Surya, Jacob Gardner – Honors College, Earth Sciences

1:00 – Gia Fisher, Cell Biology & Neuroscience (Mentors – Christopher Organ)
Title: How is Cancer Incidence Driven by Stem Cell Division Rate?

11:15 – Jacob Gardner, Earth Sciences (Mentor – Christopher Organ)
Title: The Evolutionary Dynamics of Vertebrate Genome Size

1:30 – Rudy Hummel, Earth Sciences (Mentor – Christopher Organ)
Title: The Evolution and Biogeography of the Carnivorous Mammal Predecessors, Gorgonopsia

1:45 – Kevin Surya, Interdisciplinary Studies (Mentor – Christopher Organ)
Title: Which Phylogeny Better Fits Species Trait Data: Time or Molecular Tree?

2:00 – Jacob Gardner– Earth Sciences (Mentor –)
Title: The Evolution of Culture and the Rise of Civilizations in Eurasia

** List represents order of presenters – times are approximate*

Topical Sessions – SUB Ballroom D

April 13, 2018

Mathematical Science 11:00 am – 12:30 pm

In the mathematical sciences, we have a unique opportunity to use our expertise on research projects in several disciplines including Mathematics, Applied Mathematics, Statistics, as well as Mathematics and Statistics Education. In this session, we will give an overview of a few current projects in topological data analysis, spatial point processes, structural equation modeling, student assessment, qualitative research, and differential topology.

Moderators: Catherine Potts, Allison Theobold – Mathematical Sciences

11:00 – Daniel Perry, Mathematical Sciences

11:15 – Kenny Flagg, Statistics

11:30 – Paul Wilson-Harmon, Mathematical Sciences

11:45 – Jordan Schupach, Mathematical Sciences

12:00 – Adewale Adeulu, Mathematical Sciences

12:15 – Allison Theobold, Statistics Education

12:30 – Panel Style Q & A

Biomedical Engineering Research at the MT Bench and Beyond 1:00 pm- 2:30 pm

The goal for this session is to describe Biomedical Engineering Research at MSU, including opportunities for students and applications to human health. This work spans multiple departments and includes students from multiple colleges. Biomedical Engineering brings together multiple disciplines including mathematics, physics, chemistry, biology, and many types of engineering to develop novel solutions that improve human health and treatment for diseases. Research topics will include neuroengineering, microfluidics, novel genetic testing technology, and biomechanics.

Moderators: Anja Kunze, Ron June, Connie Chang, Stephanie McCalla – Engineering

1:00 – Jacob Kerner, Chemical & Biological Engineering

1:15 – Daniel Salinas, Computer Science

1:30 – Alyssa Carlson, Molecular Biosciences

1:45 – Burcu Ozay, Chemical & Biological Engineering

2:00 – Derek Judge, Electrical & Computer Engineering

2:15 – Kendra Hergett, Chemical & Biological Engineering

2:30 – Hannah Szafraniec, Chemical & Biological Engineering

2:45 – Jacob Carter-Gibb, Chemical & Biological Engineering

** List represents order of presenters – times are approximate*

The Territory's Best 3:00 pm- 5:00 pm

This is a short film that explores feminism and the genre of the western. Presenting this would be an excellent means for us to show the tangible results of USP funding for creative student projects as well as for us to get feedback from people who may not have seen any of the rougher edits of the film prior.

Moderators: Timothy Wells, Michael Petty – Film & Photography

3:00 – Timothy Wells, Film & Photography

3:15 – Michael Petty, Film & Photography

3:30 – Mac Palin, Film & Photography

3:45 – Jacob Robinson, Film & Photography

4:00 – Colter Peterson, Film & Photography

4:15 – Seth Wyberg, Film & Photography

4:30 – Timothy Wells, Film & Photography

4:45 – Timothy Wells, Film & Photography

** List represents order of presenters – times are approximate*

2018 STUDENT RESEARCH CELEBRATION

GRADUATE ABSTRACTS

Sorted by Student Major

COLLEGE OF AGRICULTURE

Andrea Creel: Agricultural Economics & Economics
Mentor: Mark Anderson - Agricultural Economics & Economics
Estimating Willingness to pay for Un-Hunted Yellowstone Grizzly Bears

The Yellowstone Grizzly Bear (Ursus arctos horribilis) was delisted from the Endangered Species Act in June 2017. Management will now fall to state agencies within Montana, Wyoming, Idaho and tribal agencies within them. Using survey data collected, this project will estimate Montanan's willingness to pay to lower and raise the hunting quota for Yellowstone Grizzly Bears, in the event that a hunting season was created. Data collection is still underway, but summary statistics will include the percentage of the sample willing to pay a positive dollar amount, and the average willingness to pay, as well as the number of people who had a positive willingness to accept.

COLLEGE OF ENGINEERING

Robert Dorsey: Mechanical & Industrial Engineering
Mentor: David Claudio - Mechanical & Industrial Engineering
Rural Healthcare Improvement in a Native American Community: Fitting Together Service and Expectations by Reducing Value Gaps

We are looking at improving patient satisfaction for patients in outpatient clinics in rural areas. The main focus on healthcare services and facilities at Native American Reservations we aim to close gaps between clinical staff services and the expectations of the patients. Due to the remote location and low income level of the community, it is critical for patients to receive care at local healthcare facilities and not have to travel to other facilities for the same care. The low Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) satisfaction scores also lead to less funding to the facility as well as lower ranking in accreditation by Centers for Medicare and Medicaid Services (CMS). These lower scores in a Native American community than state and national averages is the catalyst for the research. Utilizing the Quality Function Deployment (QFD) from Industrial and Management Systems Engineering as well as survey tools and statistical analysis we aim to bring together expectations on both sides to provide better services to the community and increase overall satisfaction. Also, from the responses from patients and staff we will look to see if HCAHPS effectively captures what is important in patient satisfaction, possibly identifying a cultural component that may be missing.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE), Sloan Indigenous Graduate Partnership (SIGP)

COLLEGE OF EDUCATION, HEALTH & HUMAN DEVELOPMENT

Rae Birdhat-Howe: Community Health
Mentor: Suzanne Held, Mark Schure, Sarah Allen – Health & Human Development
Counting Coup: Development of an Indigenous goal-setting tool

Báa nnilah is comprised of 7 gatherings that are led by community members who have chronic illness and are trusted individuals in the community. Programs to improve chronic illness self-management include goal setting as an integral component. We see goal setting as a tool to benefit participants, however we have not found any examples of Indigenous goal setting. Because of this, we used a community-based participatory research and Indigenous research methods approach to develop a goal setting tool to be specific to the Crow people – we call this counting coup. We co-developed this tool with our community advisory board and mentors. In this presentation, we will briefly discuss CBPR and IRM principles, will share information on how there is no existing tool for goal setting specific to Indigenous people, describe the process we went through to develop our coup list, and share the final counting coup method and how it is being used in the 7 gatherings. We will share specific examples in our gatherings that show how our community members counted coup in their personal lives.

Shannen Keene: Community Health
Mentor: Suzanna Held – Health & Human Development
Monitoring Treatment Fidelity in an Indigenous Chronic Illness Self-Management Program

Indigenous communities experience disproportionate rates of chronic illness (CI) compared to Whites. Existing CI management interventions are not adapted to the diversity of Indigenous cultures which limits their effectiveness. To address this gap, the Apsáalooke (Crow) Nation and Montana State University partnered using a community-based participatory research approach to develop the Báa nnilah CI self-management intervention. The program is tailored to the cultural strengths of the Apsáalooke Nation and consists of seven gatherings led by mentors (Aakbaabaaniilea), who are identified by the community as successful managers of their CI. To increase the effectiveness of Báa nnilah, it is important to monitor and improve treatment fidelity. Despite its significance, treatment fidelity remains underreported in health behavior interventions, particularly among Indigenous communities. To address this issue, a treatment fidelity monitoring plan was developed to enhance two areas identified by the National Institutes of Health Behavioral Change Consortium: 1) provider (Aakbaabaaniilea) training and 2) treatment delivery. The fidelity monitoring plan included strategies such as support surveys, tailored ongoing support and feedback, skill-building activities, and direct observation using a checklist. The goal of these strategies is to increase confidence and comfort levels among Aakbaabaaniilea in delivering the intervention, further enhancing the internal and external validity of the Báa nnilah intervention. Ultimately, optimizing treatment fidelity can advance the reliability and validity of this intervention, further promoting health equity among Indigenous populations.

Acknowledgements: Mikayla Pitts (MSU Undergraduate Student) – Community Health, Laurel Fimbel (MSU Undergraduate Student) – Community Health, March Schure (MSU Faculty Member) – Health & Human Development, Alma Know His Gun McCormick (Crow Agency, MT) – Messengers for Health

Melinda Smith: Health & Human Development
Mentor: Mary Miles - Health & Human Development
Inflammatory effects of the Food Distribution Program on Indian Reservations (FDPIR)

American Indian and Alaskan Native (AI/AN) communities have high death rates in many categories including type II diabetes mellitus, chronic liver disease, and cirrhosis. The Food Distribution Program on Indian Reservations (FDPIR) is a primary food supplement program that serves AI/AN communities in the United States. Recent studies

have reported that FDPIR monthly food packages do not meet Dietary Guidelines for Americans (DGA). On average, the packages are high in refined grains and lack in fresh produce. The objective of this study is to measure the inflammatory effects of two FDPIR diets. One FDPIR diet is comprised of food that meets DGA and the other is comprised of food that meets an average FDPIR diet. The hypothesis is that an average FDPIR diet will result in a higher inflammatory response than a FDPIR diet that meet DGA in all participants. Interleukin-1 beta and interleukin-6 pro-inflammatory cytokines will be used to measure the inflammatory response of each diet. Participants are men and women (n=15) between the ages of 18-55 years with a waist circumference of > 40 inches for men and >35 inches for women. A randomized, crossover design will be used to compare two conditions: 1) FDPIR diet that meet DGA; 2) FDPIR diet that does not meet DGA. Each participant will serve as their own control and undergo both conditions. Baseline measurements will include body composition, waist circumference, and initial inflammatory cytokine measurements.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Coleen Trottier: Pre-Medical Certificate
Mentor: Suzanne Held – Health & Human Development
Messengers for Health Baá nnilah program

Messengers for Health was initiated in 1996 through members of the Apsáalooke (Crow) Nation and a Montana State University faculty member. They developed a program to address health equity through the community women regarding cancer screenings using a Community Based Participatory Research approach. We are now working on a project with Chronic Illness (CI) self-management on the Crow Reservation. The program is called Báa nnilah, which will have 7 gatherings. The gatherings are led by community members who have chronic illness and are trusted individuals in the community. In these gatherings, our mentors will focus on different areas such as nutrition, physical fitness, spirituality, relationships, health knowledge, treatments, historical stress, grief, loss, self-advocating for better health, and better communication with healthcare providers. This presentation will discuss the background of Messengers for Health and the development of the Baá nnilah program.

Acknowledgements: March Schure (MSU Faculty Member) – Healthy & Human Development, Alma Know His Gun McCormick (Crow Agency, MT) – Messengers for Health

COLLEGE OF LETTERS & SCIENCE

Luke Berry: Chemistry & Biochemistry
Mentor: Brian Bothner - Chemistry & Biochemistry
Mass Spectrometry-Based Structural Analysis of MoFe and FeFe Nitrogenase to Elucidate the Role of Structure-Function in Nitrogen Reduction

Nitrogenase enzymes are a class of enzymes capable of forming reduced species of nitrogen (NH3) from nitrogen gas (N2) through a process known as nitrogen fixation. Organisms possessing these enzymes are responsible for producing 50% of the world's reduced nitrogen supply. There are three types of nitrogenases, each characterized by a unique metal cluster at the active site (MoFe, VFe, and FeFe). Structural models have successfully been developed for the MoFe and VFe nitrogenases. However, a high resolution structural model for the Iron only class of nitrogenase (FeFe) has not been obtained despite numerous attempts. We have employed mass spectrometry-based chemical cross-linking and H/D exchange with computational modeling to generate quaternary structural models of the FeFe Nitrongenase.

Acknowledgements: Oleg Zadvornyy (MSU Research Scientist) - Chemistry & Biochemistry, Biological Electron Transport & Catalysis Energy Frontiers Research Center (BETCy-EFRC), Monica Tokmina-Lukaszewska, Derek Harris

Kenneth Flagg, Christopher Barbour, Michaela Powell, Tan Tran, Stephen Walsh: Statistics, Mathematical Sciences
Mentor: Lillian Lin, Megan Higgs – Mathematical Sciences, Statistics
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.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE), AI/ANCTR

Kenneth Flagg: Statistics
Mentor: Andrew Hoegh, John Borkowski, Megan Higgs– Mathematical Sciences, Statistics
Inferring Spatial Point Intensity of Geomagnetic Anomalies from Transect Sampling

Geomagnetic anomalies recorded at munitions use sites are often collected along transects that cover a very small proportion of the site area. Munitions items are assumed to occur in elliptical regions of high point intensity, so a primary analysis goal is to map the intensity over the site and identify high-intensity regions that might contain unexploded ordnance. We propose a Bayesian spatial Poisson process model with a Dirichlet process mixture as the inhomogeneous intensity function. Then we incorporate data augmentation into a Gibbs sampler to fit the model to data observed in a subset of the site region. We demonstrate fitting the model to simulated data, using both the fully-observed region and the restriction to two different subsets. Finally, we fit the model to data collected at the Victorville Precision Bombing range in southern California.

Amanda Fuchs: Chemistry & Biochemistry
Mentor: Valerie Copie, Mary Cloud B. Ammons - Chemistry & Biochemistry, Other
NMR Metabolomics Analysis of Human Macrophages Co-Cultured with Pseudomonas aeruginosa Biofilms

Pseudomonas aeruginosa is a Gram-negative, facultative anaerobic bacterium that has been associated with acute and chronic wound infections. Dissimilar to acute wounds, chronic wounds fail to progress through the reparative stages of wound healing in a timely, orderly manner and feature a prolonged inflammatory response. Over 50% of chronic wounds in the U.S. demonstrate colonization by P. aeruginosa biofilms, immobile microbial communities encased in an extracellular polymeric substance. Bacteria growing within a biofilm have several advantages over planktonic microbes, including greater antibiotic resistance and an enhanced ability to evade the endogenous immune system. Acute wound healing is achieved through the coordinated efforts of multiple host cells, including but not limited to neutrophils, macrophages, fibroblasts, and keratinocytes. Macrophages, a type of phagocyte, are of notable interest in the context of chronic wounds because they are heavily involved in the transition from inflammation to proliferation during wound healing. Since this transition is delayed in chronic wounds, we are investigating the impact of P. aeruginosa biofilms on human macrophages using a simplified in vitro co-culture model. Using 1D 1H NMR-based metabolomics, our studies indicate that macrophage metabolism is differentially modulated in the presence of P. aeruginosa biofilms relative to control macrophages. Our findings provide crucial insight into how P. aeruginosa biofilms influence metabolic pathway modulation and function of human macrophages to interfere with the host innate immune response.

Acknowledgements: Mary Cloud B. Ammons (MSU Faculty Member) – Chemistry & Biochemistry, National Institutes of Health (NIH)

Jacob Gardner: Earth Sciences
Mentor: Chris Organ - University Honors Program
The Evolutionary Dynamics of Vertebrate Genome Size

Genome size--the amount of genetic material--varies widely among vertebrate animals from 350 million to 130 billion base-pairs. However, this variation is not associated with organismal complexity. Although it does correlate with the proportion of repetitive, non-protein-coding genetic sequences, it remains unclear whether genome size is an adaptive feature or one that evolves neutrally over time without any specific function. Some of these hypotheses make testable assumptions about the rate and mode (i.e. gradual or punctuated) of evolution. To test these hypotheses, we conducted a vertebrate-wide comparative genome size analysis to reveal the rate and mode of genome size evolution. We collected genome size range data for ~2,600 living and extinct vertebrate species and tested multiple models of evolution. We determined the mode of genome size evolution by regressing genome size against the net number of bifurcations (speciation events) in the phylogenetic tree along a given species' lineage. A significantly positive correlation is consistent with punctuated evolution (evolutionary change is coupled to speciation). We followed this with a test for whether bigger genomes evolve at faster rates by regressing rates of evolution against genome size. Our preliminary results show that genome size evolved slowly and gradually throughout most of vertebrate history despite multiple major environmental and morphological changes and several genome duplication events. This suggests that genome size was not adaptive to those changes. We also find that the rate of genome size evolution is not proportional, suggesting increased levels of regulation to prevent heightened mutation rates.

Jacob Gardner: Earth Sciences
Mentor: Chris Organ - University Honors Program
The Evolution of Culture and the Rise of Civilizations in Eurasia

The origin and development of Eurasia's first civilizations are contentious. Multiple competing hypotheses propose a range of drivers that lie between mostly environmental and cultural factors. In addition, evidence suggests that the growth of civilizations resulted in many dietary changes and community health problems for the people involved. However, to quantitatively test these hypotheses we need to integrate paleogenomic and archaeological data into large-scale, comparative cultural analyses. Language trees based on cognate characters are a widely used framework for reconstructing the relationships among human populations and for testing hypotheses of cultural evolution. Previous studies have focused on the development of complex political systems in Southeast Asia, the influence of supernatural punishment and ritual sacrifice on societal control, and the evolution of marital systems; yet, none of these studies incorporate data on ancient cultures into the large-scale, comparative cultural analyses. Most cultures that have ever existed are now "extinct" or have evolved into new cultures. To test hypotheses about the origin of Eurasian civilizations it is imperative that we include those ancient cultures. Moreover, the inclusion of ancient cultures will vastly improve model estimates, such as ancestral character states, at the base of the language tree; this is comparable to the use of fossils and extinct organisms in evolutionary biology. Here, we review previous studies that yield novel insights on the development of complex societies from both genomic and macroevolutionary lenses. We then propose a methodology for synchronizing the two that will help elucidate the origin of civilizations in Eurasia.

Rowen Oswald: Physics
Mentor: Alan Craig - Physics
Design of a Magneto Optical Trap to Achieve Sympathetic Electron Cooling

From the first observation of a Bose-Einstein Condensate in 1995 to modern efforts to improve quantum computing technologies, the Magneto-optical Trap (MOT) has been a powerful workhorse for cutting edge physics. MOTs combine two powerful principles, Doppler cooling and Zeeman splitting, to trap atoms and reduce their temperature to the Î¼K range. Radio frequency (RF) traps are another useful tool for trapping ions and electrons. Construction of a MOT and RF in the same ultra high vacuum chamber would give a lab a valuable tool to investigate ultracold properties of atomic and subatomic substances. We have refined the design process for this kind of hybrid trap, allowing it to be easily customized for any size vacuum chamber and began construction on two of our own for use in studying ultracold electron topology.

Burcu Ozay: Chemical & Biological Engineering
Mentor: Stephanie McCalla
Ultrasensitive MicroRNA Amplification for Disease Diagnosis

Early detection of diseases has a huge impact on treatment success. Recent studies show that microRNA expression (miRNA) levels change in response to disease, often in the early stages, which makes them potential biomarkers for early diagnostics. However, miRNAs have short sequences and are usually in low concentrations, such that cost-effective specific detection is a challenge. Currently, qPCR is considered the gold standard for miRNA detection. However, qPCR is a time-consuming, expensive method that is not suitable for limited resource settings. In this study, we developed and characterized a new tunable DNA amplification chemistry that mimics the switch-like characteristics of biological systems such as cell signaling and genetic regulation. This tunable switch-like chemistry allows DNA amplification to be more specific by providing a yes/no answer for the presence of the miRNA molecules. The non-linear kinetics and high output nature of the reaction will make suppressing amplification below a threshold level possible, which turns a rapid method that can have false positives into a specific method. This application can be converted into a quantitative assay by counting single amplified molecules with help of microfluidic tools to create a digital assay for miRNA detection. A switch-based assay in clinics for early diagnosis, detection of diseases, or determining disease progression will be one step closer with this new

technology. Our future goal is to diagnose a variety of diseases in early stages using newly developed miRNA detection methods that are rapid, affordable and easier to apply

Acknowledgements: Cara Robertus (MSU Undergraduate Student) – Chemical Engineering, Jackson Negri (MSU Undergraduate Student) – Chemical Engineering

Daniel Perry: Mathematical Sciences
Mentor: David Ayala – Mathematical Sciences
Contact Homotopy Groups of Three-Dimensional Contact Manifolds

Restrictions of motion in a smooth manifold may be captured by a distribution, a subbunde of the tangent bundle. Considerations of distributions, along with the Lie Bracket, allow for interpretation and definition of certain structures, foliations and contact manifolds, along with an appropriate sense of mapping, contact maps. These contact maps are used to define homotopy groups on contact manifolds. An indication as to what these groups are will be provided.

Mariana Olsen: Psychology
Mentor: Keith Hutchison, Sara Waller, Frank Marchak - Psychology, History & Philosophy, Psychology
Does Increased Task Difficulty Reveal Individual Differences in Executive Function in Domestic Dogs?

Executive function (EF) facilitates the expression of optimal behavior through inhibition of inappropriate responding, focus on relevant stimuli in the face of distraction, and adaptation to changes in the environment. Although heavily researched in humans, EF has only recently received attention by canine cognition researchers, many of whom have used the cylinder task as a measure of EF. Unfortunately, robust ceiling effects have led researchers to suggest that this task is too easy to make individual differences readily apparent. Across two experiments, I test whether ceiling effects in the cylinder task can be attenuated by having subjects engage in self-control (Experiment 1) and eliminating practice with the apparatus (Experiment 2) prior to testing. I also compare cylinder task performance to performance on another presumed measure of canine EF (the A-not-B task), as well as previously-validated psychometric indices (e.g., inattention, impulsivity, behavioral regulation, responsiveness). Additionally, I provide reliability estimates for the cylinder and A-not-B tasks, currently missing from the literature and critical for assessing utility of cognitive tasks. Finally, I examine whether demographic variables like training history and age are related to behavioral and psychometric measures of canine EF. Ultimately, results from this study could benefit the growing field of canine cognition by encouraging use of power analysis, providing the first reliability estimates for two frequently-used tasks, and contribute a greater understanding of how to best measure EF in “man’s best friend.”

Mohammed Refai: Chemistry & Biochemistry
Mentor: Brian Bothner - Chemistry & Biochemistry
Proteomic analysis of the role of thiol switches in the metabolic transition between aerobic and anaerobic conditions in E. coli.

Thiol-based redox switches play an essential role in the regulation of protein function. However, the role of thiol-switches in the transition between aerobic and anaerobic conditions is not fully understood. Of significant interest is the role cysteine (Cys) oxidation in cell signaling and catalysis. We choose Escherichia coli as a model system to study the transition. The primary objective of this study is to map regulatory pathways responsible for the metabolic shift that takes place as the cellular environment transitions between aerobic and anaerobic and aerobic conditions at the level of protein oxidation. The main experiment design is to trap the reduced Cys group using NEM and sequentially reduced the disulfide bonds for a subsequent alkylation step using IAM. Gel-based and shotgun proteomics experiments were conducted. Over 500 Cys was identified in the two conditions. In addition, the ratio of reduced/oxidized Cys containing peptides is 1.3 Â± 0.32 and 0.5 Â± 0.1 for aerobic and anaerobic

conditions, respectively. Moreover, 44 and 46 proteins are regulated in the aerobic anaerobic, respectively ($p>0.01$, FC).

Acknowledgements: Nina Paris (MSU Undergraduate Student) – Chemistry & Biochemistry, Dana Kramer (MSU Undergraduate Student) – Chemistry & Biochemistry, Paul Greico (MSU Faculty Member) – Chemistry & Biochemistry

Allison Theobold: Statistics Education
Mentor: Stacey Hancock – Mathematical Sciences
Aligning Statistical Computing Education with Expectations for Data Practitioners

Computing has become foundation in the fields of Environmental Sciences, however, the gap between Environmental Science education and computation has become more evident. With the growth in computational power, the complexity of Environmental Science models has followed, multiplying the computational, mathematical, and statistical expectations of students' abilities. This study describes both the computational expectations faculty and practitioners place on students graduating with advanced degrees in Environmental Science fields, as well as the computational abilities of a sample of graduate Environmental Science students. A discussion will be had on what computational abilities are crucial for successful in today's world of statistical modeling. Workshops developed to teach for computational skills and understandings will then be described, outlining the materials that have shown to be successful in this study

Paul Wilson-Harmon: Statistics
Mentor: Mark Greenwood, Laura Hildreth – Mathematical Sciences
An Alternative to the Carnegie Classifications: Using Structural Equation Models to Identify Similar Doctoral Institutions

Institutional classification systems, such as the Carnegie Classifications, are used to delineate groups of institutions with similar characteristics and by administrators to guide policy decisions. However, the Carnegie Classifications are marked by several statistical and practical shortcomings. First, they are neither well-documented nor easily reproduced. Second, the statistical methodology that underlies them, dimension-reduction based two Principal Components Analyses (PCA), may not be the best way to model institutional characteristics.
Using the 2015 data set from the Carnegie Classifications for Doctoral granting institutions, we propose an alternative method of classification that relies on Structural Equation Modeling of latent factors rather than PCA-based indices of institutional productivity. In this method, we create a single index created from two latent factors: one pertaining to STEM research outcomes and the other to non-STEM outcomes. Classifications can then be made using a univariate mixture model as opposed to subjective determination of groups, as is done in the Carnegie method. To explore the two classification methods, we created two R-Shiny applications that allow a user to change the underlying variables on which universities are measured and assess the resulting changes in group membership.

Acknowledgements: Ian Godwin (Montana State University Staff Member) – Office of Planning and Analysis

Summer Whillock: Psychology
Mentor: Michelle Meade - Psychology
Age Differences in Collaborative Memory

The current study examined how young and older adults' memory is influenced by remembering together with a partner. Specifically, we examined the influence of same-age and mixed-age dyads on the collaborative inhibition effect (reduced recall in collaborative groups compared to the combined recall of the same number people who recall individually). Younger adults (age 18-25) and older adults (age 65 +) studied categorized word lists and completed a series of recall and recognition tasks. For the first free recall test, participants recalled the lists alone

or in collaboration with a same-age partner or a different-age partner. All participants were then asked to recall the information again on their own and to complete a final recognition test. It is predicted that collaborative inhibition will be found in both same-age and mixed-age partners. Further, collaborative inhibition will be greater in the mixed-age partners because the manner in which mixed-age pairs interact with each other to negotiate and exchange information is more disruptive to memory. The results of this study have important implications for understanding age differences in how people work together on memory tests.

Acknowledgements: Megan Tsosie (MSU Graduate Student) – Psychology

2018 STUDENT RESEARCH CELEBRATION

UNDERGRADUATE ABSTRACTS

Sorted by Student Major

COLLEGE OF AGRICULTURE

Kegen Benson: Animal & Range Sciences
Mentor: Jamie Sherman - Plant Sciences & Plant Pathology
Genetic Dissection of Malt Quality

The potential of barley to meet malt quality standards has a huge impact on Montana's economy. Barley farmers can receive twice as much for malt barley than barley sold for other uses. Montana breweries also require quality malt to use in their production. However, malt quality is genetically complex, and further research is needed to better understand this phenotype. Since seed shape, seed size, quality of hydration, germination, and malt quality have never all been studied in a single experiment, the purpose of this research is to genetically dissect the impact of seed morphology on malt quality. Through various tests performed in the lab, data has been produced to quantify differences among the crosses of Conlon (a malt barley variety) and 13 nested association mapping (NAM) parents. A NAM panel consists of multiple bi-parental mapping populations all with one parent in common, in this case Conlon. NAM panels provide higher resolution and more power to genetically dissect traits. From the initial Chapon Test, NAM parent 61 was selected as it had significantly higher quality of hydration than Conlon or any of the other parents. The family created by crossing NAM 61 and Conlon, using parents as controls, then underwent malt quality tests to find total protein, extract, turbidity, soluble protein, FAN, Beta-glucan, Alpha-amylase, and diastatic power. The data will eventually be compared to a quantitative trait loci (QTL) map of seed shape. The information collected will provide more insight into the genetically-complex trait of malt quality and aid barley breeders to better select for this trait.

Lilianna Bento: Plant Sciences & Plant Pathology
Mentor: Lauren Kerzicnik - Plant Sciences & Plant Pathology
Density and diversity of spiders in conventional and IPM-managed apple orchards in western Montana

With integrated pest management (IPM) practices, commercial orchards in Montana have the potential to preserve insect diversity and density and to promote a balance of pests and predators, reducing the need for pesticides. By conserving predators, the pest populations, damage to crops, and pesticide use can be reduced. Conventional pest management systems tend to use broad-spectrum insecticides, which can reduce arthropod populations including natural enemies. This can often offset the balance of pests to natural enemies, which in the long run can lead to an increase in populations of pests and pest damage. A subset of data was taken from Dr. Lauren Kerzicnik's study of arthropod pests and predators in commercial apple orchards in western Montana, testing whether density and diversity are lower in orchards managed with IPM. There are two objectives for this study-to characterize the density and diversity of spiders found in western Montana apple orchards in 2017 and to test the hypothesis that the density and diversity of spiders in orchards will be higher in IPM orchards compared with conventionally managed orchards. Spider densities and diversity will be described at the family level. Data will be analyzed as a randomized complete block design. Results will be discussed with a focus on the prospective role of spiders as a component of IPM of orchard pests.

Evan Crittenden: Plant Sciences & Plant Pathology
Mentor: Jamie Sherman - Plant Sciences & Plant Pathology
Developing Acid Tolerance Screening for a Breeding Program

In parts of Montana, soils are becoming increasingly acidic. Barley performance is reduced in acidic soils, causing a loss to growers. Acidic soils reduce the development of the barley root system, causing weak poor yielding plants to develop. Growers' remedies require either liming the soils, which adds production costs or to grow resistant varieties. Last year we tested Montana varieties and none performed well in acidic soils. The primary objective of this research experiment is to obtain preliminary data through a greenhouse experiment on lines that have been reported to be acid tolerant, but never tested in Montana. These lines will then be planted in field trials in an acidic high aluminum environment. The secondary goal of this experiment is to determine if screening can be done on lines in a greenhouse rather than being dependent on field testing in acidic high aluminum soils. If selection can be performed in a greenhouse then it will allow for more efficient screening of lines for acid tolerance. These lines would be very important for Montana producers that are seeing a large drops in soil pH. The lines could also provide an affordable alternative to liming soils.

Acknowledgements: Hannah Turner (MSU Undergraduate Student) – Liberal Studies, Kia Maas (MSU Postdoc/Research Scientist) – Plant Sciences & Plant Pathology, Megan Getz (MSU Graduate Student) – Plant Science, Liz Elmore (MSU Graduate Student) – Plant Science

Katelin Hancock: Microbiology & Immunology
Mentor: William Dyer, Barbara Keith - Plant Sciences & Plant Pathology, Land Resources & Environmental Sciences
Experimental Methods Development for Avena fatua In Vitro Growth Assays

My project set up experimental systems to further investigate the molecular changes identified in multiple herbicide resistant (MHR) Avena fatua, specifically the possible involvement of heat shock proteins (HSPs) in herbicide tolerance. This project established a method for growing A. fatua plants in CYG Germination Pouches, a simple growth container that requires a minimum amount of medium so that heat, herbicide, and other stress treatments can be applied more efficiently. Media composition was altered throughout my experiment to establish the ideal growth conditions for A. fatua. Plants were pre-treated with the HSP90 inhibitor radicicol to test for changes in herbicide tolerance to pinoxaden (Axial) and flucarbazone (Everest). Initial findings suggest that addition of radicicol increases herbicide susceptibility, perhaps by inhibiting HSPs' involvement in the resistance mechanism. Additionally, methods were developed for Arabidopsis thaliana seedlings grown on Phytagel-solidified agar medium in Petri dishes. Dose response tests were conducted and appropriate application rates chosen for A. thaliana for the herbicides First Rate and Beacon. An over-expressing HSFA1b transgenic A. thaliana line was tested for radicicol-induced changes in tolerance to these herbicides. HSFA1b is a transcription factor that activates heat stress pathways, and its ver-expression increases the level of heat stress defense proteins. Both experimental methods developed here are now being successfully used in the Dyer laboratory.

Joseph Jensen: Plant Sciences & Plant Pathology
Mentor: MacDonald Burgess - Plant Sciences & Plant Pathology
Dry Bean Variety Trial

A dry common bean (phasolus vulgaris) variety trial was conducted at the Montana State University Horticulture Farm in Bozeman, Montana. Twelve varieties of dry bean were planted and compared to determine which ones were able to mature and yield well in Bozeman's short growing season. Dry beans are a warm season plant susceptible to frost, so a successful crop must be able to mature and dry within the frost free growing period (about 110 days in Bozeman). Further complicating the path to maturity, the physiological process of flowering is

affected by an interaction between photoperiod and temperature, with low nighttime temperatures noted to delay flowering. For each variety, the number of days until flowering and to maturity were recorded, to be compared to results from dry bean variety trials conducted elsewhere. Upon harvest, the yield, 100 seed weight, number of plants per yard and number of pods per plant were measured. Significant differences in yield and flowering and maturity times were found among the varieties. The weather in 2017 allowed for 119 growing days for the dry beans, which was not enough for some varieties to mature despite their listed days to maturity being lower. The variety with the longest listed days to maturity flowered earliest and was one of the first to reach maturity. The results of the variety trial show which of the tested varieties yielded highest and matured earliest in Bozeman, Montana, which could be useful to local producers choosing dry bean varieties to grow.

Acknowledgements: Hannah Turner (MSU Undergraduate Student) – Liberal Studies, Liz Elmore (MSU Graduate Student) – Plant Science

Uriel Menalled: Land Resources & Environmental Sciences
Mentor: Rachel Endecott - Animal & Range Sciences

The immunological and economic effects of utilizing local anesthesia during branding of pre-weaned angus-cross calves

In a typical Montana ranch setting, beef cattle are a primary commodity. With this commodity, routine ranch procedures including branding, castration, and dehorning are commonly performed without the use of an anesthetic. These traditional procedures have caused increased conflict amongst animal advocates, producers, and consumers regarding if, with the advanced technology available today, they are still considered necessary or humane due to the pain inflicted on the animal. To quantify this pain, plasma cortisol levels can be analyzed. Cortisol, a steroid hormone produced in mammalian bodies as a response to stress and often pain, has been noted to decrease immune responses, increase incidence of disease, reduce weight gain and decrease overall production of livestock. The purpose of this project was to provide substantial evidence that utilizing a local anesthetic during branding not only minimizes the pain of the procedure on the animal but additionally decreases cortisol levels resulting in animals with more efficient immune systems and higher weight gains, ultimately contributing to more economic benefit for the producer. By measuring behavioral symptoms of pain, cortisol levels, vital signs, weaning weights (WW) and average daily gain (ADG) of the calves, comprehensive data encompassing the intricacies of severe, acute stress imposed on the body was investigated. Within this experiment, treatment steers (those which received local lidocaine injections) on average exhibited lower cortisol levels than control steers whom experienced branding without (Pvalue: 0.259484), decreased changes in both pulse and respiration rate, and higher WW and ADG than control steers (Pvalues: 0.205728, 0.209456).

Acknowledgements: Timothy Seipel (MSU Undergraduate Student) – Microbiology & Immunology

Tavin Schneider: Plant Sciences & Plant Pathology
Mentor: Timothy Seipel - Land Resources & Environmental Sciences

Understanding the Interaction of Crop Management System and Crop Identity on biologically-mediated Plant-soil Feedbacks

Cropping system characteristics such as tillage intensity, cover cropping, and the application of off-farm synthetic inputs influence weed abundance, community composition, and crop-weed competition. The resulting plant community, in turn, has species-specific effects on soil microbial communities and can impact the growth and competitive ability of subsequent plants, completing a plant-soil feedback (PFS) loop.
This study seeks to assess the impact of cropping systems on PSFs. Specifically, it compared the PSFs of certified organic-grazed, certified organic reduced-till, and conventional no-till management systems cropped with safflower (Carthamus tinctorius), yellow sweet clover (Melilotus officinalis), or winter wheat (Triticum aestivum). These cropping systems follow a five-year rotation at the Montana State University Fort Ellis Research Center.

Target cropping systems scenarios were replicated in a greenhouse setting using soil samples obtained at the Fort Ellis site. Steam pasteurized greenhouse soil was inoculated with either biologically active or inactive soil from each of the cropping systems. PSFs were calculated by comparing the biomass of the response plants grown in the biologically active and inactive inoculum. Preliminary observations suggest that microbial activity and crop identity influence PSFs. However, cropping system does not appear to affect PSFs.

Acknowledgements: Emma Jobson (MSU Undergraduate Student) – Land Resources & Environmental Sciences, Michael Giroux (MSU Faculty Member) – Plant Sciences & Plant Pathology

Melissa Soddy: Plant Sciences & Plant Pathology
Mentor: Craig Carr - Animal & Range Sciences
Plant Species Diversity and Short Term Impacts of Road Rehabilitation in the Northern Mixed Grass Prairie

Before and after assessment is essential to understanding the results of management practices on a vegetation community. In September 2017, Montana Fish, Wildlife, and Parks decommissioned and rehabilitated a trail within Madison Buffalo Jump State Park. To evaluate trail rehabilitation efforts, vegetation data were collected along the trail prior to its rehabilitation and these data were also used to evaluate the trail influence on adjacent vegetation communities. The study area was divided into three blocks, lower, middle, and upper trail, and within each block seven 12m transects were placed perpendicular to the trail. To represent a gradient in trail influence, each transect was divided into On-Trail, Near-Trail, and Far-Trail positions. Vegetation cover was estimated using a 20x50 cm quadrat. Measurements were taken four times within each position yielding 12 measurements for each transect. Analysis of Variance was used to test the null hypotheses that distance from footpath has no effect on species richness, species abundance, or ground cover. The data show species richness increasing with increasing distance from the trail. Perennial grass and litter cover was higher in the Near-Trail and Far-Trail than the On-Trail, there was more bare ground in the On-Trail compared to the Near-Trail and Far-Trail, and significantly less perennial forbs in Near-Trail compared to the Far-Trail category. No differences in annual grasses or annual forbs were found. This pre- and, the forthcoming, post- disturbance data will help inform future trail rehabilitation projects, illuminate potential revegetation challenges or successes, and enhance knowledge of vegetation dynamics following disturbance.

Natalie Sturm: Land Resources & Environmental Sciences
Mentor: Mike Giroux - Plant Sciences & Plant Pathology
Reduced Height Alleles (Rht) Significantly Impact Bread Making Factors in Wheat

The most impacting development of the Green Revolution was the discovery of the reduced height gene, Rht, which allowed for greatly increased yields. Today, two variations of this mutation, Rht-B1b and Rht-D1b, are widely used in wheat breeding. Although the Rht genes have played an important role in crop production, there has been relatively little research into their effects on end-use quality. This study tested near-isogenic lines from a standard height spring wheat variety (Fortuna) varying for the two most common Rht mutations, (Rht-B1b and Rht-D1b), and a separately acting semi-dwarfing line, Rht-8. We observed over a 20% height reduction and 13% yield increase in Rht-B1b/Rht-D1b compared to the tall isoline, agreeing with previous studies. Decreases in grain protein (from 15.4% to ~13.6%), kernel weight (15%), and loaf volume were also seen in the Rht-D1b and Rht-B1b isolines compared to the tall line. Statistically significant increases in falling number (5%), mixing tolerance (56%), and baking mix time (33%) were observed in the Rht-B1b and Rht-D1b lines. An increase in flour yield (2%) was found, yet unexpected since Rht-B1b/Rht-D1b decreased seed size. Rht-8 results were midway between the tall line and Rht-B1b/Rht-D1b for almost all criterion. Although Rht-B1b/Rht-D1b decrease wheat protein content and kernel size, our results indicate that they positively impact flour milling yield and that dough strength is not negatively affected.

Acknowledgements: Selena Ahmed (MSU Faculty Member) – Health & Human Development , Carmen Byker- Shanks (MSU Faculty Member) – Health & Human Development, Debra Kraner (MSU Undergraduate Student) – Sustainable Food and Bioenergy

Kasey Sweeney: Animal & Range Sciences
Mentor: Selena Ahmed - Health & Human Development

Comparison of the Effects of Organic Versus Conventional Agricultural Management Practices on Nutrient and Phytochemical Profiles of Ancient Grains in Montana

Wheat is one of the most important staple crops in the world today and supports the diets of millions of people through its nutritional profile rich in carbohydrates, protein, fats, minerals, vitamins, and phytochemicals. While previous research demonstrates that crop quality (including nutrient and phytochemical concentration) varies with genetic, environmental, and management factors, there remains a research gap on how organic agricultural practices impact the nutrient, mineral, phytochemical, and sensory profiles of wheat in Montana, and how this varies across different varietals of grain. The objective of this study is to address this research gap by examining the effect of organic agricultural management practices on nutrient, mineral, phytochemical, and sensory profiles of wheat in Montana. I am currently working in the MSU Food and Health Lab along with wheat growers in Montana, including Kamut® International, to address this study question through examining ancient, heirloom, and modern wheat varieties. Phytochemical results to date demonstrate that antioxidant content varies between variety and species and does not vary based on management practice. Findings from this study have the potential to inform nutrition-sensitive agricultural management decisions by providing data on the effects of management and grain varietal on wheat yields and quality as measured based on nutrient, phytochemical, and sensory attributes.

Acknowledgements: Cassidy Wong (MSU Undergraduate Student) – Microbiology, Ben Bottcher (MSU Undergraduate Student) – Animal Science

COLLEGE OF ARTS & ARCHITECTURE

Chase Auger, Tyler Coorough, Christina Dahl, Clayton Ehlers: Music
Mentor: Kristin Harney - Music
Setting Goals + Monitoring Goals = Meeting Goals: An Examination of Individual Music Practice Among Undergraduate Music Students

All undergraduates at Montana State University are required to generate a scholarly project and participate in a research/creative experience. We participated in a semester-long project designed to introduce us (second year, pre-service music education students) to the tools we will need to successfully design, carry out, and complete research during our senior year. Eight students who were enrolled in MUSE 383, Foundations of Assessment, conducted the study. As a way to explore a variety of research strategies in a safe, supportive environment, we engaged in a collaborative research study exploring the impact of goal setting and monitoring on the quantity and quality of undergraduate music students' individual practice. We created research questions, created and administered a survey, coded qualitative data, performed simple statistical analyses of quantitative data, created tables and graphs, and drew conclusions. Individually, each researcher developed a literature review, made observations, interviewed a student, and transcribed the interview. Products from individual tasks were all brought back to the large group for discussion and analysis. Although the focus of the study was on the rehearsal of research, rather than on the generation of a specific research product, our conclusions point toward a direct correlation between goal setting/monitoring and the quality and quantity of studentsâ€™ practice. Key themes identified included focused reflection, consistency, employing effective strategies to overcome obstacles, intention, skill building, and feelings of accomplishment.

Anna Stone: Music
Mentor: Gregory Young - Music
Refinement of "Rocky Mountain Elk: A Suite for Orchestra"

The purpose of this project was to refine the new composition for symphony orchestra, entitled "Rocky Mountain Elk: A Suite for Orchestra", by my professor and mentor, Dr. Gregory Young. We wanted to create further emotional impact of the works for a more convincing climax, and to enhance the musical imagery of the lives of elk along the Rocky Mountains. The main issue at hand was reworking the structure, instrumentation, and specific parts of each movement in order to create coherency, and also finishing the project with detailed editing of the score and parts for a professional look and sound. The methods used for this project involved the music notation software program Sibelius and the use of music theory and orchestration knowledge. I also used the playback feature of Sibelius, along with aural (ear training) skills to assess the sound of the works. I ended up stripping, deleting, and rewriting parts of the works, while also keeping the best sections and making sure it stayed true to the sound that Dr. Young had originally intended it to have. In the end, I created coherency for the works, so that the listener can follow along more easily and grasp the mood that is intended. This project also helped further my knowledge of music creation and editing as a composer, musician, and music technology major at MSU.

Qi Wang: Music
Mentor: Gregory Young - Music
Composition and Mixing of an Album

As a composer and a guitar player, I chose to write an album as my graduation project. This will be heavy metal style mixed with orchestral lines, and include composing, sound generation, and final mixing. Central to this style are the sounds of the electric guitar, bass, and drums, as in a traditional heavy metal band. The more I learned about classical music, the more I realized that there are connections between these two different styles. Much of

the metal music I know, was composed in classical rules for instrumental playing, structure and harmonizing. I am inspired by a famous performance of Metallica and the San Francisco Symphony orchestra in 1999. Their opening piece 'The Call of Ctulu' is by far the most shocking music I have ever listened to. When I first heard this music, I immediately knew I wanted to compose in this style because of its power and energy. My favorite composer is J.S.Bach, and I especially like his polyphonic keyboard works. I am given the utmost satisfaction when I hear multiple melody lines at the same time. I am trying hard to create the same sensation in my music. It will be complicated, and emotionally overwhelming. The way to do it is quite straight forward. On the composing process, I start with guitar lines, and add bass and drums, and finally adding orchestral lines using synthesized string sounds. There will be at least eight tracks with a variety of different structures. The resulting album will be fully mixed, printed in score form, and available online.

Timothy Wells, Tessa Kier, Kevin Nolan, Tyler Weil, Connor MacKinney: Film & Photography
Mentor: Dennis Aig, Andrew Nelson, Cindy Stillwell – Film & Photography
Lucid

Lucid is a student-made short film written and directed by Tessa Kier. It follows a flight attendant who is grappling with where she is in her life the night before her younger sister's wedding. The film's narrative blurs the boundary between reality and nightmare as Tiffany, the protagonist, experiences a series of nightmares that force her to deal with her fears. At its core, *Lucid* deals with the fear of never reaching self-made ideals of success in life. The film's protagonist starts to question where she is in life when she sees her younger sister starting a family and a successful career.

Timothy Wells, Jacob Robinson, Michael Petty, Seth Wyberg, Colter Peterson, Mac Palin: Film & Photography
Mentor: Dennis Aig
The Territory's Best

The Territory's Best is a student-made short film. It is a film about being so blinded by one's own preconceived notions so as not to see the truth staring them in the face. *The Territory's Best* appears a traditionalist Western but subverts the genre by using its own conventions to subtly explore the issue of femininity both in the Old West and today. Its production has provided an invaluable learning experience of both creativity and the production process for all of the crew members involved.

Hayden Woods: Music
Mentor: Gregory Young - Music
Musical Emotion: A meta-analysis on the connection of music and human emotion

Music has the profound ability to bring out a variety of complex emotions that are dependent on the subjective and objective preferences of the listener. While studies have focused on the effects of certain musical elements, music theory must be further explored to uncover specific relationships between music and emotion. How do theory rules and qualities of tonal intervals affect the listener? How does the relationship of scales and harmony play into the writing of music in a way the evokes emotion in the listener? In a study that Dr. Gamble has given to music majors, the results of giving one hundred sound samples to analyze as "favorable" or "unfavorable" were unexpected compared to what the expectation was. Was there a correlation within music education majors, B.A. of music major or music technology majors that connect each group to a school of perceived favorable music qualities. As this study included a mass variety of individuals whose musical tastes all vary, is there a way to give light to a universal ideal of "favorable" music? Subjectivity may be an obstacle, but with the analysis of objective rules in music, perhaps there is a plausible relationship between the subjectivity and objectivity in music and emotion. As a parallel to Dr. Gamble's experiment with sound samples given to music majors and business majors, I plan to do a meta-analysis of research papers on music and emotion and reveal evidence of a methodical process of determining music theory and the emotional link to "favorable" qualities.

COLLEGE OF EDUCATION, HEALTH & HUMAN DEVELOPMENT

Tommy Baldwin: Education
Mentor: Anne Ellsworth - Education
Break Time in Finnish Classrooms

The focus of this research examines how the length of the school day and implementation of break time impacts student learning and achievement in classrooms in Finland. Unlike the United States, Finland has enjoyed high literacy scores in international performance measures. From my early exploration, I have learned that their school day is very different from ours here in the United States. Schools here start around 8 or 8:30 a.m. and dismiss around 3:30 p.m. Elementary students here are able to have a morning and afternoon recess, but as they get older, they receive a lunch break in middle school, and an even shorter break in high school. On the other hand, for every 45 minutes of instructional time in the Finnish school system, the students receive a 15-minute break. Students also generally have much shorter school days as a whole and utilize their free time in many different ways. The research I have conducted while abroad showcases ways in which teachers in the United States can implement effective break times in their own classrooms.

Terry Bradley: Education
Mentor: Jioanna Carjuzaa - Education
Storytelling: Building Relationships to Improve Student Success

Traditionally, reading, writing, and arithmetic are considered to be the three Rs learning, but the learning goals have changed over time. In recent years, there has been a push to look at rigor, the thinking skills needed to acquire knowledge, and relevance, the application skills needed to use knowledge. While the Rigor/Relevance Framework does an amazing job at addressing how students can learn and apply new knowledge, but it does not explain why the students should care about the knowledge. Humans by nature are social creatures. Every aspect of life is based in and around social interactions with fellow humans. Humans are hardwired to give and receive care. In order for the students to care about the knowledge, the introduction of a third R is needed: relationships. Within an educational setting, it is important for relationships to be fostered for successful learning and teaching. Teacher-Student and Student-Student relationships are critical to create an environment of safety, risk-taking, and motivation. Building the relationships makes relevance possible by applying experiences, feelings, and thoughts of others to the students' personal lives. With relationships in action and relevance established, rigor can be achieved. The new Rs of learning have a potential in creating a more successful learning environment that is engaging and effective. In order to successfully apply the three Rs of learning, we must first decide how to develop relationships with and between students. Using storytelling as a methodology proves effective in establishing and nurturing relationships. This method of building relationships validates all experiences shared, recognizes feelings, and promotes shared understandings.

Acknowledgements: McNair Scholars Program

Brianna Bull Shows: Microbiology & Immunology
Mentor: Suzanne Held - Health & Human Development
Importance of healthy patient provider interactions

Messengers for Health is a program that involves members of the Apsáalooke (Crow) tribe and Montana State University faculty and students. In 2013, project partners decided to focus on developing a program to help community members with chronic illness improve their self-care. The program is titled Baa nnillah, which translates to advise or instructions for life that are received from others, often in a story form. The method for Baa nnillah is centered on Crow cultural strengths and is comprised of 7 group gatherings led by community members

who are doing well managing their chronic illness. The purpose of the program is to encourage and support the Apsáalooke people with ongoing illnesses to take positive steps to manage their illness, as well as to be an advocate for themselves to improve their health while staying true to Apsáalooke traditions and values. Each gathering includes a meal, discussion, and hands-on activities with Apsáalooke culturally relevant educational materials. One of the gatherings will focus on relationships and communications between program participants and the healthcare system and their healthcare providers. This presentation will focus on that gathering and discuss the development process and resulting content and activities. Topic areas include the importance of a healthy relationship between patients and providers, including ways to learn how to build a relationship with a healthcare provider, ways to have productive visits, and problem solve issues dealing with the health care system.

Katelyn Claunch: Health & Human Development
Mentor: Selena Ahmed, Carmen Byker-Shanks, Debra Kraner - Health & Human Development
Perceptions of the Digestibility and Effects of Cricket Based Protein Powder in the Body Compared to a Whey Based Protein Powder

With the sustainability challenges linked to meat production including greenhouse gas emissions, there is a need to identify alternative sources of protein that are more sustainable to support both environmental and human health. Insects are consumed as an important source of protein in numerous countries around the world and are increasingly being recognized as a more sustainable alternative to meat-based diets in the Western world because of their production requires less natural resources including water, land, and feed. Crickets are being called the new superfood of athletes- being composed of crude protein, chitin, fiber, all 9 essential amino acids, and all 3 BCAA's. However, there remain challenges regarding introducing insect-based protein into diets as well as a lack of understanding of consumer perceptions of the digestibility of cricket-based foods and products compared to other protein products. In order to address the aforementioned knowledge gaps, I am conducting a feeding trial through the MSU Food and Health Lab by comparing athlete's perceptions of consuming cricket-based protein powder versus whey-based protein powder. A total of nine participants were recruited for this study following human subjects IRB guidelines. Participants are supplementing their diets and workouts with whey-based protein powder for two weeks followed by a one-week flush out period and two weeks of cricket-based insect powder. After each workout, participants are requested to complete a survey regarding perceptions of digestion. Findings have the potential to better understand consumer perceptions of consuming insect-based products from a health perspective towards promoting foods and food systems that support sustainability.

Acknowledgements: Selena Ahmed (MSU Faculty Member) – Health & Human Development , Carmen Byker- Shanks (MSU Faculty Member) – Health & Human Development, Debra Kraner (MSU Undergraduate Student) – Sustainable Food and Bioenergy

Audrey Dickinson: Health & Human Development
Mentor: Kris Juliar, Renee Erlandsen, Amy Royer - INBRE
Factors affecting life expectancy in rural Montana

The life expectancy gap in the United States between residents of areas classified as urban and residents of areas classified as rural is two years, and increasing. In order to isolate the causes of this gap in Montana, sixteen preliminary determinants of health were selected from subjects such as prenatal care, death rates, and prevalence rates of diseases. Upon comparing life expectancies for rural and urban residents within Montana however, it was found that the discrepancy in life expectancy in Montana is only 0.1 years, or roughly five weeks. When plotted on a graph, there is no association between population of the county and average age at death. Because no association was found between age at death and county population, the topic of research than shifted to finding other potential associations. Dyads studied included the relationship between county income and life expectancy, counties with reservations and life expectancy, and finally counties with the largest metropolitan areas and the

counties with the smallest populations. Data from the Community Health Services Department and the Montana Department of Public Health and Human Services will be used to further expound on data collected during the fall semester. Future avenues for research will primarily focus on incorporating communication with tribal leaders in order to identify what may be done to lessen disparities prevalent among reservation communities.

Acknowledgements: Montana Office of Rural Health

Jessica Donahoo: Health & Human Development
Mentor: Renee Erlandsen, Bill Stadwiser – Montana Office of Rural Health, INBRE
Repeating Parenthood: Grandfamilies

Longevity and aging are currently at the forefront of research institutes across the United States. Themes of mind, mobility and finances are at the core of what it takes to live a long and healthy life. When focusing on Montana's aging population, a new theme becomes apparent: grandparents who are raising their grandchildren. Grandparent's rearing their grandchildren has a direct effect on a person's mind, mobility and their financial situation. In 2016, more than 6,600 grandparents were raising their grandchildren (Bailey, Albin, Anderson-McNamee, 2016). The trend continues upwards for grandparents repeating parenthood in order to raise their grandchildren, while resources have stayed the same. There is an increased essential need for grandparents of all ages to know and understand what resources the state of Montana can provide them.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE), Montana Area Heath Education Center (MT AHEC)

Laurel Fimbel: Community Health
Mentor: Suzanna Held, Mark Schure – Health & Human Development
Báa nnilah

The overall goal of this study is to assess barriers and facilitators of study adherence and retention. Thus, the specific aims include: 1) tracking participant attendance at all program and data collection gatherings; 2) Identifying barriers to study attendance and retention; and 3) Identifying strategies that led to improved study adherence and retention. This data will be obtained using a mixed methods design (qualitative and quantitative data).
Barriers will be assessed as part of the post-intervention survey for all participants. This data will be obtained via an open-ended question asking participants whether they experienced any barriers to participating, and if so, why. If study participants are lost to follow-up, this information will be obtained from the mentor, who is asked to track this information via notes.
The effectiveness of each of strategies will be assessed as part of the post-intervention survey for all participants. Specifically, we will use a Likert scale to assess the agreement in which participants perceived each strategy was effective in motivating them to maintain participation in the study.
Attendance barriers will be analyzed using content analysis to better understand the most common issues to study adherence and retention. Both participants and mentor data will be collected and analyzed.
Strategies for adherence and retention will be analyzed quantitatively to identify the relative effectiveness of each strategy.

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Morgan Julian: Health & Human Development
Mentor: Mary Miles - Health & Human Development
The effect of acute aspartame intake on blood glucose, interleukin 6, cortisol, and substrate utilization during high intensity interval exercise.

Aspartame is a nonnutritive sweetener that may exhibit measurable effects on the body. The purpose of this research is to look at how aspartame affects blood glucose, IL-6, and cortisol activity during high intensity interval training (HIIT) as well as how aspartame affects substrate utilization during exercise. We hypothesize that aspartame intake during HIIT will (a) increase blood glucose levels, (b) decrease cortisol (a stress hormone), (c) decrease IL-6 (a molecule that influences inflammation) production, and as a result (d) decrease fat utilization. A double blind, randomized, crossover, counterbalanced study design was used to compare two conditions; 1) an aspartame sweetened herbal tea and 2) a unsweetened herbal tea control. The participants in this study were between the ages of 18-35 with a healthy BMI. Before breaking the blinded conditions, fat burning ranged from 22-39% with a difference between conditions ranging from 3.5-4%. The findings in this research can be useful in both research and real world applications. If aspartame is found to have a noticeable effect on the above variables this may alter the methods in research that commonly uses aspartame as the control variable assuming it has no effect. It can also be useful to know for people who are looking for alternatives to sugar sweetened sports drinks.

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Sophia Koopmeiners: Health & Human Development
Mentor: Selena Ahmed - Health & Human Development
Consumer Preference and Nutrient Content of Aquaponically Produced Vegetables

As global climate change and environmental degradation increasingly presents challenges to the success of agricultural systems worldwide, sustainable food production systems are called for to support community health. Aquaponics is a low input high yield production system in which plants and fish live in a closed loop symbiotic relationship. Fish waste is converted into plant available nutrients by microbial activity while plants filter out harmful waste products from the fish water. Produce from these systems can be grown without the input of fertilizers and with minimal water inputs. As aquaponics expands as a viable production practice of produce and animal protein, research is called for to determine consumer's perceptions, preferences, and attitude towards food produced from these systems. I am working in the MSU Food and Health Lab to compare quality between produce grown in an aquaponics system compared to conventionally grown produce. In the context of this study "quality" refers to an increase in both consumer preference and phytonutrient concentrations compared with conventionally produced vegetables. Specifically, I will be conducting consumer sensory surveys to identify perceptions, preferences, and willing-to-pay for tomatoes produced conventionally versus using aquaponic methods. In addition, I will be conducting nutrient and antioxidant analysis to determine varying levels of phytonutrients between the tomatoes. I hypothesize there will be an increase in phytonutrient levels in the aquaponically grown produce, and consequently consumers will prefer the taste of the aquaponically produced vegetables. Due to the precisely regulated growing conditions of the plants, there is potential for the vegetables to contain higher amounts of phytonutrients, and in turn produce a more delicious flavor. Findings have the potential to help determine the economic feasibility of this sustainable agricultural production method enhance consumer awareness regarding food quality on the basis of how food is grown.

Debra Kraner: Health & Human Development
Mentor: Selena Ahmed - Health & Human Development
An Exploration of Indigenous Food Environments and Cultural Practices in Southeast Guizhou Province, China

Food environments and diets are transitioning globally including shifts from indigenous food systems towards those that resemble westernized diets. Research is called for to document indigenous food systems and how these are responding to global change. During the summer of 2017, I carried out ethnographic research and field surveys in indigenous food environments in Guizhou Province in China to address these research needs. This research was hosted by the MSU Food and Health Lab's collaborators at the Ethnobiological Research Group, College of Life and Environmental Sciences at Minzu University of China. A total of 35 villages were surveyed comprising of Miao (苗族), Dong (侗族), Shui (水族), and Buyi (布依族) minority socio-linguistic groups. Ethnographic work and survey analysis revealed three prevalent themes regarding the region's food environments and cultural practices: (1) modernization of food environments and diets; (2) food as medicine; and (3) food as celebration. As Guizhou Province continues to modernize and its citizens gain greater access to outside resources, diets are shifting with a loss of traditional knowledge and practices. These themes are in line with previous research regarding challenges and opportunities for supporting sustainable food systems. Research and outreach efforts are called for to empower community members in indigenous areas for the preservation of traditional knowledge and customs that support healthy food environments and sustainable food systems.

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Lori Lindgren: Health & Human Development
Mentor: Darcy Hunter - Health & Human Development
What Barriers Prevent Early Prenatal Entry into the WIC Program ?

Women, Infants, and Children (WIC) is a supplemental nutrition program of the USDA that provides healthy foods, nutrition counseling, and recommendations to health and other social services to income-eligible pregnant women and their children up to age 5. Although the health benefits associated with WIC enrollment are well known, many women delay enrollment into the program until after the first trimester of pregnancy. A review of state data showed Healthy Gallatin WIC had lower prenatal entry into the program than other state WIC agencies. The purpose of this study is to use a qualitative open-end questionnaire distributed to WIC program managers and staff interviews to determine the barriers associated with entry into the WIC program. Findings showed there were recurring themes associated with delayed prenatal enrollment. The top themes were lack of awareness of WIC, misinformation (the belief that proof of pregnancy is required for enrollment), lack of intra agency referrals, and lack of transportation. After review of the data and discussions with the other WIC agency staff that have higher prenatal enrollment, Healthy Gallatin WIC has begun renewed outreach efforts targeted at reaching women in the early first trimester of pregnancy.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Jacie Meldrum: Education
Mentor: Kalli Decker - Health & Human Development
Family-Centered Early Intervention Services in Montana

This study builds upon previous research investigating the experiences of parents and children receiving early intervention services in Montana. When asked about services they receive from early intervention providers (physical therapists, occupational therapists, and speech-language pathologists), parents primarily described characteristics of a medical model approach, rather than a family-centered approach. For example, parents frequently reported that therapists typically work with their children while they are in another location (e.g., a waiting room); furthermore, some parents expressed a desire to be more involved in their child's services. These findings are concerning since research indicates that children's health and developmental outcomes benefit

substantially when parents are actively involved in early intervention services. Therefore, we are currently in the process of collecting videos of early intervention therapists providing services to infants and toddlers from across Montana in order to better understand possible barriers to providing family-centered early intervention. The videos gathered will be scored using the HOVRS-A+ rating scale; for example, therapists will be scored on their responsiveness and use of relationship building strategies with the family. Surveys will be distributed to parents that include questions about their involvement in services and the parent's comfort level when working with therapists. Information collected during this study could be used to help early intervention providers across Montana integrate more family-centered techniques into their therapy services. Initial findings indicate the need for establishing a deeper understanding of the influence that therapists have on parent comfort level and how this may influence family involvement in early intervention.

Acknowledgements: Emma Williams (MSU Undergraduate Student) – Cell Biology & Neuroscience, Amanda Belleville (MSU Undergraduate Student) – Health & Human Development, Brooklyn Stern (MSU Undergraduate Student) – Early Childhood Education & Child Services, Alexandra Corcoran (MSU Graduate Student) – Counseling, IDeA Network of Biomedical Research Excellence (INBRE)

Christiane Parrish: Community Health
Mentor: Suzanne Held – Health & Human Development
Selection and co-development of a new topic area of focus in a community-based research project: Improving Healthy Relationships

Messengers for Health (MFH) is a partnership between Montana State University and the Apsáalooke (Crow) Nation that aims toward improving the health and wellness of the Crow People through community-based participatory research projects. Messengers for Health has been successful in reaching out to the community and educating individuals on various health issues and providing resources and support for over 20 years. All work is done with a strengths-based approach and with topics of interest to the community. Recently, the topic of healthy relationships was brought out as a potential area of focus from the partnership's Community Advisory Board. Community members discussed domestic violence as a significant issue and the importance of starting with youth to foster healthy relationships. This presentation will discuss the steps MFH has taken when the community provides a new area of focus for the program including 1) discussing the topic with community members, 2) reviewing research literature on this topic, 3) reviewing previous programs in the community centered on youth and relationships and 4) looking at and talking with other programs and interventions that have been effective in other communities and how we can apply them. The process we are using has been effective in the development of successful programs in the community in the past and it can be helpful to other community-academic partnerships that are learning how to develop programs that are based in and lead by the community partners using community strengths and the local culture.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Mikayla Pitts: Community Health
Mentor: Suzanna Held – Healthy & Human Development
Messengers for Health Baá nnilah program: Understanding community context when recruiting study participants in an American Indian community

Many American Indian communities face continued social and economic conditions that may impact participation in many community health studies. Researchers at Montana State University are collaborating with Messengers for Health, a non-profit Apsaalooke (Crow) organization, in order to implement a culturally-appropriate chronic illness program, called *Baá nnilah*, which is designed to successfully improve health care behaviors and outcomes for tribal members living with chronic illnesses. This study uses a randomized waitlist controlled trial design with community members as program leaders. Ten program leaders were assigned the responsibility of recruiting 20

community members each to participate in the trial (n =200). We will describe how the actual recruitment process unfolded and reflect on lessons learned. We will also discuss the ethical implications of using traditional based recruitment methods in American Indian communities. This will inform researchers on alternative methods for culturally-consonant recruitment of American Indian to chronic illness management studies.

Brooklyn Stern: Early Childhood Education and Child Services
Mentor: Kalli Decker - Health & Human Development
Family-Centered Early Intervention Services in Montana

This study builds upon previous research investigating the experiences of parents and children receiving early intervention services in Montana. When asked about services they receive from early intervention providers (physical therapists, occupational therapists, and speech-language pathologists), parents primarily described characteristics of a medical model approach, rather than a family-centered approach. For example, parents frequently reported that therapists typically work with their children while they are in another location (e.g., a waiting room); furthermore, some parents expressed a desire to be more involved in their child's services. These findings are concerning since research indicates that children's health and developmental outcomes benefit substantially when parents are actively involved in early intervention services. Therefore, we are currently in the process of collecting videos of early intervention therapists providing services to infants and toddlers from across Montana in order to better understand possible barriers to providing family-centered early intervention. The videos gathered will be scored using the HOVRS-A+ rating scale; for example, therapists will be scored on their responsiveness and use of relationship building strategies with the family. Surveys will be distributed to parents that include questions about their involvement in services and the parent's comfort level when working with therapists. Information collected during this study could be used to help early intervention providers across Montana integrate more family-centered techniques into their therapy services. Initial findings indicate the need for establishing a deeper understanding of the influence that therapists have on parent comfort level and how this may influence family involvement in early intervention.

Acknowledgements: Jacie Meldrum (MSU Undergraduate Student) – Health & Human Development, Emma Williams (MSU Undergraduate Student) – Cell Biology & Neuroscience, Amanda Belleville (MSU Undergraduate Student) – Health & Human Development, Alexandra Corcoran (MSU Graduate Student) – Counseling, IDeA Network of Biomedical Research Excellence (IDeA Network of Biomedical Research Excellence (INBRE)

Megan Strain: Elementary Education
Mentor: Ann Ewbank - Education
Non-academic K-12 Learning Factors in the United States and Finland: A Comparative Analysis

Finland has been a model for K-12 education for years, especially in math and science. This is a remarkable achievement for an entire country and educators often discuss what methods they use to be as successful as they are. Researchers have studied Finland's educational system (TeiKari,2016) and analyzed how teachers in America could incorporate practices into our school systems, which could enhance the learning of our students, advance the quality of our teacher education programs, help our students to be more excited about school and improve our test scores. Looking at the physical approaches to teaching is important to consider for the success of our students; however, there are many non-cognitive factors that relate to the learning environment, such as, "academic behaviors, academic perseverance, social skills, learning strategies and academic mindsets," (Nagaoka et al, 2013) that affect the educational outcome for our students. This study of Finland's education system will evaluate the different factors that come into play and how they affect the students. After the study, I will be able to develop my teaching practice to enhance the learning development of my future students.

Vanessa Walsten: Sustainable Food and Bioenergy Systems
Mentor: Selena Ahmed - Health & Human Development
Progression of microbial growth in vegetable fermentation

The consumption of fermented foods is rising with increasing recognition that supplementing probiotics into your diet can provide multiple health benefits. Fermented foods are those that have undergone a process of lacto fermentation in which bacteria feed on sugar and starch in food and result in the creation of lactic acid, beneficial enzymes, vitamins, Omega-3 fatty acids along with multiple strains of probiotics. The process of fermentation preserves fresh vegetables while providing food with different sensory qualities and other attributes.Â Â However, while the process of fermentation has been practiced for hundreds of years, there remains a knowledge gap regarding the effect of fermentation time on the presence and concentrations of micro-organisms, antioxidants, and associated sensory attributes. To address this knowledge gap, research is being conducted in the MSU Food and Health Lab to measure the effect of fermentation time over six weeks on three fermented vegetable products: sauerkraut, kimchi, and carrots. Each week, measurements are being collected for the fermented vegetables for the following parameters: aerobic count, antioxidants, vitamins, yeast and mold, lactic acid bacteria, sodium levels, pH, temperature, and sensory attributes. Findings have the potential to inform evidence-based processing practices of fermented vegetables that are safe, healthy, and desirable to consumers.

Mary Watson: Microbiology & Immunology
Mentor: Agnieszka Rynda-Apple, Kelly Shepardson, Kyle Larson - Microbiology & Immunology
Determining direct and indirect antibacterial effects of P22-capsid

Secondary bacterial pneumonias (SBPs) caused either by S. aureus or S. pneumoniae are primary causes of morbidity during influenza virus outbreaks. However, we have demonstrated that early during influenza infection, mice have reduced susceptibility to subsequent SBPs. Moreover, previous work in our laboratory demonstrated that virus like particles, which are viral capsid protein assemblies that lack nucleic acids, can induce a similar immune response to influenza virus in the host. We also found that this anti-viral response induced by the viral capsid was effective at providing protection from SBP. However, it remains unknown if virus capsids affect the bacteria directly or indirectly, by stimulating anti-bacterial secretions from host lung cells. My preliminary results showed that P22-capsid, derived from Salmonella P22 bacteriophage, was unable to kill S. aureus directly. Thus, I hypothesized that P22-capsid will also be unable to directly kill S. pneumoniae. Instead, I rationalized that P22-capsid, when introduced into the lungs of mice, induces anti-bacterial secretions that when isolated by bronchoalveolar lavage (BAL) and applied to the bacteria ex vivo will be effective in either killing or restricting growth of S. aureus and S. pneumoniae. I found that when S. aureus was incubated with cell-free BAL fluid (BALF) secretions isolated from P22-inoculated mice compared to BALF secretions from naÃ¯ve mice, there was less S. aureus growth. As expected higher concentrations of BALF secretions resulted in less S. aureus growth than lower BALF concentrations. Currently I am determining whether P22-capsid can affect growth of S. pneumoniae either directly or indirectly. I am also investigating whether BALF secretions from P22-casid-inoculated mice kill S. aureus bacteria or prevent its growth. Overall, these experiments will help us understand the mechanisms of reduced SBP susceptibility early after virus infection.

Acknowledgements: Hannah Cho (MSU Undergraduate Student) – Microbiology & Immunology, IDeA Network of Biomedical Research Excellence (INBRE)

Amber Yates: Education
Mentor: Megan Wickstrom – Mathematical Sciences
Mathematical Modelling: Analyzing Students' Notions of Mathematics in Primary Education

Mathematical modelling is a process that uses both traditional mathematics and real-world questions to encourage students to interpret data, engage in investigations and represent information mathematically. In other words, mathematical modelling can be defined as "a system of conceptual frameworks used to construct, interpret and describe a situation" (English, 2004, p. 59). Mathematical modelling in secondary and college education begins

when the students have identified a problem. This problem is derived from a task that addresses the natural curiosity that students have about a real-world situation; a situation they want to understand and explore on a deep, mathematical level. From there, students select important variables and determine the relations between them. By determining which information is important and which does not relate to the task, the students formulate different ways of reaching an answer. Next, the students take this data and rewrite it into mathematical language. Finally, they are able to compute and interpret this data to see what new insights and results were achieved. Not only is mathematical modelling structured differently than traditional mathematics, but the students themselves engage in this process in ways that can be enriching to mathematical education. The research conducted throughout this project looked at how elementary students define mathematics and view themselves as learners while doing mathematical modelling and also during traditional instruction. This was done by creating a lesson plan, providing surveys to elementary students, observing instruction and conducting interviews with 3rd Grade Students.

Acknowledgements: TRiO, McNair Scholars Program

COLLEGE OF ENGINEERING

Rebekah Anderson: Chemical & Biological Engineering
Mentor: Brent Peyton, Rebecca Mueller - Chemical & Biological Engineering
Microbial Characterization and Biotechnological Enzyme Discovery in Hot Springs of Yellowstone National Park

Yellowstone National Park offers opportunities for cutting-edge research, one being the extreme environments of the thermal hot springs. Microorganisms found within the springs have adapted to not only survive but thrive in these seemingly harsh conditions. The adaptations that allow these microbes to survive are of particular interest not only because of their unique ecology, but also because of their potential for biotechnological capabilities. This research project aims to characterize the microbial ecology of thermoalkaline environments in Yellowstone National Parks and to identify enzymes with potential uses in biotechnology. Samples have been taken from the four different hot spring sites, all of which are alkaline (pH > 7) and high temperature (> 70ËšC). Enrichment culturing techniques have been used to culture both community and pure isolate cultures, using cellulose, xylose, and lignin as carbon substrates. Molecular methods including DNA extraction, quantification, PCR, and sanger sequencing have been employed to help identify novel organisms. Thus far, pure cultures have been isolated and identified as Thermus, Bacillus, and Geobacillus. Specific environmental parameters have been adjusted (i.e. temperature) to select for Archaea as opposed to Bacteria. As soon as Archaea is identified in the samples, gradient experiments will be conducted to determine ideal environmental ranges for these organisms. The enzymatic degradation capabilities of these communities will then be characterized using fluorometric assays. By understanding the microbial ecology and the enzymatic degradation capabilities of these communities, we will be able to characterize these understudied communities and discover enzymes with potential uses in biotechnology.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Zoe Benedict: Mechanical & Industrial Engineering
Mentor: Roberta Amendola - Mechanical & Industrial Engineering
Thermal and Environmental Barrier Coating (TEBC) on SiC

Aerospace gas turbine engines operate at high temperatures and use lightweight silicon-based ceramic matrix composite materials like silicon carbide (SiC) to optimize their efficiency. Thermal and environmental barrier coatings (TEBCs) are used in the engines to increase their service life by preventing surface degradation from oxidation with air and hot corrosion from suspended molten salts (Na2SO4) reacting with sulfur gas (SO2) from the engine fuel. Ti2AlC is an extensively researched TEBC that is resistant to oxidation but suffers under hot corrosion. This project aimed to develop an effective process for depositing a thin film Ti2AlC TEBC onto SiC with electron beam physical vapor deposition that has good oxidation and hot corrosion resistance. Control SiC (as is) substrates were tested for 100 hours in a high temperature (700Â°C) oxidation environment in air and hot corrosion environment with 1 mg/cm2 Na2SO4 salt applied to substrate surfaces and 100 ppm SO2 gas. Bulk SiC substrates were coated in a 5um thin film of Ti2AlC using electron beam physical vapor deposition (EB-PVD) and then tested in the same oxidation and hot corrosion environments.
The corrosion behaviors of the coated and uncoated SiC substrates were compared to determine the suitability of the thin film Ti2AlC process developed. Thermogravimetric analysis was used to compare the surface oxidation layer evolution on the hot corrosion SiC substrates with oxidation layer development on the oxidation environment substrates. Phase composition and their corresponding morphologies were determined by X-ray diffraction (XRD) and scanning electron microscope (SEM) respectively for substrate surfaces and cross sections.

Acknowledgements: Madison McCleary (MSU Graduate Student) – Mechanical & Industrial Engineering

Taylor Blossom: Chemical & Biological Engineering
Mentor: Ross Carlson - Chemical & Biological Engineering
Medical Microorganism Robustness Study

Biofilms are formed when microorganisms attach themselves to a surface and excrete Extracellular Polymeric Substances. This state can provide microorganism with increase stability and toxin resistance through the formation of complex structures. This effect can be amplified by microbial interactions within a biofilm. Monoculture biofilms do not occur naturally, but consortia biofilms are exceedingly common. Coculture biofilms can have properties that allow them to be more resistant to stressors such as forming super competitor units, creating special shielding, and stabilizing themselves in EPS. This project explored the antibiotic resistance of three medically relevant microorganisms that are thought to be common in hospital infections; Staphylococcus aureus, Pseudomonas aeruginosa, and Candida albicans. The three microorganisms were tested against three different classes of antibiotics; a penicillin, fluoroquinolone, and aminoglycoside. The microorganisms were grown on agar plates supplemented with tryptic soy broth that contained no antibiotic for a set period until the biofilms were mature, and were then transferred to plates containing the antibiotic of interest. Colony forming unit counts were performed on the biofilm inoculum, at the time of transfer and after the treatment period using selective plates for each microorganism. Comparisons were made between the antibiotics for each microorganism. This procedure was first performed with monocultures and will be compared with cocultures in the same conditions. For monoculture experiments inoculums were performed at a constant optical density, but this showed a large variation in initial colony forming units across microorganisms. Cocultures showed similar results to monocultures, with some combinations of microorganisms and antibiotics having increased resistance. Continuing work will include high performance liquid chromatography analysis of cocultures that showed increased resistance to try and determine how the microorganisms are interacting to enable increased resistance, as well as nutrient variation in test media.

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Mason Bowditch: Civil Engineering
Mentor: Ellen Lauchnor - Civil Engineering, Computer Science
Plants Ability to Remove Varying Levels of Nitrate

While vertical flow wetlands are efficient in the process of nitrification, much more effort is needed to successfully denitrify wastewater. The purpose of this study is to analyze wastewater wetlands ability to remove varying levels of Nitrate by feeding wetland columns, that emulate a vertical flow wetland, synthetic wastewater with concentrations of Nitrogen ranging from 40 mg/L-N to 120 mg/L-N. Three types on plants, Carex, Schoenoplectus and Phragmites, and an unplanted control column, were fed every week and given six days to treat the synthetic wastewater before the Nitrate levels were analyzed. Current results show that the plants are efficiently removing Nitrate at all concentrations. As this study continues, the removal rates for each plant will be analyzed to determine which plant, among the three, removes Nitrate most efficiently. The results of this study are exciting because they show that wastewater wetlands are capable of efficiently removing above normal concentrations of Nitrate. These results are relevant to the research being done at Bridger Bowls wastewater wetlands which is helping to increase understanding of the process of denitrification in vertical flow wetlands.

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Jacob Carter Gibb: Civil Engineering
Mentor: Connie Chang - Chemical & Biochemistry
Measuring Oxygen Distribution in Bacterial Biofilms

A biofilm is a community of bacteria that adhere to a solid surface, and biofilms are ubiquitous in ecological, medical, and industrial settings. Oxygen concentration gradients strongly impact biofilm growth. In efforts to analyze oxygen transport, it has been demonstrated that there is a linear relationship between the spin-lattice relaxation rate R1 (=1/T1) of 19F nuclei in fluorinated compounds such as hexafluorobenzene (HFB) and local oxygen concentration, and this relationship has been exploited in the medical literature to quantify oxygen in animals in vivo. In this project, we will be measuring local oxygen distribution in a packed bed column containing bacteria. The packed bed will be constructed of alginate beads, which we have designed to contain an oxygen sensor core of perfluorooctylbromide (PFOB). We found that when placing a single alginate bead inoculated with E coli into a test tube with alginate beads (diameter ~3mm), over time the inoculated bead functions as an oxygen sink for the entire system and allows us to evaluate bacterial growth kinetics. To create a better surrogate for an ideal packed bed, which would eliminate wall effects and increase the number of fluid flow paths, the diameter of the beads needs to be smaller. With collaboration with the Chang lab, smaller droplets can be fabricated from a double emulsion template that is created in a microfluidic glass capillary device. By being able to non-invasively quantify oxygen distribution and correlate fluid flow dynamics and resulting oxygen transport in these types of systems, we can learn important information such as intrinsic bacterial growth parameters under different conditions, evaluate rate-limiting substrates, and characterize metabolic differences between different bacterial species.

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Ryan Clarke: Mechanical & Industrial Engineering
Mentor: Dr. Renee Reijo Pera, Dr. Shelly Hogan - Other
Is germ cell differentiation limited by lack of SMAD expression?

Human germ cells give rise to sperm and eggs, which in turn propagate reproduction and the continuation of life. In the US, approximately 1 in 8 couples are affected by infertility (1), and a recent report has shown an approximate 59.3% decrease in sperm count in the developed world (2). Despite this, little is known about the development of human germ cells and the underlying mechanisms that lead to their differentiation. In order to better understand human germ cell development and to learn about the etiology of infertility and potential treatments, the Reijo Pera Lab uses human embryonic stem cells to differentiate to primordial germ cells in vitro. In vitro formation of germ cells, however, is very inefficient and inconsistent. In order to address this, my project focuses on analyzing a conserved set of signaling proteins, the SMADs, which have been shown to be essential in germ cell formation from Drosophila to Mouse. We performed immunofluorescent analysis on human fetal testis in our lab and found that we could detect high levels of SMADs 1,4, and 9 (for which we had working antibodies). In comparison, human embryonic stem cells expressed undetectable levels compared to a positive control. When we overexpressed all the SMADs (1,4,5, and 9) in a reporter line, and differentiated for 8 days, we found that SMAD overexpressing hESC stem cells differentiated more efficiently into germ cells. These results suggest that the rate-limiting step in differentiation from stem cell to germ cell may be SMAD expression.

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Clarissa DeLeon: Electrical & Computer Engineering
Mentor: Brock LaMeres - Electrical & Computer Engineering, Center for Biofilm Engineering
Improving Spatial Intelligence Through Minecraft

Improving STEM curriculum will have lasting benefits for the STEM workforce, specifically helping to increase and diversify it. Targeting the improvement of skills beyond a person's ability to perform well in math and science is

key to making STEM seem more realistic for a larger number of people. Research has found a direct link between a person's spatial intelligence and their success in STEM fields. Creating curriculum to target spatial intelligence could potentially help improve it, and consequently work to increase the long term diversification of the STEM industry. Directed activities are being created in Minecraft, for this purpose. Each activity will aim to improve a specific aspect of spatial intelligence: rotation, mental slicing, 2D to 3D transformations and perspective taking. The curriculum is being developed for the middle school level, based on research that shows that a significant gender gap, in spatial intelligence, appears during these years. A camp will be held at Montana State University in the summer of 2018 to pilot the activities, it is during this time that data will be collected to prove or disprove four major hypotheses: (1) Spatial intelligence can be improved, (2) Specific activities cause higher improvement beyond just free play, (3) Males naturally have a higher spatial intelligence than females, (4) Playing Minecraft in any capacity begins to close this gender gap.

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Matthew Doran, Samuel Kern: Computer Science
Mentor: Clemente Izurieta - Computer Science
Visualizing Historical Data with Augmented Reality

This CS capstone project serves as a communication and social platform for a group of users, visualizing geographic coordinates. Users are able to place anchors onto a 2D map synchronously with other users, creating a "rally point" that serves as a point of interest. These rally points are accessible in 2D and 3D, leveraging Apple's ARKit and the Mapbox Framework. A user can then point their camera around their surroundings and see an accurate approximation of shared locations, meeting areas, and/or points of interest within a contextual setting. This precision can be useful for a wide range of settings, including music festivals, concerts, farmer's markets, conferences, and metropolitan areas. The result of this project is an iOS application that can place users into groups and allow users to set rally points that are shared within a group. These rally points are visualized in both 2D and 3D and give information about their distance from the user, what group they belong to, and other context. Outcomes of this project include the application designed around core functionality and user experience. Final conclusions outline the hardware limitations for consistent and accurate location data, as well as experiences in matching user experience to new frameworks.

Thayne Ekness: Chemical & Biological Engineering
Mentor: Brent Peyton - Chemical & Biological Engineering
Examining the Response of Diatomic Algal Species Growth and Development with Supplemental Iron Concentrations

The utilization of microorganisms to provide humans with products and services is a practice that has been occurring for millennia. From food and drink production to waste disposal, the use of microbes in industry is growing in frequency year after year. To further advance this widespread use, my project was conducted to reveal a potential method for maximizing the growth rate and lipid production of microalgae. These properties are important because they are the basis for the group of organism's value as precursors to biofuel production. I investigated the effects of iron on the growth and lipid accumulation of a specific strain of algae. The effects of iron supplementation and limitation have both been studied previously in algae of different species. My studies correlates with those, in that it hoped to find an increase in biomass. It also, however, was conducted to discover whether available iron concentrations had any effect on lipid concentrations.

Callum Gannon: Mechanical & Industrial Engineering
Mentor: Berk Knighton - Chemistry & Biochemistry
Development of Flight Termination System for High Altitude Balloons

The intent of this project is to research and develop a safe, reliable, and inexpensive Flight Termination Unit (FTU) for high altitude ballooning. Many devices, whether using a razor or nichrome wire as the cut down, have been developed with varying degrees of success and safety. This design focuses on eliminating safety concerns while creating a reliable product that can easily be replicated. A parachute three ring release model was employed for the project as a method of truncating the trajectory of a flight. The three rings provide a mechanical advantage through a relationship between the ring diameters providing for a highly reduced frictional force to pull the pin. In this design, a gear and rail configuration was developed to pull the pin powered by a small servo motor. Due to the high strength of the system, the BOREALIS team will have the option to use significantly heavier payloads. However, according to regulations for payloads heavier than 12 pounds, an unmanned free balloon must be equipped with at least two flight termination units that operate independently of each other. A single ring release system has been both tested during flight and in the Snow Science Lab with success. The combination of two independent systems is currently under construction and will be tested in late March.

Tristan Gray: Electrical & Computer Engineering
Mentor: Wataru Nakagawa - Electrical & Computer Engineering, Center for Biofilm Engineering
Characterization of Optical Nano-Polarizers using a Broadband Spectral System

Optical nanostructure-based polarization and spectral filters have a wide range of potential applications in optics, remote sensing, imaging, and biomedical applications. Utilizing a broad-band measurement system, the transmission spectrum of such a filter can be characterized. This capability is critical for the design and optimization of such devices. A measurement system for this purpose has been assembled and undergone rigorous testing to ensure accurate results. This included light source stability testing, optical design modeling, analyzing polarization in different orientations, and cross-referencing to a previous spectral system. The measurement system contains key elements such as a white-light source outputting wavelengths between 350-2500 nm and a Fourier Transform Near Infrared (FT-NIR) spectrometer. These elements allow for characterization of the transmission spectrum of a polarization filter across a broad wavelength range. A graphical user interface (GUI) was also developed to efficiently and accurately characterize polarization filters, as well as other optical devices from a variety of projects. A detailed procedure for performing these measurements was written so that an inexperienced student could effectively take measurements with the system.

Acknowledgements: Torrey McLoughlin (MSU Graduate Student) – Physics

Benjamin Grodner: Chemical & Biological Engineering
Mentor: James Wilking - Center for Biofilm Engineering, Civil Engineering
Chickensplash! Analysis of droplet distribution during splashing

In 2013, the FDA has recommended against washing raw chicken with limited research to support their statements and as a result has lost significant face with the cooking community. Direct transfer of pathogenic bacteria from raw chicken to surfaces has been studied, but there is no information about the transfer of microbes via splash droplets. The objective of this research project was to explore the transfer of microbes through droplets and describe the droplet distribution process. Giant agar plates were used to determine the presence of microbes and explore the surface transfer pattern. High speed imaging of splashing events and image analysis were used to capture and quantify the 'splash envelope' while systematically varying flow rate, faucet height, and surface curvature. The size of the splash envelope depends strongly on the faucet height and weakly on the flow rate. There is a transition zone between splashing and non-splashing regimes for the faucet system developed. The transition with height occurs because of shift from 'pearling' flow' (splashing) at the splash point, to unbroken flow (non-splashing). In order to prevent contamination, it is important that an operator washing a contaminated

surface know the maximum allowable height for washing. Future research in this project will explore specific pathogens within transfer droplets.

Dieter Grosswiler, Daniel Church: Computer Science
Mentor: Clemente Izurieta - Computer Science, Mechanical & Industrial Engineering
ThreeEZ: A 3D Graphics Engine

Modern GPU graphics are considered a difficult subject for beginners to get started on due to the amount of upfront work. ThreeEZ is a web-based 3D Rendering Engine designed to let people start rendering right away. In this project we aim to develop a graphics engine that reduces the learning curve.
The engine uses a web flavor of OpenGL, and WebGL, thus allowing it to run on any browser or hardware. The engine also uses the modern innovative Kotlin programming language that helps maintain clean and simple code. The ThreeEZ rendering engine is designed to have some basic primitive shapes built in and ready to use (i.e., Cube, Sphere), allows models to be loaded in the obj format, and allows for transformations.The engine also includes an optional built in first person camera that allows for easy traversal of a scene or the ability for the user to define their own camera. The engine's main functionality provides the ability to easily (with just a few lines of code) set up a 3D scene with the ability to have complex textured models, real time per-pixel phong shading and normal mapping. This engine may pave the path to cheaper and easier web-based 3D graphics.

Kazi Hasan: Computer Science
Mentor: Indika Kahanda - Computer Science, Center for Biofilm Engineering
An Automated Case Notes System for Psychiatrists Using Machine Learning

Current health care systems require clinicians to spend a substantial amount of time documenting the interactions with their patients, potentially limiting the time spent on patient care. Moreover, the use of Electronic Health Records (EHRs) is known to be highly inefficient due to additional time it takes for completion, which also leads to clinician burnout. In this work, we explore the feasibility of developing an automated case notes system for psychiatrists using machine learning techniques that will not only automatically take notes but also classify collected information by identifying important keywords. First, we developed a human powered transcript annotator to generate the training dataset composed of annotated transcripts in which each part of the doctor-patient conversions is labeled with a domain such as medical history. Then we obtained a gold standard data set using this annotator with the help of NAMI (National Alliance of Mental Illness) Montana. We modeled classifying these annotated examples as a supervised learning problem and employed several popular machine learning algorithms including neural networks. According to our preliminary experiments, our models are able to classify an unseen transcript with accuracies reaching 80%. Currently we are working on generating more diverse training datasets as well as designing more informative features to improve the accuracy of our models. Subsequently, this improved model will be used to develop a prototype of an automated case notes system for Psychiatrists.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Kendra Hergett: Chemical & Biological Engineering
Mentor: Anja Kunze - Electrical & Computer Engineering, Center for Biofilm Engineering
Neuronal growth under microfluidic confinement

A significant portion of research is dedicated to discovering how the brain works. Replicating the architecture of the native brain with its cell layers, gradients, and complexity of networks in the cell culture dish would be ideal but is complicated. What we are striving to do is to create a cell culture environment in which neurons can be studied much like they occur in the brain. We have developed a combination of experiments that use microfluidic devices as a platform on which to grow neurons and form neural networks to test axonal guidance. The

microfluidic devices were fabricated using two-step photolithography in a clean room with KMPR, a negative photoresist, SU-8 developer, and poly-dimethyl siloxane (PDMS), a polymer. For cell adhesion devices were coated with Poly-L-Lysine and seeded with neurons from an E18 rat brain. Neurons are incubated in neurobasal media with 2% B-27, a supplement for growth, and 1% penicillin streptomycin. They are incubated at 37o C, 5% humidity, and monitored for several days. Growth behavior of neurons in the channels will be compared to growth behavior on PDMS and culture dish surfaces.

Elizabeth Herman, Samuel Hulme, Gregory Gilbert, Miriam Rognlie: Computer Science
Mentor: Clem Izurieta - Computer Science
Cricket Farming Automation

The focus of this research is to assist in the development and advancement of the current cricket farming method at Cowboy Crickets, a Montana based business. In preparation for this project and to understand requirements, we developed an understanding of farming methods that are currently in practice by Cowboy Crickets. This allowed for better understanding of the technical aspects that would allow for improvements in their automation process. Automation of the current process will be controlled using a website and specially designed cricket containment bins; which are currently in development at Cowboy Crickets to monitor and control the entire lifecycle of the crickets. Cowboy Crickets will also use this system to record data for future research; which is to be stored in a database for easy retrieval. The final product will include a web-based database to store data recorded by Cowboy Crickets as well as make a website to allow viewing of this data and to independently control the bins. This will decrease the labor costs and increase yields, allowing Cowboy Crickets to begin operating on a much larger scale.

Timothy Johnson: Chemical & Biological Engineering
Mentor: Jeff Heys - Chemical & Biological Engineering
Mathematical Model of Microbial Growth on Various Substrates

The motivation behind my research was to develop a mathematical model to accurately depict how wild-type E. coli growth compares to an engineered E. coli consortia growth under varying conditions. The creation of a mathematical model is motivated by the desire to reduce the number of experiments required to measure growth under a wide range of possible conditions. The mathematical model was developed using experimental growth data of various E. coli strains on different substrates, including sodium acetate, sodium lactate, and glucose. Various mathematical models of growth and inhibition have been published previously, and these different growth functions were fitted to the experimental data using a custom Python algorithm. The optimal model parameters and goodness-of-fit measurements were analyzed to determine the best mathematical model of growth for the system of interest. Future work includes applying the best growth function and parameter values into a model of microbial growth in a biofilm, including the spatial segregation behavior of the system. A publication is being prepared that reports the growth functions and parameters of different E. coli systems on various substrates.

Derek Judge: Electrical & Computer Engineering
Mentor: Anja Kunze - Electrical & Computer Engineering
Magnetic Traps for Biomedical Applications

Magnetic traps act as a way to exert a mechanical force on cells using a magnetic field gradient. This force can be used for a variety of purposes, such as influencing neuron polarity[1], inducing calcium influxes[2], and cell sorting[3]. This research involves the differentiation of neurons from a population according to their biological differences between the cell types. This is useful for creating separate populations of cells, which can be studied separately. The study of the separate cell types has applications in Alzheimer's disease research, such as studying excitatory and inhibitory neurons separately.

The aim of this research is the development of system with which cells are able to be sorted using magnetic field gradients. I have designed a device which allows us to separate cells from suspension via magnetic nanoparticles pre-tagged with antibodies designed to target a biological characteristic of a cell type. The current focus of the design is the simulation and optimization of the design in COMSOL Multiphysics, as well as designing the microfabrication process of the device. Nanomagnetic forces are produced on antibody-marked nanoparticles using a removable permanent magnet in conjunction with magnetically permeable microelements to amplify the force produced. A microfluidic chamber is used to contain the cells which are flowed through the device, and the marked cells are stopped within the device while the unmarked cells flow through.

The cell sorting device has been designed and simulated in COMSOL with various magnetic element designs. Using the formulas $F_{magnetic}=((V_p*\Delta\chi)/(\mu_0))*(B\bullet\nabla)*B^3$ and $F_{fluid} = \rho A v^2$, the force required to stop an individual cell with one nanoparticle can be predicted. Peak forces on the order of 100 pF per particle were observed in the device simulations, and with and average diameter of 20 um per cell body, the maximum predicted velocity of the fluid is 564 mm/s, for the successful capture of a cell. Previous studies report capture rates of 100% at 0.5 mm/s, so this shows improvements are possible.

The next stage of the project is to fabricate the device and verify the forces created. After this is created, the biological sorting can be investigated.

Kayla Keepseagle: Chemical & Biological Engineering
Mentor: Joseph Seymour - Chemical & Biological Engineering
Measuring Oxygen Distribution in Bacterial Biofilms

A biofilm is a community of bacteria that adhere to a solid surface, and biofilms are ubiquitous in ecological, medical, and industrial settings. Oxygen concentration gradients strongly impact biofilm growth. In efforts to analyze oxygen transport, it has been demonstrated that there is a linear relationship between the spin-lattice relaxation rate R1 (=1/T1) of 19F nuclei in fluorinated compounds such as hexafluorobenzene (HFB) and local oxygen concentration, and this relationship has been exploited in the medical literature to quantify oxygen in animals in vivo. In this project, we will be measuring local oxygen distribution in a packed bed column containing bacteria. The packed bed will be constructed of alginate beads, which we have designed to contain an oxygen sensor core of perfluorooctylbromide (PFOB). We found that when placing a single alginate bead inoculated with E coli into a test tube with alginate beads (diameter ~3mm), over time the inoculated bead functions as an oxygen sink for the entire system and allows us to evaluate bacterial growth kinetics. To create a better surrogate for an ideal packed bed, which would eliminate wall effects and increase the number of fluid flow paths, the diameter of the beads needs to be smaller. With collaboration with the Chang lab, smaller droplets can be fabricated from a double emulsion template that is created in a microfluidic glass capillary device. By being able to non-invasively quantify oxygen distribution and correlate fluid flow dynamics and resulting oxygen transport in these types of systems, we can learn important information such as intrinsic bacterial growth parameters under different conditions, evaluate rate-limiting substrates, and characterize metabolic differences between different bacterial species.

Acknowledgements: Jacob Carter-Gibb (MSU Undergraduate Student) – Civil Engineering, Phil Steward (MSU Faculty Member) – Chemical & Biological Engineering), Connie Chang (MSU Faculty Member) – Center for Biofilm Engineering), Jeffrey Simkins (MSU Undergraduate Student) – Engineering, Montana Space Grant Consortium (MSGC)

Whitney Kieffer: Chemical & Biological Engineering
Mentor: Ellen Lauchnor - Civil Engineering, Civil Engineering
Remediation of Mine Tailings Using Microbially Induced Calcite Precipitation

Mining produces large amounts of waste products, including mine tailings which consist of finely pulverized and sometimes chemically processed rock. The presence of large piles of mine tailings poses risks to the environment

and human health. Microbially induced calcite precipitation (MICP) makes use of natural bacterial processes to promote the precipitation of calcite and can help to stabilize soils. This study investigated the feasibility of using MICP to solidify mine tailings and thus reduce the possibility of erosion and spread of tailings into the environment and decrease the amount of heavy metal leaching from tailings. A large syringe was filled with mine tailings and inoculated with native bacteria isolated from mining influenced water. They were fed a solution containing nutrients and calcium using several different feeding strategies over the course of the experiment. Samples of the effluent were taken over the course of a week to measure concentrations of heavy metals, calcium, and urea, and tailings were allowed to dry before removal from the syringe to assess the amount of solidification that occurred. MICP has showed promising results for the solidification of the tailings, with some feeding strategies producing solidified columns of tailings. The presence of bacterial activity in uninoculated controls suggests that native bacteria present in the tailings could also contribute to calcite precipitation. However, a large amount of copper dissolution occurs during this process. More analysis is being conducted to determine if the solidified tailings samples will leach less heavy metals than unsolidified samples.

Melisa Kral Yilmaz: Chemical & Biological Engineering
Mentor: David Hodge - Chemical & Biological Engineering
Biomass Fractionation by Using Organic Solvent

Lignocellulosic biomass is the most abundant raw material on Earth used in production processes of biofuels, especially bioethanol. Due to the complex structure of the lignocellulosic biomass, some methods are developed for the separation of structural components from each other. One well known and extensive way that is utilized for the pretreatment of biomass is organic solvent pretreatment. In this study acetone-based organic solvent fractionation of corn stover was performed in order to see theÂ mass yield and lignin yield. Low boiling point and the possibility of derivation from renewable sources were two effective characteristics of acetone for us to prefer it. The influence of the reaction time and acetone-water ratio on the corn stover were examined in this study to see it's effect on mass and lignin yield of biomass. Three different ratios of acetone-water and reaction times were applied. Temperature was set to a constant value which was 1800 C in all experiments. Beside this, 0.1% biomass weight loading of H2SO4 was used as the catalyst for hemicellulose depolymerization. Finally, from acetone based organic solvent pretreatment lowest mass yield and highest lignin recovery was obtained from 60:40(v: v) acetone: water ratio at 90 minutes which was 77.2%, 3.58% respectively.

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Fei San Lee: Chemical & Biological Engineering
Mentor: Paul Sturman, Diane Walker - Center for Biofilm Engineering
Growing a Mixed Species Biofilm with Modification to an ASTM International Standard Test Method

Under moist and nutritive conditions, it is likely that microbes will adhere and grow on a surface to form a community of bacterium attached to each other called biofilms. Biofouling is one of the most common biofilm-associated problems in many industrial and household systems. The bacteria that has gained popularity in the biofilm research field is Legionella pneumophila, which is the etiological agent for Legionnaireâ€™s disease, a severe form of pneumonia. This pathogenic bacteria commonly thrive in aquatic environments such as in cooling towers, air conditioning systems and other public locations, like decorative fountains or hot tubs. In the interest of public health, many companies are testing disinfectants in laboratory settings for product research and development to combat this pathogen. Unfortunately, it is notoriously difficult to grow a L. pneumophila biofilm because it requires a protozoan host to survive, and thus the need to grow a mixed species biofilm. Currently, research is underway in the Standardized Biofilm Methods Laboratory (SBML) to develop a method to grow a mixed species biofilm that includes L. pneumophila by modifying ASTM E2562 Standard Test Method for Quantification of Pseudomonas aeruginosa Biofilm Grown with High Shear and Continuous Flow using CDC Biofilm

Reactor. Working with the CBE biostatistician to validate the method, the goal is to produce a statistically repeatable and reproducible standard test method for conducting efficacy testing for industries interested in submitting biofilm kill claims to the US EPA.

Courtney Linder: Computer Science
Mentor: Clemente Izurieta - Computer Science
Phone App for better facilitation of communication between students and the respective offices of interest in writing thank yous to scholarship donors

Students at universities across the nation receive scholarship every fall and spring. With the scholarship comes a responsibility to write a thank you to the donor who provided the scholarship money to the school. Many times, though, either the student forgets to write their note of appreciation or writes an unacceptable letter, resulting in lost money to the student and potentially lost money for the university as the donor may decide not to renew their scholarship fund. The objective of this phone application is to allow for better communication between student, the respective offices of interests and their administrators, and the donor. The application will include 1) a way for students to make a 20-30 second video to thank their donor, 2) send the completed video to the donor over email, 3) have a sign in process that automates who the video is being sent to based off of chosen university, and 4) allow administrators the ability to check the thank you before sending it off to the donor.

Josephine Maley: Mechanical & Industrial Engineering
Mentor: Sarah Codd - Mechanical & Industrial Engineering
Exploring Large Amplitude Oscillatory Shear (LAOS) by means of Rheology

The study focused on rheologically characterizing the flow of different fluids. The fluids tested were ketchup, a shear thinning fluid, glycerol and water, both newtonian fluids, and yogurt and carbopol, both yield stress fluids. Each fluid was tested at large ranges of strain and angular velocity through strain sweeps and frequency sweeps. The objective of this project was to assess the structure and viscoelastic properties of a range of complex fluids using large amplitude oscillatory shear, LOAS, tests. The storage and loss moduli were found for each fluid when subjected to different conditions. The storage modulus found during strain sweeps showed the strain percentage at which the nonlinear region started for each fluid,1 for Carbopol, .4% to 1.99% strain, .25 to 1% strain for ketchup, and both water and glycerol are Newtonian so they do not have a nonlinear region. After this was found two sets of frequency sweeps were performed, one in the linear region, .1% strain, and one in the nonlinear region, 10% strain. These tests showed the loss and storage moduli as well the viscosity of each fluid. The nonlinear viscoelastic characteristics of each fluid were identified and compared to the linear viscoelastic characteristics.

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Anna Martinson: Chemical & Biological Engineering
Mentor: Adrienne Phillips, Guneycan Dicle Beser - Civil Engineering
Effect of MICP and EICP Additives on the Mechanical Strength of Concrete

Finding a way to make concrete more environmentally friendly is necessary for creating a sustainable construction industry, as cement production makes up 5% of carbon dioxide emissions worldwide and is important to making concrete, the most used construction material. Reducing the amount of cement needed to make concrete and decreasing the need for maintenance would help the environment. Microbially induced calcium precipitate (MICP) and enzyme induced calcium precipitate (EICP) has been used to make biocement. In this research, S. pastuerii and Jack Bean are coated in silica gel to protect them from the high pH of the concrete so they can form calcium carbonate. As calcium carbonate is formed, the porosity of the concrete should decrease. Decreasing the porosity

would strengthen the concrete and reduce the effects of weathering. To test if enzyme and microbe enhanced cement is stronger than cement at cold temperatures and ambient temperatures, regular cement, cement with urea and calcium, cement with urea and enzyme or microbe, cement with urea, calcium, and enzyme or microbe, and cement with urea, calcium, and enzyme or microbe coated in silica gel will be strength tested by ASTM standard compression test. My hypothesis is that the enzyme coated with silica gel enhanced cement will have a higher compressive strength than microbially enhanced cement or cement kept at the same temperature.

KaeLee Massey: Chemical & Biological Engineering
Mentor: Matthew Fields, Heidi Smith, Anna Zelaya - Center for Biofilm Engineering
The Role of Environmental Isolates in Cycling Heavy Metals in Groundwater Ecosystems

A fundamental goal in the field of microbial ecology is to link the activity and structure of microbial populations to processes occurring within an ecosystem. An essential ecosystem that supports a large majority of microbial life is the subsurface environment. The focus of this project is to characterize two isolated anaerobic microorganisms and to investigate the physiology with respect to contaminated subsurface environments that contain nitrates and U(VI) by 1) elucidating suitable growth conditions for the isolates in liquid media, 2) determining physiological and morphological characteristics, and 3) identifying tolerances and metabolic interactions with heavy metals important to the field site. My working hypothesis is that the selected isolates will have varying tolerances to heavy metals dependent upon the presence of nitrate. Preliminary results identified two isolates collected from core sediment as belonging to the bacterial phylum Firmicutes. The first isolate was most closely related to genus *Desulfosporosinus*, while the second was most closely related to the genus *Pelosinus*. Based on initial microscopic observations, *Desulfosporosinus* is a filamentous rod. Growth curves are currently being conducted for both isolates using three different media: $FMnO_2$, LS4D, and CCM. All three media have been tested under two different temperatures (22°C and 37°C) and different agitation conditions. LS4D media has been the most successful for liquid culture growth of *Desulfosporosinus*, allowing the organism to reach a maximum OD600 of 0.2 after approximately 2 months of growth at room temperature (22°C). Current and future studies will test different carbon sources as well as the capabilities of these isolates to reduce iron and other field relevant heavy metals. Understanding how microorganisms can adapt and remediate conditions is critical for human and environmental health because all biological organisms depend on the microbial metabolisms within these subsurface environments to help sustain life above ground (*e.g.*, global elemental cycles).

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Carter McIver: Mechanical & Industrial Engineering
Mentor: Randy Larimer, Shelly Hogan - Electrical & Computer Engineering, McNair Scholars Program
Positioning and Testing of Inertial Measurement Units

This paper discusses our ongoing research into assessing the accuracy of inertial measurement units (IMU). We used three different IMU's varying in price and performance. The utilization of the different models was explored over the recent August 21st, 2017 total solar eclipse high-altitude ballooning live stream project. The IMU's were used on the ground tracking station for orientation. Understanding the precision and accuracy of different units was paramount to the ground station's functionality. The results of our findings are presented in this paper; distinct configurations, including being near metallic materials and how that affected the inertial measurement unit's performance are discussed.

Acknowledgements: Trevor Gahl (MSU Graduate Student) – Computer Science, McNair Scholars Program, Borealis, Montana Space Grant Consortium (MSGC), NASA

Prasaad Milner: Chemical & Biological Engineering
Mentor: Ryan Anderson - Chemical & Biological Engineering
Three-Dimensional Computational Modeling of PEM Fuel Cells

Polymer electrolyte membrane (PEM) fuel cells generate electrical energy with zero pollution emissions through a hydrogen-oxygen electrochemical reaction. Current research is focused on addressing cell water concentration and developing control strategies to optimize performance and safety. This project demonstrates the development of three-dimensional computational models of spatial water concentration, velocity, and temperature within a PEM fuel cell to better understand transport mechanisms associated with undesired water distributions. Computational models were generated with COMSOL Multiphysics software and outlet relative humidity (RH), water mass flux, and pressure drop values were determined across both anode and cathode channels with varied inlet stoichiometric conditions. Results were compared to experimental values to evaluate the accuracy of the model and resulting spatial distributions. Anode and cathode RH values were observed to decrease with increasing anode (hydrogen) stoichiometric flow rates, with larger gradients present across the anode outlet and at low anode stoichiometric conditions (1.5 to 4). Water mass flux across the anode outlet was found to increase with anode stoichiometric flow rate with values greater than experimental predictions at low stoichiometric conditions (0.12 g/min, 0.02 g/min) and lower at high stoichiometric conditions (0.21 g/min, 0.24 g/min). Pressure drop across the anode channel increased with anode stoichiometric flow with larger gradients at high anode stoichiometric conditions. General trends in outlet RH, water flux, and pressure drop with respect to stoichiometric conditions mirrored experimental trends, indicating the applicability of this model with moderate parameter refinement.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Youra Moeun: Chemical & Biological Engineering
Mentor: James Wilking - Chemical & Biological Engineering
Quantifying a Drug Composite Breakup using a Hydrophone

Drug formulation is crucial because many newly discovered drugs have low solubility, resulting in a need for high dosages, which can cause waste and intestinal problems. We are studying the fundamental physics and chemistry of the breakup of a poorly soluble drug, fenofibrate. To improve its bioavailability, we imbibe pellets of silica nanoparticles with the drug. We want to quantify sound emitted during drug composite breakup to supplement results obtained by image analysis. Using an underwater microphone, or hydrophone, to detect the acoustic signal, we systematically varied several variables. Changing the position of pellets or the hydrophone in the beaker had negligible effects on the signal. However, varying the depth of water or beaker diameter resulted in dramatic changes, as did storing pellets at differing relative humidity. Higher humidity inhibits composite breakup; pellets stored at 100% humidity barely broke up in water at all. This reinforces the importance of using humidity-proof containers in storing and packaging poorly water-soluble drugs. All acoustic data exhibited both noise and signal saturation. The rigid glass beaker, we hypothesized, might add background noise by reflecting sound back to the hydrophone. To address this, we will adjust the recorder's sensitivity. Decreasing it will reduce the saturation point of larger events, allowing us to measure precisely how big they are. Increasing it may let us focus on smaller events, although noise is also amplified and could become problematic. We therefore plan to build on insulating experiments performed earlier, such as using cotton balls and plastic bag containers.

Marie Morin: Computer Science
Mentor: Clemente Izurieta - Computer Science
A Longitudinal Study of Technical Debt in Gaming Systems

Technical debt pervades almost every area of computer science, as it represents the time that must be spent refactoring poorly written code. The technical debt metaphor gives a hypothetical measure of the time needed to

refactor suboptimal code. Technical debt is not necessarily a bad thing—it can be helpful to take on technical debt in the early stages of projects, as long as that debt is paid back. It has become a common issue that video games are sometimes released without proper testing, resulting in shortcuts that can accumulate in the form of technical debt. In this exploratory longitudinal study, we aim to obtain insights into the following research question: does the amount of design pattern instances and/or the size of open-source video games code impact the amount of technical debt over time? Four versions of open-source video games were selected for analysis. Technical debt, lines of code (LOC), and number of design pattern instances was recorded for each version of the selected games. Lines of code and number of design pattern instances were both compared against technical debt to determine if either measure correlated to a change in amount of technical debt over time.

Shannon Muenchow: Civil Engineering
Mentor: Kathryn Plymesser, Nolan Platt - Civil Engineering
A Study Testing the Accuracy of the USGS Midsection Method When Measuring Discharge Through a Denil fishway.

The aim of this study was to test the validity and accuracy of those flow rate readings. Studying the accuracy of the method in which discharge is measured is beneficial to Arctic grayling studies because it provides method validation for the modified USGS method and allows the researchers to interpret their data to assess error. In addition, the value of this study extends beyond the Arctic Grayling study. It gives other researchers data to assess which method is best to measure volumetric flow of a Denil fishway and a range in which the data collected can be used based on error calculated. The primary results of the study showed greater accuracy of this USGS midsection method at higher flow rates than lower flow rates. The difference in accuracy did not follow a linear correlation to flow rate. Analysis indicated the midsection method, even at its highest flow accuracy was precise, but only around 80% accurate in measuring flow rate. The project gave me ideas for how I may be able to investigate more accurate flow collection methods in the field with limited technology and equipment.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Justin O'Dea: Computer Science
Mentor: Shelly Hogan, Dave Millman, Brittany Fasy - McNair Scholars Program
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.

Ryan Odstrcil: Mechanical & Industrial Engineering
Mentor: David Miller - Mechanical & Industrial Engineering
Neat Resin Coupon Manufacturing

In the process of manufacturing neat resin coupons, there are a variety of factors that affect the end quality of the samples. When trying to create the coupons, variables such as porosity, internal stresses, and geometry play a significant role in the quality, measured by the variation in strength properties, of the finished sample. The purpose of this research was to investigate techniques for manufacturing the resin coupons that reduce the variation of material properties amongst samples and enable the determination of constitutive properties without defects from manufacturing. To accomplish this, factors such as pouring technique, mold geometry, and the sample curing environment had to be better understood. It was discovered that the best technique to manufacture the samples was to utilize a three-piece mold with a vertical pouring configuration, as this process resulted in samples with the most uniform thickness and reduced porosity significantly, when compared to a horizontal pouring configuration. The next step in the research is to examine the variation of strength properties within the samples. A high variation indicates non-uniformity across samples, which prevents a subsequent research of this material due to a lack of a solid foundation of knowledge on the primary structural properties of the material.

Timothy Olsen: Chemical & Biological Engineering
Mentor: James Wilking - Chemical & Biological Engineering
Developing a Method for Freeze Drying Microbial Loaded Hydrogels

This project seeks to develop a procedure for the freeze drying of microbial loaded hydrogels. These hydrogels consist of poly(ethylene glycol) diacrylate and are produced using a stereolithography based 3D printing method, developed by the Soft and Biological Materials Lab, in the Center for Biofilm Engineering. There are a variety of potential applications for these hydrogels, ranging from studying the formation of biofilms to functioning as small bioreactors. Freeze drying these hydrogel bioreactors would allow for them to be easily stored and shipped throughout the world and possibly even into space. Initially unloaded hydrogels were printed and freeze-dried to ensure that there would be no complications arising from the hydrogels during the freeze-drying process. Microbial loaded hydrogels were then produced using two Escherichia coli strains, one containing the pRSET-mcitrine plasmid, which expresses a yellow-green fluorescent protein, and the other containing the pRSET-td-tomato plasmid, which expresses a red fluorescent protein. The loaded hydrogels were printed on a Form 1+ SLA 3D printer using the standard hydrogel resin mixed with a small amount of liquid cell culture. Once printed, the gels were immediately imaged using a fluorescent microscope and then freeze-dried. Following freeze-drying, the gels were rehydrated using LB broth and imaged at 24 and 48 hours after rehydration using a fluorescent microscope. Initial results have shown that the E. coli are able to survive and replicate following the freeze-drying and rehydration process. Going forward, more work will to be done to optimize the process for maximum cell survival rates.

Siri Orser: Electrical & Computer Engineering
Mentor: Anja Kunze - Electrical & Computer Engineering
Soft-gel Integration of Micro Channels to Study Brain-like Neural Dynamics

Neurodegenerative diseases present difficulties in both the diagnosis and treatment. In part, the problem stems from an incomplete understanding of the brain and how neurons can experience failure. To help remedy this, many researchers seek to observe and better model neuron growth and decay. However, parts of the brain including the cortex and the hippocampus require neurons to grow directionally which presents difficulties when grown in vitro. One method by which to control cell growth is defining growth channels using a moldable gel know as agarose.
The concentration of agarose within a solution determines the strength of the final gel and to optimize the agarose solution, 0.5%, 1%, and 5% concentrations of type I-A and type VII-A agarose were prepared and droplets were placed on a petri dish and cooled for at least one minute. The petri dishes were then seeded with E18 rat cortical neurons and are currently under observation for what concentrations prevented neurite growth within the

droplets. After determining the optimal concentration of agarose, masks will be created at varying heights and observed to determine at which height neurites can escape the channels.
Thus far, the agarose at a 0.5% concentration has failed to form stiff droplets and at 5% concentration results in a viscous solution that the pipettes had difficulties measuring accurately. An agarose solution at 1% concentration, however, successfully pipetted onto the petri dish and initial observations prove to be positive. The type VII-A agarose allowed for easier pipetting, likely due to its lower gel strength, compared to the type I-A agarose.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Carie Pointer: Computer Science
Mentor: David Millman - Computer Science
Share Code: An Active Learning Tool for Computer Science

The purpose of this project was to promote active learning in undergraduate computer science courses by creating an online application for students to submit code solutions to in-class assignments. This application provides features for users to submit code or to view published code from their personal computers. The instructor end of the application contains additional features for viewing a list of user submissions, publishing submissions, and deleting lists of submissions. We presented the application during a tutorial session pertaining to programming concepts in order to compare traditional lecture format and active learning utilizing a web-based platform. We plan to implement a full-scale version of the application in an undergraduate computer science course at Montana State University.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Joseph Prior, Marshall Carpenter: Mechanical & Industrial Engineering, Elementary Education K-8
Mentor: Megkian Doyle, Thomas Jungst – TRiO Retetion Specialist, Mechanical & Industrial Engineering
Enriching the Ingenuity of Youths: An Engaging and Enlightening Engineering Program for the Next Generation

If 4th and 5th grade children are exposed to engineering principles, then they will be able to identify and solve a problem reflecting a societal need that includes; specific criteria for success and constraints on materials, time, and cost.There are five one-hour lesson plans in the five-week unit. Each lesson is carefully designed to use direct instruction along with problem solving techniques, through prototype construction, to teach basic engineering principles. The priority of the unit plan is educating the students about: basic physics, material properties and selection, basic engineering mathematics, design, and manufacturing. Lessons introduce the 4th and 5th graders to case studies about children from Mexico with disabilities, applying what they've learned solve problems using prototypes.The purpose of the prototype is to provide children with disabilities the opportunity to live a better life. The instructor evaluates the children's completed work and prototype for specific design and production criteria. Some specific criteria and constraints regarding the prototype include; material selection, fastening methods, mechanical drafting, and appearance considerations. The outcome of this research, and further research, will determine the earliest starting age for children to become well-educated on the rudimentary principles of engineering.

Levi Rak: Computer Science
Mentor: David Millman - Computer Science
Reacting to Events on the Blockchain

The introduction of Bitcoin has stirred up a lot of interest in decentralized systems in the past several years. The financial side of this is in the intended purpose of Bitcoin as a completely decentralized currency, and the technical

side of this is in the core technology powering Bitcoin: the blockchain. Since Bitcoin's introduction, many other applications of the blockchain have come to be recognized, and many more are yet to come.
With this on the horizon, it is necessary to build tools for dealing with the blockchain and performing useful tasks. One such task is merely being able to efficiently collect information from and react to events that occur on the blockchain. In the example of Bitcoin, such a tool could be used to assess what Bitcoins are being used for; e.g., if the typical transaction is small, it may be inferred that Bitcoins are being used to purchase mundane things such as groceries. If one day a service similar to Craig's List or eBay were to be implemented using blockchain technology, then such a tool could be used to identify when listings are posted or removed.

Benjamin Rhuman, Isaac Sotelo: Computer Science
Mentor: Clemente Izurieta - Computer Science
NuMo - A Better Diet a Better Life

NuMo is a nutrition monitoring software mobile application for both Android and iOS devices. Its main functionality addresses the problem of inaccurate data sources often found in other nutrition tracking software. It uses the United States Department of Agriculture (USDA) National Nutrient Database that provides accurate and detailed nutrition profiles for more than 8,000 different types of foods. Unlike many other nutritional tracking applications, NuMo does not focus on weight loss/gain. Instead it guides users to optimize ratios of required nutrients, most notably with a focus of omega-6/omega-3 ratio. Calculations of total daily grams of sugar and amino acids that are consumed each day are also included. The app was beta tested with a group of students from the University of Wyoming by comparing NuMo to other alternatives on the market. The current goals for NuMo are to revamp data visualization, improve the readability of charts, add new diagrams for other nutrients, improve food searching functionality, change the food query to display clearer results, and add support for more advanced macronutrient tracking. Many of the steps above will simplify the user interface (UI), improve the user experience for Android and iOS devices, and provide a more complete nutrition tracker.

Dean Ricker: Chemical & Biological Engineering
Mentor: Christa Merzdorf - Cell Biology & Neuroscience
How Does Aqp3b Orchestrate Neural Tube Closure?

Early in the development of the nervous system, vertebrate embryos undergo neural tube closure. This is a process where the cells in the dorsal part of an embryo, the neural plate, constrict on their outward facing side (apical constriction) to form a tube. The Merzdorf lab has found that inhibiting expression of the protein Aquaporin 3b (Aqp3b) in Xenopus laevis embryos prevents neural tube closure from happening. Given that aqp3b is only expressed in a welldefined line along the outer edge of each side of the neural plate, this action at a distance suggests some form of intercellular communication. In fact, calcium waves are required for neural tube closure. My hypothesis is that Aqp3b triggers the calcium waves that cause neural plate cells to apically constrict. To address this question, the number and characteristics of calcium waves will be compared between normal embryos and embryos that have been inhibited from expressing Aqp3b. My specific hypothesis is that the neural plate in embryos with inhibited aquaporin expression will have fewer calcium waves with different characteristics. Working towards the goal of answering this question I have developed and finetuned a method for injecting the embryos with a calcium indicator and imaging them. I have begun collecting time lapse images of calcium activity during neural tube closure and am designing methods for analyzing the time lapses I capture. This research is significant because, while calcium transients are known to be necessary to neural tube closure, no triggers of these calcium waves are known.

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

Riley Scherr, Will Senecal: Civil Engineering
Mentor: Michael Berry - Civil Engineering
Non-Proprietary Ultra-High Performance Concrete

Ultra-high performance concrete (UHPC) is a unique type of concrete with applications in projects where ordinary concrete would not be sufficient. The use of commercial UHPC has been limited in the field because the cost is 20-30 times that of conventional concrete. The objective of this research is to test the feasibility of non-proprietary mixes of UHPC developed at Montana State University in the field, by testing properties of mixes which utilize realistic field mixing conditions. The collected test data is then interpreted and used for calculations in accordance with ASTM standards to determine if the non-proprietary mixes can hold up their adequate mechanical and durability properties once implemented in projects. UHPC has been mixed and tested using equipment in the MSU concrete lab and materials testing lab.
Data is collected as mechanical strengths and durability properties interpreted from the lab testing done on UHPC specimens. From past tests, non-proprietary mixes of UHPC produced adequate mechanical strengths, and the durability testing exhibited little effects on the UHPC specimens. In more recent testing, mechanical strengths of UHPC, using varying mixing components to replicate field applications, have been recorded at ideal levels including up to 15-ksi average 7-day compressive strengths.
Uses of UHPC in the U.S. include field-cast connections of prefabricated bridge components, precast/prestressed girders, precast piles, and thin-bonded overlays for bridge decks. MDT Bridge Bureau is interested in using UHPC for field-cast joints between precast concrete deck panels. Research on UHPC is ongoing, and more research must continue to better replicate different field applications in terms of the concrete mixing variables.

Joel Seeley: Mechanical & Industrial Engineering
Mentor: Roberta Amendola - Mechanical & Industrial Engineering
Investigation of hybrid coatings for hot corrosion protection in coal fired boilers

Hot corrosion is an important issue in modern coal fired boilers. For last decade, law regulations have forced to reduce emission of harmful substances from combustion in power plants equipment, including ashes and gases (NOx, SO2, CO, CO2). Emissions of Nitrogen oxides (NOx), which are among the most toxic exhaust gases, may be limited only by modifying the combustion process, i.e. combustion atmosphere with low partial pressure of oxygen. This reducing atmosphere, along with the presence of low grade coal, containing sulfur, chlorine, sodium and potassium, generates H2S and molten salt deposits which may react with the metallic pipes increasing the corrosion rate in a phenomenon known as “hot corrosion”. Development of suitable metallic alloys against hot corrosion is expensive, time-consuming and difficult using standard bulk alloy fabrication techniques. Instead, durable coatings which act as barriers between the substrate material and the aggressive environment, can be designed to protect the material and minimize the damage. The purpose of the proposed research is the assessment of durability of a protective hybrid coating to be used in power plants where low-NOx emission boilers are used. This project tests a multi layered hybrid coating named HybridMD. This coating consists of a 30 to 80 µm inner layer containing a spherical aluminum powder filler and a 25 to 60 µm outer layer, which is a mixture of spherical and/or flake powders of aluminum and silicon. This multi-layered coating has been applied to AISI 441 ferritic stainless steel (FSS)substrates by researcher in the Department of Material Science and Ceramics at AGH University of Science and technology in Krakow (Poland).

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Seth Severa: Computer Science
Mentor: Clemente Izurieta - Computer Science, Computer ScienceComputer Science
A Social Approach to Music

VibeTribe is an application designed to share personalized snapshots of music with one's peers quickly and seamlessly. By creating a web-based client that utilizes Spotify's extensive library while remaining lightweight and easy to navigate, this project seeks to combine robust design, efficient structure, and a touch of artistry. VibeTribe is built using Javascript both for the server and functionality on the front end, which allows for easier collaboration and clearer focus. Standard web design procedures complemented by intuitive graphics provide a user with a platform with which to communicate with Spotify's API, retrieving songs and user information. Using the server and an online database, users can call upon their peers' snapshots and share their own. The web application supports communication with Spotify and song playback through means of Spotify's own program. A cyclical iterative approach to building the software allows for a steady incline in the strength of each element of the design. At the time of presentation, a working prototype complete with all major functionality and elegant design will be ready to present. A showcase will overview front end design, interaction with the API, and the server's utility.

Tiana Smith, Elias Athey: Computer Science
Mentor: Clemente Izurieta - Computer Science
AutoArt

Abstract art is resource expensive and time consuming to both create and purchase. In order for a piece to sell, it must be visually appealing and meaningful to the buyer. The problem for consumers is the tradeoff between meaning and price; art that is meaningful is often expensive as the artist must tailor the piece to the buyer. Attempts have been made to build programs that generate affordable art, but these programs fall short in their ability to create meaningful art. AutoArt is an art generation program that aims to solve this problem by creating abstract art from answers to personal questions. In our solution, the questions are mapped to distinct visual aspects including color, form, and texture, and a user's answers determine which visual elements will be built. This mapping from personal traits to visual elements is a difficult problem because of its lack of objectivity. So along with AutoArt, a literature review is conducted analyzing the relationship between personality and meaning in art.

Jordan Sparr: Computer Science
Mentor: Clemente Izurieta - Computer Science
Analyzing popular text media for gender bias

Identifying bias within popular text-based news media has come a long way with modern techniques of computational linguistics. By utilizing language models and probability of word usage, this research project aims to give a sociological and linguistic basis for modern language analysis techniques in identifying gender bias. To best identify the gender bias of a piece, this project will be taking apart articles by use of these metrics: him/his/he pronoun usage versus her/hers/she, gender of quoted parties, and utilizing a semiotic approach for identifying cultural connotations within the meanings of specific words. These metrics will then be provided as percentages. The constraints listed above have been chosen due to being the most effective way to translate bias to a wide audience of potential news readers. To validate these methods of analysis, the output of these analysis techniques will be compared against a sample set of people who have read the articles being analyzed, and have provided their own interpretation as to the gender bias they perceived in the piece. The accuracy of this analysis will be measured by comparing the output to a professionally generated gender bias value, and quantifying the accuracy of this researches analysis technique against the results given by the sample set of news readers. As such, this research will help to create a foundation for giving news readers a method for identifying gender bias that is quick and easy to digest.

James Stangeland: Chemical & Biological Engineering
Mentor: Phil Stewart - Chemical & Biological Engineering
Measurement of Bacterial Growth Rates Using 13C Incorporation

The purpose of this project is to develop an alternative means of measuring bacterial specific growth rates by the incorporation ratio of Carbon-13 to Carbon-12 in the proteins of Staphylococcus aureus. This is done by creating a medium that simulates known growth rates in serum and with most of the carbon being carbon-13. This will be pulsed into the bacterial culture and then harvested the proteins from the S. aureus at different time points to develop a standard curve. Sonication and centrifugation was used to lyse the cells and separate the proteins from other cellular components respectively. Once the cellular components were separated, the proteins were suspended in an aqueous buffer.
As this is part of an ongoing research project, the following procedures will be forthcoming. A mass spectrometer will be used to measure the ratio of Carbon-13 to Carbon-12 in proteins. It is hypothesized that the rate of increase in this ratio will be proportional to the bacterial specific growth rate. Two models will be used during this process: the traditional planktonic culture and a biofilm grown on a glass coverslip. The planktonic model will be used to determine maximum specific growth rate. The biofilm model more accurately simulates the environment of a chronic wound than the more common planktonic culture model, as the bacteria form small aggregates and are limited in growth by the rate of diffusion of nutrients. Potential advantages of this method would be a more accurate growth rate measurement in aggregating microorganisms such as S. aureus, or finding growth rates with mixtures of microbial species if proteins can be associated with specific species.

Nathan Stouffer: Computer Science
Mentor: Brittany Fasy - Computer Science
Generating Data for Prostate Cancer Diagnosis

The goal of my project is to computationally generate biologically accurate simulations of prostate glands in various stages of prostate cancer. This is part of a larger project, headed up by Computer Science professor Dr. Brittany Fasy, with the goal of using Topological Data Analysis and Machine Learning to diagnose prostate cancer. While Dr. Fasy is hard at work on a program that can perform gland analysis, she has a data shortage: only thirty patients are donating samples. However, even if Dr. Fasy had more patients, the process of collecting and rating the cancer's severity is long and arduous. This project takes the first steps in providing those samples, which will allow the Machine Learning process to advance far more quickly. In addition to providing more data, simulated samples grant an element of control when testing the sample grading program.
The prostate is a glandular structure created by packing glands together. This semester, my focus was on generating the glands, not the packing itself. To complete this, I generated an ellipse and varied the radii of points on that ellipse using a combination of Gaussian and Brownian Bridge randomization. A Brownian Bridge curve begins and ends at the same point, but varies the intermediate space while Gaussian randomization just moves the points a small distance in a random direction.

Acknowledgements: Andrew Sholl (Faculty Memebr at Tulane University) – School of Medicine

Laura Sullivan-Russett, Melody Tribble, Tanner Gascon: Computer Science
Mentor: Clemente Izurieta - Computer Science
HP Remote Graphics System: Performance Data Collecting

During the development and maintenance of a proprietary software product, there is a need for developers to measure any improvement or regression in the performance of that software. HP's Remote Graphics Software (RGS) provides the ability to access graphics intensive software from high-powered workstations remotely from a laptop or tablet. Using software engineering techniques we have designed and implemented a performance testing suite for HP developers working on RGS. The testing suite includes specific tests for the major components used in the conversion/sending of digital images and high-frame-rate video. These components include capturers, encoders, and decoders. The tests can be customized using a configuration file that will allow the tests to be run

automatically at anytime. We are using the Visual Studio IDE and C++ compiler to be compatible with the HP's legacy code. Google's GTEST framework has been implemented for the tests themselves. Tests are configured to have output that is both readable and parseable in an XML format with the intent of a future database implementation.

Hannah Szafraniec: Chemical & Biological Engineering
Mentor: Connie Change - Chemical & Biological Engineering, McNair Scholars Program
Characterization of Influenza A using Microfluidics

The purpose of this project was to characterize viral infectivity of Influenza A virus (IAV) using bulk assays and microfluidic assays. MDCK and siat7e-expressing MDCK cells were cultured to serve as host cells for IAV and to compare differences in results when using an adherent cell line or spinner cell line.
Influenza A is a highly mutagenic virus that has only been studied under bulk cell culture conditions. Microfluidic approaches to studying this virus will allow for the recognition of small populations of Influenza A with pathogenic capabilities but are genetically different than the dominant species. This technology will allow researchers to study the genetic diversity of a population of virus and predict the evolutionary path the population will take when subject to environmental pressure.
Influenza A/California/7/2009(H1N1) was the viral strain of interest for this project. The traditional bulk assays of interest were the TCID50 assay. The results of this assay can then be compared with the microfluidic viral infectivity assay.
The project consisted of developing a microfluidic viral assay to determine the amount of virus reproduced after one infection cycle of 24 hours by encapsulating a cell and virus in 100 um drop. The goal was to determine any difference in viral replication between the bulk and microfluidic assays. It was determined that the siat7e cell line was not suitable for hosting IAV. Research has been directed toward the A549 cell which can host IAV and be adapted to spinner cells.

Angus Tomlinson: Computer Science
Mentor: Clemente Izurieta, Brittany Fasy, David Millman - Computer Science
Representing Music with Simplicial Complexes

In recent years, topological data analysis (TDA) has become increasingly popular in the research community for studying large, multidimensional datasets. While TDA has been applied to a variety of datasets, it has been rarely employed to examine music. One reason for its seldom usage in the music realm is the difficulty of representing music in a graphical format. Therefore, we are seeking to develop software which can accurately convert music to simplicial complexes, graphical structures useful for TDA. For our dataset, we parse music scores in the MusicXML format. From each music score, we extract the key signature, time signature, instrumentation, and note pitches. Once we have parsed a score, we convert the note pitches to their equivalent interval classes. After we have gathered the interval classes within a song, we generate harmony and melody simplicial complexes. For the harmony graphical representation, we create a sliding window embedding of a song's interval classes. We output the sliding window embedding as interval vectors, a music representation used by composers and musicians to classify pitch classes. To generate the harmony simplicial complexes, we combine the interval vectors with the L2 metric. A sliding window embedding is also employed for the melody, but we instead use ordered interval vectors with a modified edit distance. In this manner, we can capture the melody of a song. By producing of these simplicial complexes, we hope to enable further research of musical structure using TDA. Such research could lead to the classification of musical features and the ability to compare songs through topology. Eventually, these topological tools could be used by music services like Spotify and Pandora to recommend songs.

Acknowledgements: Christa Merzdorf (MSU Faculty Member) – Cell Biology & Neuroscience, Jennifer Forecki (MSU Postdoc/Research Scientist) – Cell Biology & Neuroscience

Xuying Wang, Steve Rolland: Computer Science
Mentor: Clemente Izurieta – Computer Science
Modeling Effective Interactive Technology for Education

Literacy development is a critical life skill necessary for an individual's socio-economic growth. Yet, 66% of US fourth graders cannot read at grade level, leaving that group 4 times more at risk of dropping out before finishing high school. Model Driven Architecture (MDA) can be used to address problem solution sets, with specific constraints independent of the systems that carry out the instantiation of the design. Assistive technologies that build associations between text and speech, can improve reading comprehension, and increase vocabulary levels in children and young adults. From a Structural perspective, research centers around using MDA to implement platform specific applications, and processes of fine grain audio segmentation. Behavioral research will look at learning with regards to early literacy development, and the effects that highlighting text while the words are spoken has on word association, reading comprehension, and overall reading level. Using MDA as a template to design a phoneme base recognition system. Test effectiveness of highlighting on word comprehension and recall.

Theodore Warthen: Chemical & Biological Engineering
Mentor: Christa Mezdorf - Cell Biology & Neuroscience
Connexin expression and function in Xenopus laevis embryos

Connexins are intermembrane proteins that form protein complexes called connexons. These complexes bind together to form intercellular pores, known as gap junctions by binding to connexons of adjacent cells. 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. Due to the necessity of gap junctions for the transport of these ions, it is hypothesized that gap junctions are involved in developmental processes such as convergent extension during the stages of gastrulation and neurulation. Before we can discover what role these proteins play in the development of the nervous system, we have determined at what stages these proteins are expressed. To do this, cDNA (DNA reverse transcribed from RNA to only contain expressed genes) was made from different developmental stages of Xenopus laevis embryos. The stages used were stage 6 (prior to activation of embryonic transcription), stage 8 (blastula), stages 10 and 12 (gastrula), stages 14, 16, 18 (neurula) and stage 20 (tailbud). This cDNA was then standardized by PCR using primers specific to ef1 alpha. This series of cDNA was then used as a template for PCR reactions of Xenopus connexin genes. The PCR reactions were then analyzed via gel electrophoresis in order to determine what stages of development each gene is expressed. Gap junction gene alpha 3 was found to be expressed throughout neurulation and Gap junction gene alpha 7 was found to be expressed at all stages that were tested. Gap junction gene beta 2 and beta 2 were found to be expressed throughout gastrulation and neurulation. Gap junction gene alpha 2 was found to be maternally expressed as well as expressed in early gastrula, while Gap junction gene alpha 5 and alpha 4 are only expressed though early gastrulation.

Acknowledgements: Robin Belton (MSU Graduate Student) – Mathematical Sciences, Kira Wencek (Undergraduate Student at the University of Rhode Island) – Computer Science

Sean White, Justin O'Dea, Matthew Wentz: Computer Science
Mentor: Clemente Izurieta - Computer Science
DLGIN: A Deep Learning Approach to Defining Musical Genre

Defining an artist's sound can be difficult. Music, like all forms of art, is entirely subjective and classifying it by genre has proven to be an incredibly complicated task even for single songs, let alone musicians and groups with multiple albums released over the span of decades. For example, which single genre does Michael Jackson falls under? Or Prince? How about the Gorillaz, whose musical style spans from rap and hip hop to lofi and grunge? An

answer to these questions will change based on the individual answering them and the specific song, or group of songs that pop into their head at the time. In this project we propose a computational approach to defining genre, outlining the creation of a deep learning genre identification network (DLGIN). DLGIN is a statistical multi-label classification model that uses techniques from machine learning, image recognition, and music information retrieval to identify songs and groups of songs as a combination of 16 different musical genres, both individually and sequentially. We will discuss the creation of DLGIN, as well as a few possible applications of such a tool by musicians or music-minded data scientists and statisticians in the future.

Jaclyn Wing: Mechanical & Industrial Engineering
Mentor: Scott Monfort - Mechanical & Industrial Engineering
Establishing initial reliability of a clinical tool for measuring gait stability and variability

This research project investigates the reliability of characterizing natural walking using an inertial measurement unit (IMU) to measure gait stability and variability by accomplishing 2 objectives. (1) Development and investigation of methods of collecting and processing IMU data to assess for measures of variability and stability of gait. (2) An evaluation of the reliability of the methods to establish the feasibility of their use in a clinical setting. This analysis requires the collection of pilot data from multiple subjects to determine repeatability and consistency of the results. These procedures include an analysis of between session reliability as well as the effect of multitasking on normal walking kinematics. Subjects are asked to walk during 3 sessions that occur within a 2 month span. During these sessions subjects are asked to walk normally, and for 2 dual-task conditions. These dual-task conditions include a simple task (counting up by 1) and a more challenging task (counting down by 7).
The use of these methods would make gait analysis more accessible and affordable to patients in a clinical setting. As of yet there is no clinically accessible and consistent method or gold standard of collecting these measurements. This will contribute to improving patient outcomes through the use of preventative measures to decrease the fall risk for populations including the elderly and groups with neurological impairments. With new technologies becoming more affordable and accessible, the development of a clinical gait analysis tool is in reach.

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Mark Young: Chemical & Biological Engineering
Mentor: Joseph Seymore, Sarah Codd – Chemical & Biological Engineering, Mechanical & Industrial Engineering
NMR Investigation of the Microphysical Structures of Ice-Regolith Mixtures

Colloidal systems are observed on Mars where the Martian soil (regolith) acts as a colloid to form frozen ice-regolith systems. Imaging performed by the Mars Odyssey revealed a widespread presence and abundance of these ice systems which is problematic for current models of the planets climate history. In this project, nuclear magnetic resonance (NMR) was used to investigate the properties of these ice-regolith systems. The system was modeled using Poly(methyl methacrylate) (PMMA) beads that were dispersed in a MgCl2 solution and then sedimented into a packed bed where they were then frozen. Bead sizes of interest were 0.4 µm and 102.2 µm and salt concentrations of interest were 15 mM, 30 mM, and 60 mM. The effects of temperature, particle size, and salt concentration on the unfrozen water content were monitored through the measurement of spin-spin (T2) relaxation times with a Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence. Results have shown the liquid water content at -15.4°C to range from 0.006, 0.016, and 0.162 for samples of no particles, 102.2 µm particles, and 0.4 µm particles respectively. Qualitatively, the increase in liquid water content with increasing temperature is observed to be minimal for the sample with the 0.4 µm particles, as the curvature of the particles and ice grains play a larger role in the freezing point depression. In future work, correlations relating the observed T2 distributions to the size of pores within the samples will be investigated.

Acknowledgements: Peng Lei (MSU Graduate Student) – Chemical & Biological Engineering

COLLEGE OF LETTERS & SCIENCE

Trenton Aiello: Earth Sciences
Mentor: Kevin Hammonds - Civil Engineering
Surface hoar: finding a secondary source of water vapor and its effects

Surface hoar is a critical and potentially deadly weak layer in a snowpack that causes large slab avalanches. The consensus is that surface hoar crystals form on the surface of snow like frozen dew during cold and clear nights. The current assumption is that the water vapor contributing to surface hoar growth comes entirely from the air above the snow surface. The purpose of this research is to determine if there is a secondary source of water vapor originating in the snowpack that influences surface hoar growth. Therefore this research will be done by controlling the micro-meteorological conditions surrounding and within a snow sample that cause surface hoar growth such as air temperature, air saturation and air flow across the surface. More importantly, a temperature gradient will be applied to the snow sample to facilitate water vapor flow towards the relatively colder air above the surface. This study provides an improved understanding of the influence of internal and external snowpack factors on the size and shape of surface hoar which will assist avalanche forecasters in predicting the magnitude of surface hoar growth that might be seen in avalanche terrain; this can further indicate the potential danger of the layer once buried. This can also provide insight on the metamorphism and stabilization of surface hoar that occurs once the layer is buried which can greatly influence the stability of the snowpack.

Kirina Amada: Microbiology & Immunology
Mentor: Margaret (Mari) Eggers - Microbiology & Immunology
Creating an effective public health campaign regarding the potential health risks of Chronic Wasting Disease

Introduction: Chronic Wasting Disease (CWD) is a neurodegenerative disease in the family of Transmissible Spongiform Encephalopathies (TSE), also known as Prion diseases. CWD has recently been detected in cervids in Montana, posing a potential health risk to game meat consumers. Appropriate places to obtain information on CWD and test meat for infection are low profile. The purpose of this study is to identify and create an effective public health campaign about CWD.
Methods: Information regarding CWD is being obtained from the scientific literature and government websites. Additionally, presentations are being made to obtain ideas from the public. Both print and online educational materials will be made and disseminated to the MSU and Bozeman public.
Results: Recent experiments have shown that CWD can be transmitted to Macaques, genetically closely related to humans, via feeding infected muscle or brain tissue from elk and deer, including from asymptomatic cervids. Although there are no reported cases of animal to human transmission of CWD, people who have contact with and consume game meat are at possible risk of becoming infected. Prion diseases are 100% fatal. The State of Montana is offering the opportunity to get your game meat tested.
Conclusion: Despite all the risk factors, education regarding CWD in the community is limited to a couple State websites. More detailed information is needed, especially for hunters and butchers and must be disseminated to the local public.

Danny Anduza: Earth Sciences
Mentor: David Varricchio - Earth Sciences
How Might Spinosaurids Have Caught Fish? Testing Behavioral Inferences Through Comparisons With Modern Fish-Eating Tetrapods

Since the 1983 discovery of the unusual dinosaur Baryonyx, there has been great interest in the feeding behavior of spinosaurids, as the group exhibits various physical traits suggestive of fish-eating. However, despite a general

consensus over spinosaurid piscivory, there have been few detailed behavioral comparisons with similarly-adapted extant piscivorous tetrapods. An exception is the eponymous "heavy claw" of Baryonyx, suggested to have been used in "gaffing" (hooking) fish from the water in behavior supposedly analogous to that of grizzly bears. However, this hypothesis is problematic, as detailed studies of grizzly fishing behavior have never reported such "gaffing." To better characterize spinosaurid piscivory, we reviewed piscivorous behaviors, functional morphology, and possibly related adaptations in extant fish-eating tetrapods. We then assessed which of these behaviors were possible in spinosaurids based on their morphology. The antero-posterior head-darting strategy employed by herons and shoebills we deem unlikely, as spinosaurids lack a strong cervical S-curve and their orbits are poorly positioned for binocular vision. Rather, as in the gharial, the jaws seem adapted for swift lateral sweeps to seize fish. Like grizzlies and fishing cats, spinosaurids may have employed their powerful forelimbs to stamp down on large fish, impaling them on the manual claws against the river or lake bottom, from which the prey could be manipulated with the jaws. These findings not only furnish insight into feeding behavior in spinosaurs, contributing to our understanding of these bizarre and specialized dinosaurs, but also provide a window into the evolution of piscivory in tetrapods.

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Kendra Bertrand: Microbiology & Immunology
Mentor: Agnieszka Rynda-Apple - Microbiology & Immunology
Confirmation of direct molecular interaction between TLR2 and P22-capsid via proximity-based labeling techniques

The immune system is designed to recognize and eradicate foreign invaders. The first line of defense in the innate portion of the immune system involves pattern recognition receptors (PRRs) and pathogen-associated molecular patterns (PAMPs). PRRs present in the host recognize PAMPs and alert the host of infections. For viral pathogens, less known about what external PRRs are involved in recognition. Recent data from our lab suggests that TLR2, a PRR, is involved in recognizing the structure of virus-capsid and shaping the immune response to a subsequent respiratory bacterial infection (superinfection). We also demonstrated that non-viral proteins with protein subunit structure similar to virus-capsid, like F-actin (cytoskeletal host protein), induced similar timing of host susceptibility to and protection from superinfection as influenza virus. Specifically, TLR2 knockout mice were unable to effectively clear bacteria at 3 days post virus/virus-capsid/F-actin inoculation, whereas wildtype mice were. I hypothesized that because TLR2 is required for early regulation of susceptibility to superinfection, there is a direct interaction between virus-capsid/F-actin and TLR2. Treatment of macrophages with virus-capsid increased TLR2 expression, whereas treatment with F-actin did not. Using proximity-based protein labeling by APEX enzyme encapsulated within P22 virus-capsid, we demonstrated a direct molecular interaction between TLR2 and virus-capsid. Confirmation of this direct interaction provides insight into recognition of the virus by host immune cells prior to virus internalization. Our data could potentially be utilized for therapeutic development, in that stimulation of TLR2 via non-viral proteins could provide a mechanism for initiating protection against superinfection without implication of infection.

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Evan Bilbrey: Microbiology & Immunology
Mentor: Eric Boyd - Microbiology & Immunology
Attempted Isolation and Preliminary Characterization of a Putative Acetogen from Hyperalkaline Fluids in the Samail Ophiolite, Oman

Preliminary data from the Boyd Geobiology lab suggests the presence of a diverse microbial community in fluids from deep (85m) wells in the Samail Ophiolite, Oman. The mafic and ultramafic rocks that comprise the bedrock

from which these fluids emanate have been shown to undergo hydration reactions that can produce H2. In turn, this drives Fischer Tropsch (FT)-like synthesis reactions that can reduce carbon dioxide to low-molecular weight reduced carbon compounds [1]. The ancient Wood-Ljungdahl pathway of biological CO2 fixation mimics many of the steps of FT synthesis and supports the dominant microorganisms in the hyperalkaline (pH ~11) peridotite hosted waters in well NSHQ14 (Fones, unpublished data).
This research is directed at the isolation of the dominant microorganism in NSHQ14, an uncultured putative acetogen within the Candidate Phylum OP1 class MSBL6 [2]. A nearly complete genome of this organism, previously assembled by members of the Boyd lab, was used to design a series of selective media conditions to support organismal growth for use in downstream physiological characterization.
Following inoculation of well fluids from NSHQ14 into selective medium, cells were incubated at 35Â°C for 54 days. Aliquots of culture medium were sub-sampled and enumerated using epifluorescent microscopy to monitor cell growth in each culture condition. Cultures with increasing cell densities were transferred and diluted in identical media conditions. Ongoing work will include monitoring cell densities of transfer cultures and using ion chromatography to confirm production of organic acids such as acetate. Here, I present my preliminary work aimed at the isolation of this putative acetogen and present my future planned directions.

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Eric Bohrnsen: Chemistry & Biochemistry
Mentor: Brian Bothner - Chemistry & Biochemistry
Real-Time Metabolomics and Cellular Responses to Stress

Metabolomics is an emerging field in biology and biochemistry focused on the detection of the small molecule signature of a cell. The metabolic profile is a direct link to the phenotype of the cell. Meaning, any observed changes in the metabolic profile is a direct link to a change in the functional state of that cell. Metabolomicsâ€™ direct phenotypic link, makes it an optimal method for analyzing a cells response to stress. When a cell transitions from functioning to diseased, the metabolome is the first to respond (when compared to the genome or proteome). The metabolic profile can be analyzed using Mass Spectrometry. Mass Spectrometry facilitates the rapid analysis of the metabolic profile with very high sensitivity. This project is focused on analyzing cellular responses to stress in Escherichia Coli and eukaryotic stem cells. The E. coli culture was introduced to oxidative stress via hydrogen peroxide perturbation. The eukaryotic stem cells used were genetically predisposed to Parkinson's. Using mass spectrometry, both cell types' metabolic profile was analyzed. As these cells transition from healthy to diseased, we hypothesized that a shift in the metabolic profile would occur. Performing a perturbation experiment on E. coli, a shift in the metabolic profile was observed. This suggests a change metabolism as a result of the perturbation event. This study has the potential to provide insight into the metabolic pathways associated with E. coli resistance. Moving forward, by inducing stress into Eukaryotic Stem Cells via genetically induced Parkinson's disease, we aim to gain insight into the onset of Parkinsonâ€™s disease and associated biomarkers.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Nicholas Bonham: Physics
Mentor: Charles Kankelborg, Roy Smart - Physics
Characterization of the ESIS Diffraction Gratings

The EUV Snapshot Imaging Spectrograph (ESIS) is a rocket borne instrument designed to capture spatial and spectral information from the Sun in several extreme ultraviolet (EUV) emission lines. ESIS relies on four holographic diraction gratings to split incoming light into its constituent spectra,

and focus it onto four corresponding CCD sensors. However, in Earth's atmosphere, EUV is the most highly absorbed component of the electromagnetic spectrum, which means that the instrument cannot be aligned in its target wavelength. To circumvent this issue, we have manufactured a clone of the instrument, designed for operation in visible light.
Our procedure will be to align the visible-light implementation of ESIS, and then transfer that alignment information to the EUV instrument used for flight. The EUV and visible gratings are designed to be exactly identical (with the obvious exception of ruling spacing). Unfortunately, the manufacturer was not able to match the required specifi cation with regards to the angle between the ruling direction and the top face of the grating substrate, known as the grating roll angle. Therefore it has become necessary to measure this angle, to ensure reliable alignment transfer between the visible and EUV implementations of ESIS.We will conduct an experiment that leverages the Littrow condition, and several optical protractors known as theodolites to carefully characterize this roll angle.

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

Identifying biomarkers using untargeted metabolomics can be a daunting challenge, like finding a thumbtack in an overflowing junk drawer. The Bothner lab has developed an established method to gather a diversified subset of metabolites from a biological fluid by using the protein bovine serum albumin (BSA) as a molecular sensor. Naturally occurring serum albumin is the most abundant protein in mammalian blood. It is capable of binding a wide array of small molecules from lipids, to hormones, and drugs. The allosteric properties of BSA inspired the Bothner lab to test this protein's ability to bind various metabolites in order to perform targeted metabolite extractions from complex biological fluids. This innovative method has been named the protein sensor assay (PSA). In order to apply this method to mice with induced liver cancer the protocol has been modified to differentiate blood serum. The Schmidt Lab at Montana State University collected the blood samples. Using the Protein Sensor Assay we are better able to differentiate sera from mice with induced liver cancer compared to standard methanol precipitations protocols.

Acknowledgements: Rachel Rawle (MSU Graduate Student) – Microbiology, Timothy Hamerly, Ed Schmidt (MSU Faculty Member) – Microbiology & Immunology

Joseph Carey: Cell Biology & Neuroscience
Mentor: Renee Reijo-Pera, Ninuo Xia - Cell Biology & Neuroscience
Stem Cell Therapy For Multiple Sclerosis

Multiple sclerosis (MS) is a neuro-degenerative disease caused by multiple lesions in the myelin sheath of central nervous system (CNS) neurons. Because myelin acts as an insulator and promotes efficient neural communication, MS patients have difficulty with movement, balance, and sometimes mental health. The myelinating agents of the CNS are adult oligodendrocytes, and when these mature cells die they are replaced by oligodendrocyte progenitor cells (OPCs) that then mature to restructure the myelin sheath. An effective way to treat MS could be to derive OPCs from human induced pluripotent stem cells (hiPSCs). HiPSCs are made by treating adult skin cells with transcription factors that are active in embryonic stem cells. This process restores the pluripotent abilities of stem cells to differentiate into every tissue type. Using these cells would ensure that inflammatory responses due to tissue incompatibility would be minimal. This therapy could benefit from the novel application of a genetic kill switch within the transplanted cells. A genetic construct will be designed so that OPC-specific gene promoters promote expression of a tetracycline-activated transcription factor. The tet-on transcription factor will drive expression of an apoptosis gene. Thus, upon the administration of tetracycline into a transplant patient, immature

OPCs will be exterminated and mature oligodendrocytes will be unharmed because their current genetic activity is not producing tet-on proteins. Because OPCs can still undergo mitosis (while mature oligodendrocytes can't) this system will act as a barrier against tumor formation.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Jason Carr: Physics
Mentor: Rufus Cone, Charles Thiel - Physics
Flux-Growth Procedure for Rare-Earth-Doped YVO4 and NaCl Single Crystals

The flux-growth method for single crystals is a promising technique that can be used as an alternative to Czochralski-Bridgman, top-seeded, and solution growth techniques. Flux-growth utilizes a chemically-appropriate metallic flux (a substance used to lower the melting point of a solid) to promote low-temperature (>1500oC) crystal growth. The focus of this project was to create, test, and refine the chemical compositions and heating programs used to grow rare-earth-doped yttrium vanadate and sodium chloride. A major conclusion drawn from this experimentation was that differing heating programs, chemical compositions, and flux-preparation impact growth greatly. As a result of these efforts, potentially-doped YVO4 and NaCl single crystals were grown of sufficient size for optical spectroscopy. These crystals are currently being characterized (defining dopant-levels, inclusions, line-widths, etc.) using a cryogenic optical system. The presentation will include microscopic imagery of single-crystals under normal and fluorescence conditions, stoichiometric balancing diagrams and heating program graphs, as well as descriptions of the preparation process. The methods for polishing and cutting the respective crystals for testing will be described, as well as a generalized summary of what rare-earth-doped crystals are and why they are important in academia and industry.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Jacob Cavon: Cell Biology & Neuroscience
Mentor: Benfang Lei - Microbiology & Immunology
Cloning of Group A Streptococcus C5a Peptidase ScpA Gene and Preparation and Characterization of Recombinant ScpA Protein

Group A Streptococcus (GAS) isolated from invasive infections usually has enhanced innate immune evasion, systemic dissemination, and virulence. How hypervirulent GAS disseminates into the circulatory system is not well understood. We found that the GAS gene encoding the C5a peptidase (ScpA) is critical for a hypervirulent GAS to invade the vasculature for systemic dissemination in pulmonary infection of mice. The mouse C5a peptide has variation in the amino acid sequence around the ScpA cleavage site in human C5a. Thus, we hypothesized that ScpA is unable to cleave mouse C5a. To test this hypothesis, the scpA gene of GAS was amplified by PCR and cloned into the plasmid vector, pET-21d, for expression of the ScpA protein in E. coli. Overexpression of recombinant ScpA protein was achieved in E. coli through IPTG induction. The recombinant ScpA protein was purified by anion exchange, Ni-affinity, and Phenyl-sepharose chromatography. The human, but not mouse, C5a protein was cleaved by the purified ScpA protein. We conclude that ScpA does not cleave mouse C5a peptide. This finding suggests that the function of ScpA in GAS vascular invasion in a mouse model of infection is independent of its C5a peptidase activity, and that ScpA has additional functions in GAS pathogenesis.

Acknowledgements: Montana Space Grant Consortium (MSGC)

Dakota Chapman: Physics
Mentor: Brian D'Urso - Physics
Improved Quadrant Photodiode Detector

I have designed and I am currently assembling a new detector for Dr. Brian D'Urso and his team. The detector will allow them to more accurately observe the particles that they trap in their lab. He and his team are currently working on different techniques for trapping particles so that they can better measure fundamental forces. When dealing with quantum mechanics even the slightest change is significant. That is why it is imperative to have a detector that is as accurate and precise as possible; so that it may measure those changes. The current detector in use in Dr. D'urso's lab is out of date and has a few oversights on the design which causes excess noise in the system. The goal is to create a detector with less noise in order to obtain more accurate measurements. I am accomplishing this by using more advanced/higher quality technology and a different, more compartmentalized design.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Sage Chase: Microbiology & Immunology
Mentor: Doug Kominsky - Microbiology & Immunology
Defining the Mechanism of Salmonella Virulence Modulation by CD73 in the Intestinal Epithelium

The intestinal tract is lined with a columnar epithelium that is only a single cell layer. Important for nutrient uptake, the immune system, and providing a critical barrier between luminal contents and the underlying mucosa, damage to the epithelium can lead to intestinal inflammation. *Salmonella typhimurium* is a model inflammatory pathogen that initiates infection by invading host intestinal epithelial cells (IECs), stimulating the release of large amounts of extracellular ATP, leading to amplified inflammatory responses.
This year I investigated how the enzyme CD73 impacts host responses to *Salmonella* in the intestinal epithelium. I used a gentamicin protection assay and RT-qPCR to test gene expression in CD73 KD IECs. I found a relationship between CD73 and PPARg, a nuclear receptor that down regulates inflammatory cytokine and up regulates antimicrobial peptide expression. In CD73 KD cells both at baseline and at one hour and four hours post infection, PPARg expression is significantly higher than in control cells. Therefore, I hypothesize that in CD73 KD IECs, the increased expression of PPARg results in higher levels of antimicrobial peptides, which are then taken up by the *Salmonella* containing vacuoles and inhibit *Salmonella* trafficking and replication in these IECs.
To further my research I will look to recapitulate my findings *in vivo* by performing transcriptional analysis of IECs from both control and epithelial-specific CD73 knockout mice, derive intestinal organoids form these mice, and investigate other genes that may be involved in *Salmonella* pathogenesis. It is my hope that this research will reveal candidate targets for the development of novel antimicrobials for invasive intestinal pathogens.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Eleni Comstock: Earth Sciences
Mentor: Julia Haggerty - Earth Sciences, Physics
Understanding Research Fatigue in Rural Energy Boom Communities

Energy development in the USA has boomed immensely over the past two decades. The towns that host energy development, specifically natural gas production as a result of technological innovation in hydraulic fracturing, are deemed "energy boom towns" and have attracted an influx of academic research. Specifically, as social scientists enter the boom towns, community members are often recruited to participate in the research by completing surveys or being interviewed. The growing body of literature reporting on these studies has prompted questions about the presence and amount of research fatigue experienced in these places. Through a cumulative literature review of peer reviewed articles which contain human-subjects research profiling these boom towns, I will help identify the possible implications of the frequency of research, and what factors contribute to a feeling of being over-researched. This literature review is important because it has the potential to inform the development of new trainings and/or academic networks which could work to help maintain the credibility of social scientists, while at

the same time working to mitigate research fatigue within these communities, while at the same time working to mitigate research fatigue within these communities.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Cory Counts: Psychology
Mentor: Neha John-Henderson - Psychology
Childhood socioeconomic status and risk in early family environments: Predictors of global sleep quality in college students

Low socioeconomic status (SES) in childhood associates with poor sleep quality in adulthood. Separately, childhood family environments shape health into adulthood. Here, we investigated whether these early life factors independently or interactively inform global sleep quality in college students. Design: Cross-Sectional Participants were college students at a state University (N=391). As a measure of childhood SES, we asked participants to consider their families' socioeconomic standing relative to the rest of the society during their childhood. We used the Risky Family questionnaire to measure adversity and the presence of warmth and affection in the family environment during childhood, and the Pittsburgh Sleep Quality Index (PSQI) as a measure of current global sleep quality. We used linear regressions adjusting for age and gender to examine relationships between childhood SES, risk in childhood family environments and global sleep quality. Results indicated lower childhood SES and greater risk in childhood family environments independently predicted poor sleep quality. Importantly, in low risk family environments, there was no significant difference in sleep quality as a function of childhood SES. However, students who were from low childhood SES backgrounds who also reported high levels of risk in their early family environments had the worst sleep quality. Findings highlight the importance of considering socioeconomic and family environments in childhood as informants of sleep quality across the lifespan. Compromised sleep quality in college students could affect academic performance and health over time.

Acknowledgements: Fiona Grubin (Non-MSU/Other) – Psychology

Peter Crawford-Kahrl: Mathematical Sciences
Mentor: Bree Cummins, Tomas Gedeon - Mathematical Sciences
Comparison of two combinatorial models of global network dynamics

Modeling the dynamics of biological networks introduces many challenges, such as the lack of first principles to base models on, the size of networks, and the difficulties associated with parameterization. Discrete time Boolean networks and continuous time switching systems provide a computationally accessible way to characterize the long-term dynamical information of a given network.
Recent work has shown that the parameterized dynamics of switching systems can be captured by a combinatorial object, called a DSGRN database, that consists of a parameter graph characterizing a finite parameter space decomposition, whose nodes are assigned a Morse graph that captures global dynamics for all corresponding parameters.
We show that for a given network, one can associate the same type of object by considering a continuous time ODE system with a continuous right-hand side, which we call an L-system. We compare the two DSGRN databases for the same network. The L-system can be thought of as (not necessarily small) perturbations of the switching system, our results address the correspondence between global parameterized dynamics of switching systems and their nearby perturbations. We show that, at corresponding parameters, there is an order preserving map from the Morse graph of the switching system to that of the L-system, which is surjective on the set of attractors and bijective on the set of fixed point attractors. We provide important examples showing why this correspondence cannot be strengthened.

Acknowledgements: NASA Exobiology and Evolutionary Biology

Chase Dart: Ecology
Mentor: Scott Creel - Ecology
The influence of prey attributes on variation in antipredator responses for a natural ecosystem with multiple predators and prey

Research has shown that direct killing comprises only a fraction of the total effect predators have on prey. Predators can also induce antipredator responses in prey, such as an increase in vigilance, which can negatively affect growth, survival, and reproduction. Previous work has found that while variation exists in both the strength of antipredator responses and the strength of direct predation in natural ecosystems, the two effects are not correlated with one another. Using behavioral data from an ongoing field study of the Zambian Carnivore Programme, we investigated across three distinct Zambian ecosystems whether ecologically important attributes of prey species (body mass, herd size, and foraging strategy) could better explain variation in the magnitude of antipredator responses. More specifically, we tested for the effects of prey attributes on variation in proactive vigilance (routine vigilance without the presence of an immediate threat), reactive vigilance (vigilance in the presence of a threat, such as a predator), and the change in vigilance between these two conditions. In general, vigilance increased across ungulate species when a predator was present. It was found that vigilance was negatively correlated with body mass, and decreased similarly under proactive and reactive conditions. Vigilance was also lower for grazers than browsers or mixed feeders. No relationship was found between vigilance and herd size. These results have implications for our understanding of how ecological attributes of prey species may mediate the role of risk effects of predators on their prey.

Acknowledgements: Division of Paleontology, American Museum of Natural History via IMLS grant

Sarah A. Devaney, Mariah Cannon, Willie J. Freimuth: Earth Sciences
Mentor: David Mogk - Earth Sciences
Geoheritage Sites in Montana - Service Learning Project in the Earth Science Department

UNESCO has established GeoParks all around the world featuring local geoheritage and cultural heritage sites to make information available to the public about regional geology, paleontology, physiography, climate, agriculture and cultural/historical heritage. So far, the United States is not represented by UNESCO but there are local organizations who are developing geoheritage sites.
Our Service Learning Project has extensively researched the Rocky Mountain Front outside Augusta and Choteau, MT. This region is famous for its Sevier-style fold and thrust belt structures, Egg Mountain and its fossils, along with the author Ivan Doig and the numerous Native American petroglyph sites. The enormous mountain range bordering the Bob Marshall Wilderness also displays glacial valleys and is home to diverse flora and fauna. It is the site of topical issues related to wilderness preservation and oil and gas exploration.
Geoheritage sites are developed for public education and outreach, as economic drivers through promoting geotourism, and as a mechanism to identify, preserve and protect exceptional sites of geologic interest and importance. All information developed in this project is being made available through a website to promote geotourism of this remarkable area. This project will be used as a model for other areas in Montana to develop their own geoheritage sites.

Will Dumm: Mathematical Sciences
Mentor: Bree Cummins - 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 models widely ignore certain 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.
We propose an improved model for a social network on which to model disease transmission, defined by the fact that every individual in a social network belongs to a completely connected 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
Mentor: Matthew Cook – Chemistry & Biochemistry
A Convergent Synthesis of Diazonamide A

Diazonamide A is a molecule with strong cytotoxicity, of which analogs have been developed to pharmaceuticals to fight cancer. The structure contains two macrocycles and two synthetically difficult stereogenic centers, an all-carbon quaternary center at C10 and a biaryl bond from C16 to C18. Previous synthetic methods have involved many steps and small overall yields, so a more convergent method is being designed. By using an allyation-Suzuki coupling reaction with two previously synthesized bromoindoles, both the quaternary center and the biaryl bond can be synthesized stereoselectively. This key step potentially decreases the number of steps by half, increasing the chance of a higher overall yield. A simple model synthesis was used and modified to verify that the key step is possible. In the synthesis of one bromoindole, it was discovered that a MOM protection group was needed to keep the product stable and improve the yield. However, the indole product was still not clean from NMR so a new method of synthesizing the bromoindole is going to be utilized for the synthesis of Diazonamide A.

Emily Entz: Chemistry & Biochemistry
Mentor: Diane Bimczok, Gary Stoner - Microbiology & Immunology
Using the Suzuki Cross-Coupling Reaction to Synthesize Functionalized Tin Reagents

This research examines the possibility of functionalizing tin reagents through Suzuki cross-coupling. A Suzuki reaction is an organic chemistry reaction that involves coupling a boronic acid and an organohalide. This reaction is catalyzed by a palladium(0) complex, and has proven to be a powerful method to form carbon-carbon bonds. The anticipated significance of this research includes the development of a better method for synthesizing tin reagents containing functional groups sensitive to conventional synthetic methods. This research was conducted by optimizing reaction conditions to favor Suzuki cross-coupling and suppress reaction of the tin group by changing several variables and observing the effects. The variables explored include: solvents, ligands, bases, ligand loading, and reaction time. Further, this project evaluated the scope of boronic acids that can be used in the Suzuki cross-coupling under the optimized conditions. By exploring the scope of boronic acids, we can examine the possibility of creating functionalized tin reagents that would otherwise be challenging to synthesize. This research provides a

platform for our future investigation into the intramolecular competition between boronic acid and tin nucleophiles, including studies into how to switch reaction selectivity.

Acknowledgements: John Russell (MSU Graduate Student) – Chemistry & Biochemistry

Maria Clara Fernandes Martins: Microbiology & Immunology
Mentor: Eric Boyd - Microbiology & Immunology
Riding the microbial ferrous wheel with a chemolithoautotroph Archaeon from a hot spring in Yellowstone National Park

Chemolithoautotrophs are microorganisms that gain energy to support cellular metabolism by coupling oxidation-reduction reactions that involve inorganic compounds such as ferrous iron [iron(II)] minerals. I have successfully isolated a chemolithoautotroph from an acid hot spring (pH 3, 82Â°C) in Yellowstone National Park (YNP) that is closely related to Metallosphaera, the dominant microbe in this community. Genomic analyses suggest that the strain has the potential to use a range of inorganic compounds to support its metabolism, including coupling the oxidation of iron(II) with reduction of oxygen (O2) or the oxidation of hydrogen (H2) with the reduction of iron(III). Since the solubility of O2 is inversely proportional to temperature and is expected to be limiting in this spring, I hypothesized that, although this ability is not reported, the strain should grow via H2 oxidation and iron(III) reduction, allowing it to thrive when O2 is limiting and iron(III), the product of the oxidation of iron(II), is available. To begin to test this hypothesis, I separately provided iron(II) + O2 and H2 + iron(III) conditions to support growth. Next, after the growth cycle through iron(II) oxidation, I will replace the gas phase of my experiments with H2 to determine if the strain can then reverse its metabolism and reduce the iron(III) that it has produced. This research will provide insights into adaptations that allow for growth in nutrient limited conditions reminiscent to those present on early Earth, when the planet was hotter and nutrients capable of supporting microbial metabolism were in more limited supply.

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Kendra Fischer: Chemistry & Biochemistry
Mentor: Timothy K. Minton - Chemistry & Biochemistry
Effect of Cation and Anion Structure on the Scattering Dynamics of Atomic Oxygen on Imidazolium-Based Ionic Liquids

Room temperature ionic liquids (RTILs) are typically composed of relatively large organic cations paired with inorganic anions. Their chemical and physical properties, such as thermal stability, vapor pressure, surface tension, dielectric constant, solubility and capacity as a solvent, catalytic activity, etc, can be varied selectively through suitable cation-anion combinations. They can also be fine-tuned by modifying the cation, typically by varying the chain length of an alkyl substituent or by its selective functionalization. These attributes make ionic liquids attractive as “green” solvents, replacing traditional organic compounds, and in a varied range of applications, spanning catalysis, fuel cells, electrospray thrusters, nanoparticle formation, anti-electrostatic coatings, and vapor detection. Many practical applications of ionic liquids involve energy transfer and trapping during collisions at the gas-liquid interface, which are sensitively dependent on the chemical structure of the interface. We have therefore investigated the relationship between interfacial structure and energy transfer dynamics on four common imidazolium-based RTILs: (1) 1-octyl-3-methylimidazolium tetrafluoroborate ([C8mim][BF4]), (2) 1-octyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([C8mim][Tf2N]), (3) 1-dodecyl-3-methylimidazolium tetrafluoroborate ([C12mim][BF4]), and (4) 1-dodecyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([C12mim][Tf2N]). These RTILs allowed us to study the effect of anion size and cation alkyl chain length on energy transfer when a beam containing O and O2 was directed at the vacuum-liquid interface of these ILs and the

behavior of scattered inelastic and reactive products was explored through measurements of product translational energy as a function of scattering angle. In general, the average energy transfer in collisions of incident atoms and molecules with the interface increases with longer alkyl chain length and smaller anion. In either case, the alkyl chains are able to cover the anions more effectively, presenting a "softer" surface to the incoming atoms and molecules and leading to more energy transfer.

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Gia Fisher: Cell Biology & Neuroscience
Mentor: Christopher Organ
How is Cancer Incidence Driven by Stem Cell Division Rate?

Cancer takes the lives of over 580,000 US citizens every year (Siegel, Naishadham, Jemal, 2003). It is the fourth most expensive topic to research in the history of science, and while treatment has progressed, there is no cure. Cancer is caused by genetic and environmental factors, such as smoking tobacco and radiation from the sun. Although these factors contribute to the cause of the disease, new research has shown a strong correspondence between the occurrence of cancer, and the number of stem-cell divisions within tissues (Tomasetti, Li, Vogelstein, 2017; Tomasetti, Vogelstein, 2017; Tomasetti, Vogelstein, 2015; Tomasetti et al., 2017). This makes sense – there is a small chance of cancer-causing mutations during each round of cell division. However, because every cell in an adult body is the descendent of single fertilized egg, these data on cancer are not statistically independent - a critical assumption of most statistical tests. To date, studies of tissue level traits (such as stem cell division rate) have not accounted for this developmental non-independence, which is a major unidentified problem in the field. A coherent developmental model is needed to analyze such data, but also to test novel hypotheses about the tempo and mode of development. Here, my mentor (Chris Organ) and I will use phylogenetic comparative methods to build a developmental model for how tissue-level traits are related to one another through development processes. We will use these models to study how cancer incidence rates are associated with stem cell division rate and tissue-specific metabolic rate.

Emma Folkerts: University Honors Program
Mentor: Wendy Stock, Franke Wilmer - Agricultural Economics & Economics, Chemistry & Biochemistry
The Impact of Human Trafficking Legislation on Identification and Prosecution

How do federal and state human trafficking legislation impact the number of human trafficking cases identified and prosecuted in the United States? This research tests the hypothesis that trafficking legislation increases the number of trafficking cases identified and prosecuted, and that more comprehensive policy yields more identification and prosecution. This includes analysis of state and federal legislation using the categories of criminalization, state investment, and civil remedies from 2000 to 2016 to classify legislation as basic or comprehensive. Uniform Crime Report (UCR) data, arrest records, call reports from the National Human Trafficking Hotline, and other sources of data will be used to record the number of cases identified in each state. Also, state and federal prosecution data will be collected from UCR data and federal and state reporting data. To control for the impact of legislation on the number of trafficking cases identified and prosecuted, this study will incorporate confounding variables like awareness levels through Google search trends as well as information regarding demographics, unemployment levels, and dominant industry into analysis. Using statistical models and regression of means tests, this research will analyze which laws and programs are most effective and provide suggestions for improvement. This will be a springboard for further study into the impact of human trafficking laws on the crime itself.
This study will continue in the summer and into the fall with the goal of publication and presenting at conferences. Findings thus far include classification of state and federal legislation as well as preliminary data collection for identification, prosecution, and confounding variables.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Britney Gibbs: Cell Biology & Neuroscience
Mentor: Brendan Mumey, David L. Millman - Computer Science
Organizing and Analyzing Diverse Biofilm Data Types Using Ontology and Bayesian Networks (TRIO)

Biofilms Resources and Information Database (BRaID) is a centralized database and analysis tool for biofilm-related data. Biofilm-related terms in BRaID will be organized using an ontology, which is a systematic way to establish relationships between terms. Due to the diverse subfields of biofilm research, a human-generated list of terms may contain a bias towards specific fields. The goal of automating term generation is to reduce that bias. Topic modeling was used to extract keywords relating to themes from a collection of biofilm-related papers. Metadata for 2181 papers containing the keyword "biofilm" was obtained from the Application Programming Interface (API) of doaj.org. Using Java and shell scripts, 1724 PDFs were downloaded from websites extracted from the metadata. Some metadata contained a direct link to the PDF file. When no direct link was present, the PDF file was obtained by a simple redirect, modifying the URL, or extracted using the xpath. In addition to topic modeling, paper keywords were extracted from metadata. The end result was a large list of assumed biofilm-related terms. Biofilm experts stated the terms related to biofilms and appeared helpful. They are currently using the terms for ontology development. Another interesting aspect for further analysis is to compare the paper keywords generated by experts versus the terms generated by topic modeling, which may give insight into how keywords are chosen for different papers. Future directions of the BRaID project are data fusion methods, which includes finding ways to incorporate diverse biofilm data types into a Bayesian network.

Jaxen Godfrey: Physics
Mentor: Jennifer Fowler - Other
Examining Change in Planetary Boundary Layer Height during the Total Solar Eclipse over South-East Wyoming

The planetary boundary layer (PBL) is considered the lowest portion of the atmosphere, where exchanges of heat, momentum, and aerosols take place between the earth's surface and the free atmosphere. It is considered to be a turbulent mixing layer, influenced by its contact with the earth's surface and the convective heating of the sun. Its behavior is closely tied to rapid weather changes as well as long term climate trends. The height of PBL demonstrates large diurnal changes, ranging from zero to above two kilometers. During a total solar eclipse, the change from light to dark occurs almost six times faster than the change from day to night, which causes a significant temperature drop within a very brief amount of time. In short, this steep temperature gradient, along with other factors, caused a significant decrease in PBL height only after totality occurred and had no discernible effect in the period leading up to totality.

Nicolette Green: Psychology
Mentor: Matthew Vess - Psychology
True Self Alienation and Mind Wandering: The Relationship

This research is based off previous research on one of the three elements of Authenticity. The true self is something that has received more attention as of late and is one of the main variables in this study. The other being mind wandering. This research strives to show another strong correlation, building on the relationship Vess, Leal, Hoeldtke, Schlegel, & Hicks, 2016 found between the two variables. This study focuses on the physical representations of mind wandering as it measures the phenomena using an electroencephalogram. Previous studies have relied on mostly self report or probing, which are more subject to human error. By taking the human error out of the relationship it is expected that the results will show a well rounded, more clear picture of the function of mind wandering and its relationship to true self alienation.

Brady Griffith: Physics
Mentor: John Sample - Physics
GEANT Modeling of FIREBIRD

FIREBIRD is set of CubeSats launched to study Relativistic Electron Bursts. In order to clear up ambiguity about their detector's response, a GEANT model was constructed and subjected to Monte Carlo analysis. GEANT is a particle physics modeling toolkit, which is frequently applied to spacecraft detector design. This modeling allowed for specification of the detectors geometric factor over its range of energy channels. It also allowed for an accurate field of view to be determined.

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

Fly fishing for salmonid species is iconic to the American West. Anglers have been at the forefront of conservation efforts and stewards to this nation's rivers and streams for over 100 years. But we face a new challenge—the age of the Anthropocene. Dramatic losses of cold water habitat are predicted to occur in the 21st century due to human-caused climate change, impacting human and salmonid communities across the American West. Signs of these negative changes are already transpiring and predicted to worsen. Unfortunately, there are still many in fly fishing communities that do not know of these imminent changes. My research focuses on communicating the consequences of current and future climate change on freshwater ecosystems. The culmination of my project —a short book —conveys the urgency of the impacts we face in a way that is accessible not only to guides, outfitters, and anglers but everyday citizens. The book will explain the potential future effects of climate change on the social, economic, and ecological aspects of fly fishing communities on the Deschutes, Yellowstone and Madison, and Salmon Rivers within their corresponding states: Oregon, Montana, and Idaho. There is a pressing need to convey these concepts so we can save salmonid species in the West.

Katherine Hernandez: History & Philosophy
Mentor: Amanda Hendrix-Komoto - History & Philosophy
British Expansion through the Tales of the Fictitious

Eighteenth-century travelers brought the journals of their extraordinary expeditions back to metropolitan Britain. These travels included lands that would one day be colonized by the British Crown and were the beginning of the British expansion. Despite the research on these journals, little research has been conducted on the conversation between fictitious travelers and their real world counterparts. My work compares popular fictional travel journals from the eighteenth-century with real travel journals of the time. William Dampier's New Voyage Round the World will be examined in context with Jonathan Swift's Gulliver's Travels and Daniel Defoe's Robinson Crusoe. Dampier's expeditions influenced both Jonathan Swift and Daniel Defoe. Swift references Dampier's New Voyage Round the World in Gulliver's Travels, with Gulliver mentioning it in his letter to his cousin Sympson. Defoe's Robinson Crusoe was inspired by a crewmember of Dampier, Alexander Selkirk. Considering Dampier's influence on British society, I argue that Dampier and others like him influenced how British authors and everyday Britons saw foreign people, especially indigenous people. Because Gulliver's Travels and Robinson Crusoe are rooted in Dampier's travels, these fictional tales can explain the mindset of real British explorers. These interactions also explain how British subjects viewed foreign nations because they read these travels through the eyes of these biased journals. These fictional accounts can help put into context how eighteenth century intellectuals viewed British expansion, which influenced the overall opinion of the British populace.

Taylor Herzog: Microbiology & Immunology
Mentor: Mensur Dlakic - Microbiology & Immunology
Natural and partially randomized peptides preventing the activity of Cytolethal Distending Toxins

The research involves Cytolethal Distending Toxins (CDTs). CDTs were first discovered in 1987 from Escherichia coli isolated from a patient. Although CDTs have been known and studied for 30 years there is still a lot to be discovered about these toxins and their activity. In 1994 an operon from a CDT was sequenced from E. coli and it was found that the toxin was composed of 3 main subunits. These subunits are denoted as CdtA, CdtB, and CdtC. The CdtB is the catalytically active subunit that is causing damage and entering the host cell. The CdtB shares both structural and functional homology with DNase I. There is less known about the A and C subunits. A portion of the C subunit obscures the active site of the B subunit, as we know from a crystal structure that was produced out of the Dlakic Lab. This arm-like extension of the C subunit has been sequenced and we plan to create the peptide through PCR assembly. The peptides will be made with their original sequence as well as randomized sequences to find the sequence with the best binding affinity. The experiments will then test if CdtB with this portion on the C subunit will have an effect on the virulence of the CdtB. We hypothesize that the addition of just this portion of the CdtC with the CdtB will cause it to be less harmful or stop its activity all together.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Leidy Hooker: Chemistry & Biochemistry
Mentor: Sharon Neufeldt - Chemistry & Biochemistry, Cell Biology & Neuroscience
Catalyst-Controlled Selectivity in Nickel-Catalyzed Cross-Coupling

Suzuki cross-couplings reactions allow creation of carbon-carbon bonds, usually between two aryl groups, using a metal catalyst. This work utilizes nickel as the catalyst. Nickel's nucleophilic nature increases its reactivity with a broad array of electrophiles, specifically phenol-derived electrophiles. With numerous functional groups to work with, the goal of this project is to use ligands on nickel to control selectivity for different electrophilic functional groups in Suzuki cross-coupling reactions. In particular, we have found that nickel can be induced to react selectively with a halide functional group or, alternatively, with a phenol-derived functional group simply by switching the ligand in the reaction. This poster describes our path to discovering this divergent selectivity and our efforts to understand it. We have screened numerous variables such as ligand, base, and solvent. Nuclear magnetic resonance (NMR) studies were performed to evaluate major intermediates in the Suzuki cross-coupling catalytic cycle. Evaluation of the NMR spectra obtained from these studies allow us to paint a picture of how and when the various reagents interact with the nickel catalyst. These studies are aimed at gaining an understanding of how sterics and electronics of the ligand play a role in determining what functional group reacts with the catalyst. Although further work is needed to improve yields and selectivities, we anticipate that these results will have significant implications for organic synthesis. The ability to switch catalyst selectivity in cross coupling reactions could facilitate synthesis of compounds ranging from polymers (e.g., plastics) to pharmaceuticals (e.g., drugs to treat leukemia).

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Caden J. Howlett: Earth Sciences
Mentor: Andrew Laskowski - Earth Sciences
Detrital zircon U-Pb geochronology and GIS terrain analysis to determine provenance of gold placer deposits of the Pioneer District, Flint Creek Range, SW Montana.

The Pioneer District, located ~15 miles NW of Deer Lodge, MT is a 200 km2 region in which gold-bearing sediments were deposited by glaciers and streams to form productive placer deposits. We conducted U-Pb geochronology of

detrital zircon grains extracted from placer deposits and tailings to correlate their U-Pb ages to those of potential source units across the region, revealing the location of the original gold deposit(s) and the sediment dispersal pathway(s). We dated 1,058 detrital zircons from four samples using laser-ablation, inductively-coupled-plasma mass spectrometry. We interpret that zircon grains with ages between 2200-1000Ma were derived from the Paleoproterozoic Yavapai-Mazatzal accreted terranes, Mesoproterozoic Belt Supergroup (meta)sedimentary rocks, or recycled from regional Paleo/Mesozoic sedimentary rocks. Paleozoic and Jurassic grains in our samples were likely recycled from Paleo/Mesozoic strata exposed in the Flint Creek Range. A composite age-probability plot of 237 young (<250 Ma) detrital zircons reveals two prominent age-probability peaks centered at ~69 Ma and ~26 Ma, which we interpret to reflect first-cycle derivation from Cretaceous intrusive rocks exposed in the Flint Creek Range and late-stage magmatism during or after formation of the extensional Anaconda Metamorphic Core Complex, respectively. The age-probability peaks in all samples are consistent with derivation from Late Cretaceous granodiorite intrusives and surrounding middle Cambrian to Cretaceous sedimentary rocks, and/or Mesoproterozoic Belt rocks. Mixed provenance suggests that the placer deposits were derived from a region where the contact between the igneous rocks and potential (meta)sedimentary sources is exposed.
This research, along with previous measurements of gold coarseness, support the hypothesis that the Pioneer District placer gold formed due to injection of gold-bearing magma into carbonate rocks of the Belt Supergroup, Paleo/Mesozoic strata, or a combination of all three, creating a gold-bearing skarn deposit which was later eroded and deposited by streams and glaciers in the foothills surrounding the Flint Creek Range.

Rudolph Hummel: Earth Sciences
Mentor: Christopher Organ - Earth Sciences
Origin and Dispersal of Gorgonopsia: A Phylogenetic Approach to Permian Therapsid Biogeography

Gorgonopsia is a group of extinct, Permian-age, carnivorous therapsids (mammal ancestors) known largely from Russia and Africa. The origin and dispersal of Gorgonopsia and related therapsids is poorly understood; specifically, how gorgonopsian species originated in both northern and southern Pangaea (including modern day Russia and Africa) despite Permian climatic data supporting an expansive desert dividing the two regions. Although this issue could be resolved using a comprehensive phylogeny (evolutionary tree), previous phylogenetic analyses were hampered by a poor understanding of the group's taxonomy. This problem is largely the result from a lack of interest and poorly preserved holotypes. At present, there is no phylogeny combining sufficient specimens of Gorgonopsia from both regions. In fact, there is no quantitatively-inferred phylogeny for the Russian species at all. Using data from past phylogenies of African species and descriptions of Russian specimens, the author will create a specimen-level phylogeny, as opposed to the previously attempted species-level phylogenies, to bypass taxonomic issues within the group. The relationships of Russian and African specimens provided by this phylogeny will then be used to quantitatively predict the group's likely geographic origin and subsequent path(s) of dispersal. Finally, the results of this biogeographical study will be used to test whether the desert covering central Pangaea was impassable, as some authors have assumed, or possessed 'corridors' that allowed faunal interchange, as others have recently suggested.

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Frankie Johnston: Other
Mentor: Joseph Barlow - Chemistry
Isolating and Determining the Growth Rate of the Probiotics Present in Kombucha Tea

In the field of biology, the microbiome is one the most important, but least understood aspects of human health. Recently, scientists have begun to recognize the importance of bacteria beneficial to the body which are referred to as probiotics. The majority of probiotics can be maintained by the foods we eat and the environment around us. However, in the case of illness, strong medications such as antibiotics, can put a strain on the microbiome

resulting in the need to replenish probiotics. The most effective method of probiotic replenishment is not yet known. By comparing raw probiotics isolated from kombucha tea and manufactured capsule probiotics, I aim to test which form has the strongest potency by determining growth rates and performing competition assays with other normal microbiota flora such as E. Coli.

Acknowledgements: Brenda Canine (MSU Faculty Member) – Chemistry & Biochemistry

Madeline Kelly: Physics
Mentor: Sachiko Tsuruta, Ken'ichi Nomoto, Marcus Teter - Physics
Ambipolar Heating on the Thermal Evolution of Magnetars Under Semi-Exact Methods

Current theoretical studies regarding the thermal evolution of magnetars (neutron stars with extreme magnetic fields of generally between 1013 and 1015 Gauss) have yet to match the luminosity constraints provided by the growing amount of observational data. As a result, a semi-exact method of modeling the thermal evolution of such stars has been implemented that is more physically accurate than previous studies and accounts for several problems noted in previous publications. This method involves the use of an exact evolution code, which simultaneously calculates general relativistic structure evolution equations, to perform calculations from the core up to a boundary, where the magnetic field effect becomes more complicated under ultra-strong magnetic fields. The method then makes approximations from that boundary to the surface, using the core temperature versus surface luminosity relation given by Beloborodov and Li in 2016, for magnetic field strengths of 3 x 1013 and 1015 Gauss. Ambipolar heating, that is, heating caused by the movement of protons and electrons in the core of the magnetar due to the presence of ultra-strong magnetic fields, was included in the model, along with an increased thermal conductivity of the envelope. The preliminary results show that this model can match much of the observational data taken to date. With this promising outcome, continued work will be done in the near future to perform fully exact calculations, all the way from the core to the surface, for an entire range of magnetic field strengths.

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Jacob Kerner: Chemical & Biological Engineering
Mentor: Stephanie McCalla – Chemical & Biological Engineering
Modeling of Calcein Penetration in Multilatered Cellular Spheres

In spherical cancerous groups of cells, ensuring the penetration of chemotherapeutic drugs is often a major problem. Greater drug penetration is achieved through the transport of drug between cellular layers and the diffusion of the drug through interstitial space. These cancerous spheroids however, often have some form of drug resistance in the form of protein transporters such as P-glycoprotein pumps.1 P-glycoprotein pumps consist of two transmembrane domains that use adenosine triphosphate to pump foreign chemicals out of the cell into the interstitial space to prevent cell death.1 MDR1 P-glycoprotein pumps recognizes and transports a variety of substrates, many of which are natural chemotherapy drugs.1 Cells in many tumor spheroids are also connected by gap junctions which directly connect the cytoplasm of two cells. Drugs in the cell can then be passed between cells and sometimes penetrate further into the spheroid. Measuring the transport of a molecule between these layers and compartments of the spheroid is often complex. In this study, Calcein AM diffusion will be modeled using ordinary differential equations numerically solved by a MATLAB code to model diffusion through the interstitial space, diffusion through cell membranes, diffusion through gap junctions, and being converted to a florescent derivative called Calcein within cells.

Scott Killian: Cell Biology & Neuroscience
Mentor: Susy Kohout – Cell Biology & Neuroscience
Localizing Endogenous Voltage Sensitive Phosphatase in Xenopus laevis and tropicalis

Voltage Sensitive Phosphatases (VSPs) are proteins composed of a transmembrane voltage sensing domain (VSD) coupled to a cytoplasmic phosphatase domain (PD). In response to changes in membrane potential the VSD undergoes a conformational change allowing the PD to dephosphorylate phosphatidylinositol phosphates (PIPs) at specific positions. PIPs are crucially involved in a variety of cellular processes including proliferation, migration, ion channel modulation, and cytoskeleton remodeling. Although VSPs biophysical function as a PIP modulator is well known how it nestles into the greater picture of homeostasis is unknown. A step in figuring this out is localizing endogenous VSP within the tissues of Xenopus laevis (Xl) and Xenopus tropicalis (Xt) frogs. Immunohistochemistry on wholemount and sectioned embryos was used to do just that. The resulting images show bright punta of similar size to cilia located on the epidermis and within the pronephric duct, both ciliated tissues. Further images of embryos co-stained against VSP and cilia specific proteins show the two in the exact same spot allowing us to theorize that VSP is localized to the cilia of Xl and Xt frogs. If true then VSP could play a role in various ciliopathies like polycystic kidney disease and Joubert Syndrome.

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Casey Krueger: Business
Mentor: Kara Johnson, Dr. Laura Periman MD - Mathematical Sciences
Intense Pulsed Light Decreases Metalloproteinase 9 (MMP9) in the Meibomian Gland Dysfunction Patient: A retrospective analysis

The purpose of this study was to determine the effectiveness of intense pulsed light (IPL) in decreasing metalloproteinase 9 (MMP9) in Meibomian Gland Dysfunction patients. Treatment of the inflammatory component of Meibomian Gland Dysfunction is a vital therapeutic objective. Traditional methods for anti-inflammatory therapy include warm compresses, eyelid hygiene, fatty acid supplements, immunomodulators, steroids, doxycycline, and local bacterial control. New evidence supports IPL as an anti-inflammatory therapy for MGD, as it shows statistically significant decreases in the inflammatory cytokines IL-6 and IL-17. This evidence also supports the possibility for IPL to decrease the inflammatory cytokine levels of MMP9. This retrospective clinical study involved 72 patients. Each patient received 1-6 treatments at varying intervals. Several tests were performed in order to obtain a comprehensive analysis of the effectiveness of the IPL, including the Standard Patient Evaluation of Eye Dryness (SPEED) questionnaire, tear osmolarity tests, metalloproteinase 9 tests, and slit lamp examinations of the eye with topical fluorescein. For a typical patient with an MMP9 of 1 or greater, the mean MMP9 decreases by an estimated 0.5160 per session for sessions conducted at similar air qualities. The estimated median SPEED decreases by 6.8167% per session for the typical patient. IPL is associated with decreased metalloproteinase 9 and Standard Patient Evaluation of Eye Dryness in Meibomian Gland Dysfunction patients after accounting for the effect of air quality and patient to patient variability.

Abigail Lake: English
Mentor: Gretchen Minton - English, Political Science
Shakespeare's Spaces and Places in Montana's Rural Reservation High Schools

In 1995, a group of high school actors, their parents and their teachers from Mission Valley Christian Academy met in the small Catholic parish of Ronan, Montana, to perform Shakespeare's Much Ado About Nothing. This early production by the private, classical school—then two years old—was the beginning of Mission Valley Christian Academy's drama program and a school that would become known as the place where the play was the thing. This

once-robust high school theatre became my window into the extant humanities-focused educational culture of rural reservation high schools in Montana and I have been specifically researching the presence and performance of Shakespeare in two reservation high schools: Ronan's Mission Valley Christian academy on The Flathead Reservation and Lame Deer's Public High School on The Northern Cheyenne Reservation. I have interviewed teachers regarding teaching methods, intentions, and pedagogy, gathering documented descriptions and announcements of Shakespeare performances and interactions, spoken with current and former students about their experiences with Shakespeare in school, and have researched the physical performance spaces of both sites. As I focused on space, I found that the places of performance functioned similarly: both were spaces of sanctity and community where students, teachers, and civic members congregated. Lame Deer's gymnasium-theatre hosted sporting events and visiting-actor drama productions, and Ronan's auto-body-shop-turned-church regularly saw Protestant worship services and high school Shakespeare performances. Students regularly saw a multiplicity of life's moments in the same space where they either saw Shakespeare performed or performed themselves, and this close relation to Shakespearean theatre and life has manifested in rural programs that facilitate student success both academically and socially. Shakespeare, as I've found in my research, provides spaces, both textually and physically, for students to become aware of not only their own language and body, but of the history and psyche of others, specifically as theatre operates in these schools via a relationship between actors and audience in a unique performance space.

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Savanah Leidholt: Ecology
Mentor: David Willey, Tom Shultz - Ecology, Computer Science
Variation in Genetic Composition of O. annularis and O. franksi and their Symbionts by Depth

The Deep Reef Refuge Hypothesis (DRRH) states that deep reef ecosystems can serve as propagules for shallow reefs following major disturbances. This hypothesis was tested using Restriction-site Associated DNA sequencing (RAD-seq) on two species of Carribean corals, Orbicella annularis and O. franksi, to determine genetic differentiation of each species by depth. Additionally, this technique was used to determine the genetic distinction between each species at different depths. RAD-seq can also evaluate the level of hybridization, if any, between the two species. The two depths at which corals were collected were shallow (~5-8 meters) and deep (~30 meters). A total of three sites were chosen near the coast of St. Thomas, USVI, one shallow site (Brewers) and two deep sites (Sail Rock and North East Grammanik Bank). This project also investigated another vital component of coral biology by determining the variety of algal symbiont diversity and distribution within each species at all three collection sites using Single Molecule, Real-Time (SMRT) sequencing by Pacific Biosciences. The information gathered from both RAD and SMRT sequencing will make it possible to determine the level of connectivity between the deep and shallow populations for future management and conservation solutions specific to O. annularis and O. franksi.

Acknowledgements: Dan Holsten (Non-MSU/Other)

Peter Lucier: Political Science
Mentor: David Parker - Political Science, Earth Sciences
Why They Fight: Congressional Blocks of Foreign Military Sales

Presidents enjoy a significant advantage over the Legislature when conducting foreign policy (Wildavsky, 1966). Immediately after Watergate and Vietnam, there was a significant flurry of legislative activity challenging the Presidency for a larger role in foreign policy making. Since this peak of legislative activity and oversight in foreign policy in late 1970s, metrics measuring legislative action in foreign policy have declined across the board. Recently, however, Congress has begun to assert itself by attempting to block foreign military sales. In an environment with at least a diminished "electoral connection", with less statutory authority, and with fewer interest groups paying

attention--why, and when, will legislators choose to undertake foreign policy entrepreneurship? The Arms Control Export Act, and the program it created, Foreign Military Sales, provides unique insight into legislative and executive interactions and history. By assembling a data set of Member of Congress' actions to delay or block proposed FMS sales since 1976, this research provides a case study offering insight into MoC's behavior. This data can be compared against research from Mayhew (1974), Parker (2013), and Fowler (2015) with regards to both divided government, committee behavior, and oversight hearings. A statistical comparison of MOC behavior with regards to FMS, against existing behavioral theories, combined with deep examinations of the (mostly) Senators who undertake foreign policy entrepreneurship, will either enrich or challenge existing literature explaining MoC behavior, by incorporating Wildavsky's central insight – just as the Presidency acts differently in the foreign realm than the domestic, so too does the Legislature.

Oscar Machado: Cell Biology & Neuroscience
Mentor: Christa Merzdorf - Cell Biology & Neuroscience, Microbiology & Immunology
Determining the Place of aqp3b in the Wnt/Ca2+ Noncanonical Pathway

During Xenopus laevis gastrulation, convergent extension is required for the mesoderm to extend into the embryo and shape the embryonic body plan. Recent results from our lab suggest that the inhibition of aquaporin3b (aqp3b) prevents convergent extension of the mesoderm and that aqp3b acts through noncanonical Wnt signaling. Wnt signaling is a key signal pathway for embryo and tissue development and is composed of the canonical and the noncanonical pathways. Our lab has shown that aqp3b acts through a specific noncanonical pathway, the Wnt/Ca2+ pathway, and acts upstream of the cytoplasmic Wnt signaling pathway member Disheveled (Dsh). Frizzled7 (Fz7) is a membrane receptor in the noncanonical Wnt/Ca2+ pathway which also acts upstream of Disheveled. Our question for this project is whether aqp3b acts upstream or downstream of Fz7? When Fz7 was present, protein kinase C fused to green fluorescent protein (PKC-GFP) attached to the cell membrane but when Fz7 was absent, PKC-GFP remained freely in the cytoplasm. This served as our control injections: PKC-GFP + fz7 or PKC-GFP alone, respectively. The experimental injections included a morpholino (MO), small oligonucleotide that inhibited aqp3b expression, or a control MO which did not inhibit aqp3b. We have shown that the MO has kept PKC-GFP localized to the cytoplasm despite the presence of Fz7, while the control MO is allowing PKC-GFP membrane attachment. These data demonstrate that aqp3b acts downstream of the Fz7 receptor in the noncanonical Wnt signal cascade.

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Zachary Maguire: Ecology
Mentor: Lindsey Albertson - Ecology, Mathematical Sciences
Legacy Effects of Abandoned Ecosystem Engineering Structures on Stream Hydraulics

Habitat modifications from ecosystem engineering can have profound legacy effects on ecological processes and communities. Our research identifies a substantial hydraulic effect stemming from net-spinning caddisfly (Hydropsychidae) retreat structures and describes the longevity of this effect over ecologically relevant timescales. We hypothesized that water velocity would be reduced immediately downstream (5mm) of caddisfly retreat structures and that this effect would diminish overtime if retreats were abandoned by their caddisfly. We measured water velocity in front of and behind retreats and then experimentally simulated abandonment by removing caddisfly larvae and measuring 8 times over a 45-day post abandonment period in an artificial laboratory stream. Water velocity was significantly lower behind retreats by as much 90%, suggesting retreats have strong effects on local hydraulics. Reductions in flow behind abandoned retreats were also maintained for 45 days suggesting a potential ecologically relevant legacy effect of abandoned caddisfly structures on near bed hydraulics. The legacy of these local changes to hydrology may provide important refugia for less flow tolerant benthic macroinvertebrate taxa and especially to those with rapid life histories and high turnover rates. Future work will

focus on defining the persistence of caddisfly structures in the field, rates of deterioration, and influence on benthic macroinvertebrate communities.

Acknowledgements: Ben Rumolo (MSU Graduate Student) – Ecology, IDeA Network of Biomedical Research Excellence (INBRE)

Adrian Massey: Ecology
Mentor: Michael Ivie - Plant Sciences & Plant Pathology
Elmidae of Montana

The beetles (Coleoptera) represent the largest and most diverse order in the animal kingdom, with nearly 390,000 described species and more added almost daily. The family Elmidae (riffle beetles), with sub-families Larinae and Elminae, is one of many beetle families with taxa still being added. To date, there are nearly 100 species in 27 genera of these aquatic beetles described in North America. In Montana, the number of recorded species has increased from nine to seventeen, including one new species in the genus Narpus, during this project. The newly recorded species for Montana are: Cleptelmis addenda (Fall 1907), Dubiraphia bivittata (Melsheimer 1844), Dubiraphia quadrinotata (Say 1825), Narpus concolor (LeConte 1881), Optioservus divergens (LeConte 1874), Optioservus seriatus (LeConte 1874), Stenelmis occidentalis (Schmude and Brown 1991), Ordobrevia nubifera (Fall 1901) and Narpus n.s. These new records are found in 47 counties around the state. This research has greatly enhanced knowledge of the Elmidae family for the state of Montana.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Katherine McCahan: Microbiology & Immunology
Mentor: Amy Trowbridge - Land Resources & Environmental Sciences
Analysis of physiological and chemical changes due to drought stress in PiÃ±on pines

In face of the globe's rising temperatures, understanding mechanisms of plant mortality, especially with respect to their chemical defense capabilities, is incredibly pertinent. This work provides insight into the chemical and physiological response of PiÃ±on pines (Pinus edulis Engelm.) as a function of prolonged drought stress. The Growth Differentiation Balance Hypothesis (GDBH) states that there is a trade-off of resources between growth and defence, depending on resource availability and environmental stressors. This test determined the point at which PiÃ±on pines switch allocation of carbon resources from defense to other processes necessary for survival (e.g. respiration), and how the individual defense compounds are prioritized along a drought continuum. Trees were assigned to one of two treatment groups: control and acute drought stress (n=20), which were measured for volatile emissions, soil water content, stem water potential, and growth over a 14 week period. Air samples were collected using volatile organic compound collection chambers, and analyzed using Gas Chromatography-Mass Spectroscopy (GC-MS), with emission rates calculated using a known internal standard. Preliminary results suggest that as drought stress heightened, a more diverse array of compounds were produced, and concentrations of most compounds increased significantly. This rise in emissions during moderate drought stress is consistent with the GDBH because as the influence of stress escalated, resources were portioned more towards defense until drought reached acute levels. After 8 weeks of treatment, a sharp decrease in volatile production in the droughted trees compared to the control trees was observed, suggesting that the physiological conditions at that time constrained defenses and served as a threshold for production. Together, the data support the general trend predicted by the GDBH, but because not all compounds behaved in the same way, this suggests that plants may be prioritizing defenses according to their greatest biotic threats.

Acknowledgements: Jack Heneghan (MSU Undergraduate Student) – Land Resources & Environmental Sciences, IDeA Network of Biomedical Research Excellence (INBRE)

Sarah McKnight: Mathematical Sciences
Mentor: Mark Greenwood - Mathematical Sciences
Creating a Student and Sports-Based University Ranking System With Structural Equation Modeling

Students and university administrators alike use university rankings to make decisions about their future and the future of their school. Many of these rankings are proprietary, so their underlying methods are largely unknown. The purpose of this research is to use structural equation modeling (SEM) to create and test the validity of a ranking system which combines student and sports characteristics into a single score. Results indicate that the variability in most sports characteristics makes them difficult to combine. Further, this research reveals that relatively few student characteristics are required to create the ranking. The final model generates a score by merging the graduation success rate (GSR) of student-athletes, average SAT score, six-year completion rate, median 10-year earnings, and number of sports.

Acknowledgements: Paul Wilson-Harmon (MSU Graduate Student) – Mathematical Sciences

Heather Merkouris: McNair Scholars Program
Mentor: Dr. Renee Reijo Pera, Dr. Shelly Hogan - Other
Is germ cell differentiation limited by lack of SMAD expression?

Human germ cells give rise to sperm and eggs, which in turn propagate reproduction and the continuation of life. In the US, approximately 1 in 8 couples are affected by infertility (1), and a recent report has shown an approximate 59.3% decrease in sperm count in the developed world (2). Despite this, little is known about the development of human germ cells and the underlying mechanisms that lead to their differentiation. In order to better understand human germ cell development and to learn about the etiology of infertility and potential treatments, the Reijo Pera Lab uses human embryonic stem cells to differentiate to primordial germ cells in vitro. In vitro formation of germ cells, however, is very inefficient and inconsistent. In order to address this, my project focuses on analyzing a conserved set of signaling proteins, the SMADs, which have been shown to be essential in germ cell formation from Drosophila to Mouse. We performed immunofluorescent analysis on human fetal testis in our lab and found that we could detect high levels of SMADs 1,4, and 9 (for which we had working antibodies). In comparison, human embryonic stem cells expressed undetectable levels compared to a positive control. When we overexpressed all the SMADs (1,4,5, and 9) in a reporter line, and differentiated for 8 days, we found that SMAD overexpressing hESC stem cells differentiated more efficiently into germ cells. These results suggest that the rate-limiting step in differentiation from stem cell to germ cell may be SMAD expression.

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Jennifer Mikkelson: History
Mentor: William Stadwiser, Jill Holder - INBRE
Youth Educational Programming at the Gallatin Valley Food Bank

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 the GVFB best utilize this research to inform future planning and grant applications? How do other organizations that have been successful in programs

like these fund the project? Applying for funding through the state of Montana using Prevention Incentive Fund application. Partnership with MSU's Human Development Clinic, providing an avenue for graduate students to gain the hands on counseling hours needed for certification.

Acknowledgements: Partnership with MSU's Human Development Clinic, providing an avenue for graduate students to gain the hands on counseling hours needed for certification.

Hannah Monaghan: Microbiology & Immunology
Mentor: Margaret Eggers, Lori Christenson - Center for Biofilm Engineering, Director Environmental Health at Gallatin City/County Health Department
Investigation of on-site wastewater treatment system suitability for floodplains

Gallatin is the fastest growing county in Montana, hence land with high groundwater, including property within the floodplain, is under increasing pressure for development. Homes and businesses without access to municipal wastewater service are required to have a permitted on-site wastewater treatment system (OWTS) that can remove solids, nutrients, and pathogens from waste before releasing the effluent into the environment. Failing OWTS can create public health risks. While drain fields for septic systems can be adapted to high groundwater by installing them in a "sand mound," limited literature indicates sand mounds cannot withstand flood events. The project goal is to determine whether sand mound systems or other OWTS have been proven to withstand flooding and hence would be appropriate technology for floodplain installation. Online and database literature searches were conducted regarding local health department regulations and policies regarding OWTS. Phone calls were also made to various health departments in the western part of the United States. There are articles from the EPA, the University of Wisconsin – Madison and the Nevada Division of Environmental Protection stating that sand mounds should not be placed in floodplains. There are some OWTS that have potential to safely work within the floodplain, which are being investigated further. A failing or inadequate system can cause a variety of environmental and public health risks. Gallatin County is quickly growing, and it is imperative that the septic systems in floodplains will not adversely affect public health because of flood events.

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Aitana Moore: Microbiology & Immunology
Mentor: Diane Bimczok, Gary Stoner - Microbiology & Immunology, Cell Biology & Neuroscience
Evaluating the Antimicrobial Effects of Extracts from Oregon Blackberries & Black Raspberries on Relevant Strains of Helicobacter Pylori

The objective of this research is to determine the ability of standardized blackberry and black raspberry extracts to inhibit growth and kill Helicobacter pylori. Infection with H. pylori is known to cause gastritis, chronic gastritis, peptic ulcers and stomach cancer. Blackberries and black raspberries serve well in combating these ailments due to their anti-inflammatory, antibacterial and chemopreventive effects. This is important because there is growing antibiotic resistance occurring, especially with clindamycin, a first line antibiotic. H. pylori growth in Brucella broth with 10% fetal bovine serum and also monitored via tetrazolium dye colorimetric assay using an OmniLog instrument. Many different anthocyanin concentrations will be tested from various berries on several different H. pylori strains for effectiveness and the determination of a minimum inhibitory concentration determination. There is not yet enough trials to make any determinations but there has been some evidence that the anthocyanins are inhibiting growth.

Acknowledgements: Candace Goodman (MSU Faculty Member) – Chemistry & Biochemistry, Mandi Roe (MSU Graduate Student) – Microbiology & Immunology, Marziah Hashimi (MSU Graduate Student) – Microbiology & Immunology, T. Andrew Sebrell (MSU Graduate Student) – Microbiology & Immunology, First Year Research Experience (FYRE)

Julie Morgan: Chemistry & Biochemistry
Mentor: Mary Miles – Heath & Human Development
Illuminating the Metabolic Reprogramming of Human Neutrophils upon Phagocytosis of Staphylococcus Aureus

The purpose of this project is to develop a multi-faceted characterization of the metabolic changes triggered in human neutrophils upon phagocytosis of bacteria pathogens. The project seeks to investigate the hypothesis that Staphylococcus aureus (S. aureus), a key bacterial pathogen, manipulates the metabolic programming of immune cells to avoid the host's immune defenses. Distinct metabolic patterns resulting from neutrophil phagocytosis of different strains of S. aureus – either exhibiting varying levels of antimicrobial resistance or patterns of virulence factors - were denoted using Nuclear Magnetic Resonance (NMR) metabolomics technology. The strain of methicillin-resistant S. aureus (MRSA) currently being investigated is the saeR/S genetically-altered bacteria. 1D 1H NMR metabolomics data collected from a high magnetic field 600 MHz NMR spectrometer has been processed using Bruker Topspin software and Chenomx TM NMR processing software. The set of experimental data, levels of metabolites in neutrophils with phagocytosed saeR/S genetically altered MRSA and with phagocytosed unaltered MRSA, showed preliminary differences in metabolite levels. The research is being continued to verify that these differences are statistically significant and to identify which metabolic pathways play a role. The promising results of this project may help elucidate the immunometabolism of infected neutrophils. This issue is of growing interest, because MRSA represents a growing biomedical threat to the community. The project could be validated in the long term by genetic intervention during bacterial infection, aimed at blocking certain vulnerable metabolic pathways. The goal of this research would be to define new biomedical and biochemical methods to curb S. aureus prevalence.

Michelle Narayan: Cell Biology & Neuroscience
Mentor: Brock LaMeres - Electrical & Computer Engineering
Mechanisms of Calcium-mediated Polymyxin B resistance in Pseudomonas aeruginosa

Pseudomonas aeruginosa is an opportunistic pathogen that is resistant to many commonly used antibiotics, including the cationic peptide, Polymyxin B. Polymyxin B resistance is enhanced in a calcium rich environment, which is characteristic of in vivo conditions, especially in patients with the genetic disorder, cystic fibrosis. The goal of this study is to identify P. aeruginosa genes that are associated with calcium-dependent Polymyxin B resistance. In previous research from the Franklin lab, a series of single nucleotide mutant strains were obtained that had increased sensitivity to Polymyxin B compared to the wild-type strain, when cultured at high calcium concentrations. In the present study, we determined the minimum inhibitory concentration (MIC) of these strains using microtiter plate assays and disk diffusion assays. These strains were analyzed at both low and high concentrations of calcium. The sites of mutations were identified previously by DNA sequence analysis. Surprisingly, the genes identified are not associated with lipopolysacharide modification, which has been shown by another research lab to mediate Polymyxin B resistance. To identify additional genes involved in calcium-dependent Polymyxin B resistance, in the present research, we developed a transposon mutagenesis screening assay. For this assay, transposon mutants are generated at random sites throughout the P. aeruginosa genome. Strains with transposon insertions are replica plated on medium containing calcium, with either a high concentration of Polymyxin B or no Polymyxin B. Candidate strains that show sensitivity to Polymyxin B at a high calcium concentration are further tested for their MIC to Polymyxin B. So far, we have identified twelve candidate strains that are sensitive to Polymyxin B. We will now identify the sites of transposon insertions using a combination of PCR to amplify the transposon adjacent sequence, and DNA sequencing. Once identified, these genes will then be further studied to determine the mechanism and mode of action that aids in this pathogens resistance to Polymyxin B, and possibly other cationic peptide antibiotics.

Acknowledgements: McNair Scholars Program

Brady Neiberger: Ecology
Mentor: Wyatt Cross - Ecology
Effects of thermal regimes on life history traits of aquatic insects

Stream temperature is a major variable that influences aquatic insect life histories and limits their distributions. Considering global warming trends, it is vital to understand how changing stream temperatures will influence Rocky Mountain stream insects because they play a key role in stream ecosystems, contribute greatly to nutrient and energy cycles, food webs, and the trophic dynamics of stream systems. Growth rates, body mass, and abundance of two aquatic insect species (Ephemerella infrequens & Hydropsyche cockerelli) were compared between cold and warm water sites along the Gallatin River. Taxa were sampled at each site once per month from March – July 2017. Abundance and average body mass measurements for each species were found for each sample. Differences in average body mass between months were used to calculate daily growth rates. Growth and abundance for both species were not significantly different between sites. Growth rates also did not significantly correlate with stream temperatures. E. infrequens body mass did not differ between cold and warm-water sites, and H. cockerelli displayed greater body masses at the cold-water site. E. infrequens body masses increased through time at both sites, whereas H. cockerelli body masses decreased at the cold site, and fluctuated at the warm site. These results were unexpected. Local adaptation of the two species to various thermal gradients could be occurring due to high plasticity among individuals. Confounding variables such as differences in site-specific water quality and primary production, or inter/intra-specific competition could also have influenced these results. Further research examining the annual lifespan of these species is needed to better understand how their life histories could be influenced by anthropogenic stream warming.

Acknowledgements: Jenny McCarty (MSU Graduate Student) – Ecology, Wyatt Cross (MSU Postdoc/Research Scientist) – Ecology, IDeA Network of Biomedical Research Excellence (INBRE)

Robert Nerem: Physics
Mentor: Rufus Cone, Charles Thiel - Physics
Spectroscopic Investigation of Europium Doped Crystals for Quantum Information Applications

Spectroscopic investigations of the 5D3-7F0 optical transitions in Europium doped crystals at cryogenic temperatures were made to evaluate their suitability for quantum computing and information applications. Many quantum information systems currently being developed use the extensively studied Eu3+ transition at 580 nm for qubits since the upper 5D0 level can offer long quantum coherence times that are essential to quantum applications. Unfortunately, high-quality laser diodes are not available at 580 nm wavelengths so that this transition is accessible only by using complex, expensive nonlinear optical wavelength conversion systems. The recent development of low-cost, high-power, single-mode Blu-Ray laser diodes at 405 nm have made the previously unexplored 5D3 deep violet transitions a promising alternative. With this motivation, absorption spectroscopy was used to investigate Eu3+ in Y2O3, YAG, YALO, and Y2SiO5 crystals at temperatures down to 4 K. Most notably, the relevant 7F0 to 5D3 transition for Y2SiO5, a crystal with long lifetimes and coherence times at 580 nm, was found to be near 412 nm, making it a candidate for use with Blu-ray diodes. The energy level structure and relaxation dynamics of Eu3+ in Y2SiO5 were further explored using fluorescence and site-selective excitation spectroscopy. Time-resolved fluorescence measurements were also performed to determine the excited-state lifetime. The measurements presented are fundamental to developing quantum information systems using low-cost Blu-ray diodes and lay the essential groundwork for further investigation into the 5D3 Eu3+ transition, including photon echo and spectral hole burning measurements.

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Erienne Norton: Chemistry & Biochemistry
Mentor: Mary Cloninger, Martin Lawrence - Chemistry & Biochemistry
Truncated Galectin-3: Constructs of Interest for Cancerous Tumor Inhibition

The focus of this project is galectin-3, a protein that assists in cell-cell adhesion and is overexpressed when cancerous tumors form. The hypothesis for this research project is that galectin-3 exists in both a monomeric monovalent form and an oligomeric multivalent form, and that the interactions between those forms are an integral part of cancer development. High levels of full-length galectin-3 are associated with tumor metastasis and cancer severity and progression. However, a truncated version of galectin-3 has been seen to inhibit the multivalent interactions of the full-length protein that result in increased tumor formation. The purpose of this research project is to clone, purify, and characterize full-length galectin-3 and four truncated constructs, with the long-term goal of observing how these clones interact in an in vitro model of cancer. The constructs are amplified using PCR, cloned using ligase-independent cloning and transformations, and sequenced to confirm the proper construct was amplified. As of January 2018, the full-length protein and two truncated constructs have been successfully cloned. Upon completion of the cloning process, each of the 5 constructs will be purified in order to begin small-scale expression trials. Cloning, purification, and characterization of truncated galectin-3 will allow for an in-depth study of whether truncation slows or impedes cancer progression. This project will enable a better understanding of how truncated galectin-3 affects the human body and what role it may be able to play as a potential cancer therapy.

Hitomi Okada: Ecology
Mentor: Andrea Litt - Ecology
Characteristics of Bear Rub Trees in Yellowstone National Park's Northern Range

American black bears (Ursus americanus) and grizzly bears (Ursus arctos) habitually rub on trees, known as rub trees, and researchers capitalize on these rub trees as a way to collect hair samples for genetic analysis to estimate the abundance of local bear populations. Thus, better understanding the features that characterize rub trees could increase researchers' abilities to identify and find rub trees in the field, leading to more hair samples being collected. We summarized the characteristics of 206 rub trees that were located in the Northern Range of Yellowstone National Park during summer 2017. Most of these rub trees were alive (82%), had an average diameter at breast height of 118 cm, and the maximum height of the bear rub was at 155 cm; these characteristics were similar to results found in other rub tree studies. Our rub trees represented 9 different species; 91% of the rub trees were lodgepole pine (Pinus contorta), douglas-fir (Pseudotsuga menziesii), or Engelmann spruce (Picea engelmannii). Rub trees typically were found at the top of ridges or at the bottom of a creek drainages with gentle slopes, and they were distributed equally in forested and non-forested areas. Rub trees were an average of 1017 m from hiking trails, which differs from other studies that found that rub trees often were close to trails. The results could lead to collecting more hair samples and improving precision of population estimates.

Acknowledgements: Nate Bowersock (MSU Graduate Student) – Ecology

Garrett Peters: Microbiology & Immunology
Mentor: Seth Walk - Microbiology & Immunology
Characterizing Nutrient Metabolism of Resident Escherichia Coli

Due to the lack of research done on the population dynamics of the gut microbiome, the Walk Lab undertook a two-year study to examine the population dynamics of Escherichia coli in a group of eight volunteers. In seven of the eight participants, there were clones that persisted in an individual for at least two months. These long-term inhabitants were termed residents. Also, the study showed that many participants had multiple resident strains for

an extended period of time. The goal of this project was to understand whether there is a specific metabolic niche that can enable two resident strains to co-colonize in the human gut microbiome. In order to understand this, we looked at which nutrients (285 C, N, or sources) were used differentially between two resident strains of E. coli that were both inhabiting the gut in a healthy volunteer. Using the Biolog OmniLog technology, it was determined that nine different carbon sources were used differentially between the co-resident E. coli strains. These results are intriguing, as it shows that there are metabolic differences between residents. Whether these nutrients play a significant role in co-colonization in the gut is currently trying to be understood using in-vitro competition and possible gene knockout experiments. By understanding the population dynamics in the human gut, there may be opportunities to create more effective probiotics that can persist in an individual for longer periods of time.

Acknowledgements: McNair Scholars Program

John Pommer: Physics
Mentor: Rufus ConeCharles Thiel - Physics
Tunable Littrow-configuration ECDL for spectroscopy applications

Tunable laser light at many uncommon but useful wavelengths, such as the low 400 nm wavelength can traditionally only be made with expensive and difficult to operate dye lasers. This paper discusses the design, construction, and potential for implementation of an External Cavity Diode Laser (ECDL) in the Littrow-configuration which converts cheap, easily available laser diodes into lasers suitable for spectroscopy applications. Through temperature control and power modulation as well as diffraction grating order tuning, single mode lasing measured with an Optical Spectrum Analyzer (OSA) was seen from a Sony Blu-Ray diode over a wavelength range from 404.5 nm to 409.6 nm, with potential output power over 100 mW. This basic design, with minor alterations per diode selection could be used to create a series of affordable tunable lasers able to reach every wavelength at which diodes are available.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Mark Poston: Mathematical Sciences
Mentor: Ryan Grady - Mathematical Sciences
Dynatomic Curves over Finite Fields and Preperiodic Zeta Functions

In this presentation, we discuss the importance of dynatomic curves, algebraic objects which arise from simple dynamical systems. We consider the dynatomic curves associated to the polynomial map from the complex line to itself. We also consider the reduction of these curves to finite fields. After the reduction, the resulting curves are built from a collection of fixed points, periodic points, and preperiodic points. Because of this we start by exploring the relationship of dynatomic curves to directed graphs, then we consider the case of a dynatomic curve when it has no pre-periodic points. When the curve has no pre-periodic points, it is well behaved; however, when you allow for maps where pre-periodic points do exists, it becomes much more complex. We will show which conditions are necessary for pre-periodic points to not exist, and therefore which conditions we will consider to be of interest. We will then discuss the dynamics of the curve if pre-periodic points do exist, including the proofs of several results. Lastly, we will discuss the idea of similarity and equality of the polynomials, which represent the curves, over the polynomial ring on the finite field. We prove several results with the aim of creating bounds in an analogy of Hasse's Theorem.

Abigeal Riddle: Psychology
Mentor: Michelle Meade - Psychology
Social Contagion of Memory and Age Differences in Self-Initiated Relative Judgments

Although individuals frequently reminisce together, collaborators' memories are not always accurate. Individuals often incorporate others' erroneous suggestions into their own memories—a phenomenon known as the social contagion of memory. The current experiment examined the role of age and relative judgments on social contagion. Young adults (age 18-25) and older adults (age 65+) viewed household scenes (for short or long durations) and were paired with a young-adult confederate (with low or superior memory ability) who incorrectly recalled items as having occurred in the scenes. Of interest was whether or not young and older adult participants were equally likely to spontaneously evaluate their own memory relative to the confederate's memory when remembering previously suggested information. It is predicted that both young and older adults will utilize relative judgments in social contagion, showing greater social contagion effects when their own memory is relatively worse than their partners. However, older adults will be less likely than young adults to rely on relative judgments because of declines in self-initiated processing. The results of this study have important implications for understanding how remembering with others changes with age.

Sophie Rogers: Ecology
Mentor: Wyatt Cross, Charles Kankelborg - Ecology, Physics
Interactive effects of temperature and nutrient availability on primary producer community structure.

While many global change drivers can operate simultaneously in a habitat, most research investigating the effects of rising temperatures and excess nutrients has focused on their independent effects, not the potential for interactive effects on ecosystems. The few existing studies on these interactive effects suggest potential shifts in primary producer community structure and function, with implications for the rest of the food web. These community shifts also have the potential to alter ecosystem functions such as nutrient cycling or energy flows. The objective of this study was to further investigate how aquatic primary producer communities along a natural thermal gradient respond to in situ nitrogen or phosphorous enrichment. To assess community shifts, macroalgae and aquatic vegetation samples from Iceland's Hengill Valley were identified and weighed. Preliminary data suggested that while total producer biomass increased with warmer temperature under ambient nutrient conditions, this pattern may not be consistent during nutrient addition years. Forthcoming data will allow comparison with ambient conditions and assessment of community responses to these additions. Understanding these community responses will further inform how the whole stream ecosystem is responding to these interactive stressors.

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Sarah Rubin: Earth Sciences
Mentor: Colin Shaw, Bushra Hussaini, Ruth O'Leary - Earth Sciences
A Project of Paleozoic Proportions: Strategies for Curation, Digitization, and Outreach of the Royal H. Mapes Invertebrate Paleontology Collection

The Royal H. Mapes Invertebrate Paleontology Collection arrived at the American Museum of Natural History (AMNH) in 2013. This collection, the result of 45 years of collecting by Royal and Gene Mapes, has approximately 540,000 Paleozoic (predominantly Carboniferous) marine specimens from around the world. The AMNH currently has a three-year IMLS grant (MA-30-15-0491-15) to employ six summer interns per year to rehouse, catalog, and digitize the collection. Efficient processing is essential to meet the goals of the grant and to expedite researchers' access to the collection. In the grant's second year, the AMNH amended the approach to the project with the goals of improving workflow, problem solving, and documenting issues that have been resolved. At the end of summer 2017, approximately two thirds of the collection had been curated. There are three main phases in this curation process: rehousing, cataloging, and digitizing. Rehousing the specimens in archival-quality material helped to ensure the longevity of the physical collection, while capturing and digitizing the data associated with each specimen helped to establish the longevity of the collection's information. A key component in this project is

public outreach. If both the scientific community and the general public are aware that this information is out there and ready to be used, then people are more likely to use it. The specimen data will be migrated to an online database, providing researchers, students, and others alike with worldwide access to the collection and its data. The curation process was recorded in an intern-driven blog. In addition, this year's documentation standards of data-entry and methods for determining locality information has been compiled for future staff use. Refining the database and establishing a stricter protocol for data entry were necessary in order to improve access to the collection for anyone working with it in the future.

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Alpha Scheel: Cell Biology & Neuroscience
Mentor: Benfang Lei - Microbiology & Immunology
Effects of Platelet-Activating Factor on Expression of Leukocyte Adhesion Molecules in Human Umbilical Vein Endothelial Cells

Group A Streptococcus (GAS) is a bacterium that causes a wide array of infections, including pharyngitis, toxic shock syndrome, and necrotizing fasciitis. Hypervirulent strains of GAS tend to cause more severe, invasive infections and have a greater ability to invade tissue and evade immune responses. One of the mechanisms by which hypervirulent GAS inhibits neutrophil recruitment is hydrolysis of Platelet-Activating Factor (PAF) by PAF acetylhydrolase. Vascular Cell Adhesion Molecule 1 (VCAM-1) and Intercellular Adhesion Molecule 1 (ICAM-1) bind to integrins on leukocytes and allow for adhesion to endothelial cells, a crucial step to leukocyte recruitment to the site of infection. VCAM-1 expression was down-regulated in pulmonary infection of mice with the hypervirulent GAS strain, MGAS315, but deletion of the PAF acetylhydrolase gene enhanced VCAM-1 expression in venular endothelial cells. These results suggest that PAF plays a critical role in expression of leukocyte adhesion molecules in endothelial cells during bacterial infection. The role of PAF in VCAM-1 and ICAM-1 expression in human umbilical vein endothelial cells (HUVEC) was examined. HUVEC were grown and treated with PAF, followed by RNA isolation and real-time RT qPCR. Unexpectedly, there was not a significant difference in VCAM-1 mRNA expression. HUVEC were also analyzed using immunohistochemistry staining for VCAM-1 expression, but there was not a significant difference in expression between the PAF-treated and control cells. However, PAF treatment significantly increased ICAM-1 expression in HUVEC. The data suggest that PAF may contribute to neutrophil recruitment by inducing ICAM-1 expression in endothelial cells.

Liam Scott: Chemistry & Biochemistry
Mentor: Brian Bothner - Chemistry & Biochemistry
Metabolomic Profiles of Antibiotic Treated Staphyloccoccus aureus Biofilms

Many infectious microbial organisms have the ability to form complex conglomerations of cells known as biofilms. These biofilm structures are of particular interest not only due to their ability to allow microbial life to endure extremely harsh environments, but also because of the inherent antibiotic resistance that is displayed by these structures. With a more in depth biochemical understanding of these structures in mind, this study focuses on the analysis of external metabolic profiles through the use of Gas Chromatography Mass Spectrometry (GCMS). In particular, samples representing planktonic cellular life, normal sessile life, and ciprofloxacin treated sessile life will be analyzed and compared, with the goal of elucidating the metabolic pathways that are essential to both biofilm formation and antibiotic resistance for the infectious bacteria, Staphyloccoccus aureus.

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Matthew Selensky: Microbiology & Immunology
Mentor: Eric Boyd, Daniel Colman - Microbiology & Immunology
Quantification of microbial DNA extraction yields in the presence of minerals

The vast majority of microorganisms cannot be described using traditional cultivation-dependent methods. Environmental microbial community characterization has thus become reliant on cultivation-independent, nucleic acid-based approaches involving amplicon and genomic sequencing. Moreover, these methods are often used to estimate the amount of biomass associated with environmental samples through techniques such as quantitative PCR. Thus, recovery yields of nucleic acids from environmental samples is critical for estimating biomass abundance and understanding community composition. The presence of minerals in environmental samples has been suggested to affect DNA yield. Here, I aimed to quantify the influence of minerals on DNA recovery yield. To this end, I quantified DNA recovery from two phylogenetically distinct organisms, the bacterium Escherichia coli and the archaeon Sulfolobus acidocaldarius, in the presence of 10 common minerals. Recovery was significantly lower when DNA was extracted in the presence of iron-based minerals (e.g., hematite) and clays (e.g., kaolinite) when compared to no-mineral controls. Various methods were tested to mitigate decreased DNA yields. Results indicate that the addition of sterile skim milk, which is thought to interfere with mineral surface charges to decrease adsorption of nucleic acids to such minerals, enhances DNA recovery. These results highlight the need to extract environmental DNA in the presence of agents that mitigate recovery issues if biomass yields are to be accurately estimated. Ongoing work will determine the effect of minerals on estimating community composition following DNA extraction and sequencing, with the goal of reducing the bias of mineral matrices in characterizing communities from natural environments.

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 (Tuba1Î±) in which Ikbkap is deleted in all neurons. Our data show that both adult and embryonic Tuba1Î± 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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Erin Shervey: Earth Sciences
Mentor: Jean Dixon - Earth Sciences, Microbiology & Immunology
The Behavior of Fallout Radionuclides in the Course and Fine Fraction of Mineral and Organic Soil Particles

Understanding how soil moves through landscapes is essential in geomorphology and soil conservation. Fallout radionuclides (FRNs) have been used for many decades to quantitatively measure how soil moves in a landscape system. While the activity of FRNs like 210-Pb and 137-Cs provides valuable information, the way they interact with soil particles is not well understood. Current studies using FRNs to determine soil movement use only soil particles 2mm) particles in soil contain significant amount of FRNs, and the neglect of these particles may contribute to significant error in current studies. Ultimately, the data from this project will provide insight concerning the behavior of FRNs in soil and help improve studies concerning soil conservation and erosion that utilize FRN activity.

Heidi Sielbach: Microbiology & Immunology
Mentor: Jovanka Voyich, Fermin Guerra - Microbiology & Immunology, Other
Investigating the role of Staphylococcal peroxidase inhibitor on human myeloperoxidase during neutrophil phagocytosis

Staphylococcus aureus is a pathogenic bacteria responsible for a multitude of human diseases, including skin infections, endocarditis, and toxic shock syndrome. It is highly prevalent, colonizing approximately 30% of the general population. Many antibiotic resistant strains of S. aureus have arisen in the medical community in the last few decades, including methicillin-resistant Staphylococcus aureus (MRSA), a leading nosocomial infection worldwide. Phagocytosis by neutrophils is the main defense mechanism of the human immune system against S. aureus. The bacteria uses a two component gene regulatory system which produces virulence factors that limit the production of reactive oxygen species (ROS) by the neutrophil, as well as production of a conserved protein which binds to and inhibits human myeloperoxidase (MPO). This protein, staphylococcal peroxidase inhibitor (SPIN), has been the focus of my research this semester. After engulfment of the bacteria, neutrophils produce superoxide species which are converted into hydrogen peroxidase (H2O2). MPO catalyzes a reaction of the hydrogen peroxidase with chloride, to produce hypochlorous acid (HOCl). SPIN interrupts this process by binding to MPO to prevent the formation of this compound. By working with wild type and knockout strains of S. aureus (wild type LAC300 and knockouts LACΔSaeR/S and LACΔSPIN), multiple assays are being run to determine exactly how the different strains interact with neutrophils to interfere with MPO activity. More research is needed to determine the exact mechanisms of SPINs involvement with MPO.

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Karen Stengel: Cell Biology & Neuroscience
Mentor: Susy Kohout - Cell Biology & Neuroscience
Determining the Multimerization State and Functionality of the Voltage Sensing Phosphatase

Proteins form multimers for many reasons: to enhance function, to regulate function, to modulate degradation and sometimes to allow function at all. The original studies on the voltage sensing phosphatase (VSP) indicated a single subunit of VSP stays a monomer on the plasma membrane and functions as a monomer. This conclusion was supported by PTEN (phosphatase and tensin homologue deleted on chromosome 10), a closely related enzyme, also functioning as a monomer. However, in the last few years, researchers showed that PTEN can homodimerize and an inactivating mutation in one subunit of the dimer can have a dominant negative effect on function. Thus, we revisited the question of VSP multimerization in light of these PTEN studies. Using a combination of biochemical ensemble and single molecule measurements, we found compelling evidence for VSP multimerization.

Because VSP is made up of both a phosphatase domain and a voltage sensing domain, we are currently investigating which domain of the protein is involved and how function is impacted by the multimers.

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Hans Swenson: Chemistry & Biochemistry
Mentor: Nicholas Stadie – Chemistry & Biochemistry
Measuring the Extent of Helium Adsorption in Highly Microporous Carbon Materials

Standard measurements of the surface area of powdered materials are dependent on an accurate measurement of the void space of the material; the total unoccupied volume of the container which is available to be occupied by a gas. Over the past few months, this project's scope has been to analyze the use of helium in making void space measurements and to examine its efficacy, i.e. to determine what error - if at all - may be present in void space measurements. Though widely accepted as insignificant by the surface science community, any level of helium adsorption within a sample would lead to errors in any subsequent analyses of the sample's surface area, pore size distribution, and other surface-based phenomena.
The results of this experiment have been surprisingly relevant. Helium adsorption does indeed occur in measurable quantities within highly porous powders and can be quantified through data analysis of adsorption isotherms. By taking helium adsorption isotherms for carbon samples with a surface area > 3000 m2/g at temperatures from 77 K to 520 K and normalizing the free space of the isotherms with that of the highest temperature (and therefore lowest absorbance), a clear trend of decreasing absorbance can be seen, which confirms the initial hypothesis that helium adsorption is indeed a source of error in standard gas physisorption methods of analysis.

Kole Tison: Cell Biology & Neuroscience
Mentor: Steven Stowers – Cell Biology & Neuroscience
Neurotransmitter phenotyping in the Drosophila visual system

Drosophila are an ideal model organism to study due to their relative simplistic brains and genetic plasticity. Correspondingly, they are an excellent tool for understanding novel areas in neuroscience such as characterizing the novel phenomena of dual neurotransmission. The Drosophila visual system is comprised of four neural ganglia including the lamina, lobula, lobula plate and medulla, encompassed within the optic lobes. The primary goal was to test the hypothesis that dual neurotransmission occurs in Drosophila optic lobes. Using the binary transcription systems created in the Stowers lab, 12 subgroups of lamina neurons were screened for fast neurotransmitter phenotype. Each subgroup was developed in fly strains designed via placement of recombinatory elements using CRISPR technology and crossing with GAL4 lamina subtypes. Subsequent cryosection and immunostaining of progeny revealed phenotype. Neurotransmitter identity was classified as GABAergic, glutamatergic and/or cholinergic via report of corresponding vesicular transporter in each line. Our most recent results indicate most lamina neuron subtypes tested are both cholinergic and GABA-ergic, effectively confirming presence of dual neurotransmission. Further results will be provided at the time of presentation.

Alycia Thomas: Psychology
Mentor: Neha John-Henderson - Psychology
Daily Experiences of American Indian students and sleep quality at Four-year university.

This research examines relationships between daily experiences and quality of sleep among Native American students at Montana State. The focus was on how their connection to their tribal communities informs their experience at the university. Culturally specific questions were designed to capture students' relationship to their tribal community, their experiences on their reservation, and their family dynamics. This was measured by questions that looked at early life experiences and their experiences at MSU. We measured blood pressure, sleep and wake cycles and physical activity were measured using actigraphy over a 72-hour period. I recruited 40 Native

American students and 40 Caucasian students as a comparison group. It is my hope that this research will contribute to a clearer understanding of the factors that inform the quality of Native American students' experience a away from the familiarity of their homes, and to understand the factors that associate with poor sleep quality.

Acknowledgements: Moriah Giplin (MSU Undergraduate Student) – Psychology

Zariah Tolman: Cell Biology & Neuroscience
Mentor: Frances Lefcort - Cell Biology & Neuroscience
Nodose Petrosal Ganglia in mouse models of Familial Dysautonomia

My research investigated the development of neurons in nodose and petrosal ganglia in conditional knock-out (CKO) mouse models of Familial Dysautonomia (FD), a hereditary sensory and autonomic disorder that is both developmental and progressive in neurodegeneration. The vagus nerve mediates the arterial baroreceptor reflex, innervates the gastro-intestinal tract, and affects the endocrine system. The FD mice models, conditional knock-outs of the Ikbkap gene, were generated to be neural crest specific by using a Wnt1-cre recombinase. The genotyped mice were sectioned in various planes, stained, and immunolabeled for Trk-B receptors and Tyrosine Hydroxylase to visualize the baroreceptors and dopaminergic neurons in the nodose petrosal ganglia and carotid bodies. The cells were imaged using a Leica confocal microscope. The neurons composing the ganglia were counted in both control and mutant transverse sections and compared. More trials are still being completed to determine statistical significance, although the preliminary data showed a deficiency in the number of cells composing the vagal ganglia in CKO mouse relative to the control. If the data are not significant, the next step will be to to cross floxed Ikbkap mice to a Phox2b Cre that will target deletion of Ikbkap to all ectodermal placode cells, from which the majority of neurons in the nodose ganglia are derived. Research must also be done on the carotid bodies to investigate chemoreceptor presence and function. Once any difference in neuronal number is determined, the deficiencies in synthesis or transport of TrkB ligands, functionality of channels, and mitochondrial dysfunction will be investigated.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Grace Trytten: Chemistry & Biochemistry
Mentor: Brian Bothner - Chemistry & Biochemistry
Structural characterization of oxygen sensitive hydrogenase from Thematoga maritima using surface labeling approach

Hydrogenases are indispensable and unusual enzymes found in nature. Hydrogenase plays a critical role in hydrogen production in anaerobic organisms. For all their importance, little is known about these elegant chemical catalysts. Here, we propose that dansyl chloride surface labeling methods can be applied to these proteins to shed light on the structural changes associated with their catalytic properties. Dansyl chloride is a fluorescently active molecule that reacts with the primary amine of lysine residues within a protein. By monitoring this reaction, in-solution protein surface conformations can be tracked. This surface labeling technique was used to confirm and refine homology models of the three protein subunits of the Thermatoga maritima hydrogenase (Tm Hyd). Furthermore, the surface labeling allowed for the prediction of protein-protein interfaces and pockets available for substrate or co-factor binding. By combining surface labeling with other in-solution techniques, such as chemical cross-linking and native mass spectrometry, a complete model for the active Tm Hyd complex was determined. This model provides the basis for future characterization of the mechanism of catalysis for the reduction of hydrogen within Thermatoga maritima.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Megan Tsosie, Summer Whillock: Psychology
Mentor: Michelle Meade - Psychology
Age Differences in Collaborative Memory

The current study examined how young and older adults' memory is influenced by remembering together with a partner. Specifically, we examined the influence of same-age and mixed-age dyads on the collaborative inhibition effect (reduced recall in collaborative groups compared to the combined recall of the same number people who recall individually). Younger adults (age 18-25) and older adults (age 65 +) studied categorized word lists and completed a series of recall and recognition tasks. For the first free recall test, participants recalled the lists alone or in collaboration with a same-age partner or a different-age partner. All participants were then asked to recall the information again on their own and to complete a final recognition test. It is predicted that collaborative inhibition will be found in both same-age and mixed-age partners. Further, collaborative inhibition will be greater in the mixed-age partners because the manner in which mixed-age pairs interact with each other to negotiate and exchange information is more disruptive to memory. The results of this study have important implications for understanding age differences in how people work together on memory tests.

Kyle Tweedy: Chemistry & Biochemistry
Mentor: Mary Cloninger - Chemistry & Biochemistry
Synthesis and Study of TF Antigen Functionalized Dendrimers

Synthetic polymers are important tools that can be used to study protein-carbohydrate interactions. These interactions, termed "multivalent", often occur between multiple receptors and ligands because single interactions are too weak to be biologically relevant. In order to study these interactions, end groups on synthetic polymers can be functionalized with competitive ligands. It has been proposed that glycopolymers can be used to study the interactions between proteins and surface receptors. Specifically, branched glycopolymers have been utilized to study the interactions between the protein galectin-3 and cancer cells. TF antigen, the natural ligand for galectin-3, is present on the glycoprotein MUC1, a surface marker overexpressed on cancer cells. Galectin-3 is a chimeric protein with an affinity for β-galactosides and is directly involved in cellular adhesion through interactions with TF antigen. The purpose of this research is to synthesize TF antigen-functionalized PAMAM Dendrimers and study the aggregates formed with galectin-3 as well as cancer cells.

Acknowledgements: Amanda Mattson (MSU Graduate Student) – Chemistry & Biochemistry

Lazaro Vinola: Earth Sciences
Mentor: David Varricchio - Earth Sciences
First Record of Balistes (Actinopterygii, Tetraodontiformes) from Cuba and a Reassessment of Problematic Balistid Taxa

Tetraodontiformes are a widely dispersed and highly derived order of teleost fish which first evolved in the Late Cretaceous. One of the most recognizable families within Tetraodontiformes are the triggerfish (Balistidae) which generally inhabit reef systems around the world where they use their large teeth to crunch through the hard exoskeletons of coral polyps and other invertebrates. One particular extant genus, Balistes, has a very broad distribution across the Atlantic, Pacific, and Mediterranean oceans which extends back to the Early Miocene. In the Bellamar Formation (Late Miocene-Early Oligocene) and Colon Formation (Early Miocene) of Central Cuba, a number of easily-identified teeth were discovered and attributed to the genus Balistes, marking the first occurrence of this genus in Cuba. The teeth represent two distinct species and preserve examples of the extreme range of morphologies in the teeth of this fish. The Late Miocene specimens seems to belong to an undescribed species of the genus. Despite the distinct shape and preservational environments of most Balistes teeth, there are

at least three examples in the literature of misidentified Balistid teeth and another case of incorrect use of the International Code of Zoological Nomenclature which we seek to revise. The discovery of these teeth assists in the reconstruction of the paleoenvironment of Cuba in the Miocene epoch, and when associated with other vertebrate fossils from the locality, portrays a thriving near shore ecosystem.

Acknowledgements: Richard Carr (MSU Undergraduate Student) – Earth Sciences

McCall Voy: McNair Scholars Program
Mentor: Clem Izurieta - Computer Science
The influence of prey attributes on variation in antipredator responses for a natural ecosystem with multiple predators and prey

Research has shown that direct killing comprises only a fraction of the total effect predators have on prey. Predators can also induce antipredator responses in prey, such as an increase in vigilance, which can negatively affect growth, survival, and reproduction. Previous work has found that while variation exists in both the strength of antipredator responses and the strength of direct predation in natural ecosystems, the two effects are not correlated with one another. Using behavioral data from an ongoing field study of the Zambian Carnivore Programme, we investigated across three distinct Zambian ecosystems whether ecologically important attributes of prey species (body mass, herd size, and foraging strategy) could better explain variation in the magnitude of antipredator responses. More specifically, we tested for the effects of prey attributes on variation in proactive vigilance (routine vigilance without the presence of an immediate threat), reactive vigilance (vigilance in the presence of a threat, such as a predator), and the change in vigilance between these two conditions. In general, vigilance increased across ungulate species when a predator was present. It was found that vigilance was negatively correlated with body mass, and decreased similarly under proactive and reactive conditions. Vigilance was also lower for grazers than browsers or mixed feeders. No relationship was found between vigilance and herd size. These results have implications for our understanding of how ecological attributes of prey species may mediate the role of risk effects of predators on their prey.

Jocelyn Waggoner: Cell Biology & Neuroscience
Mentor: Christa Merzdorf - Cell Biology & Neuroscience
Regulation of Convergent extension by Aquaporin 3b

Gastrulation is a series of cell movements that begins at stage 10 in Xenopus laevis embryos, when the blastula forms a blastopore. Aquaporin 3b, an aquaglyceroporin that allows passive movement of water and small, polar solutes through the plasma membrane, is required for the convergent extension of the cells during gastrulation. Convergent extension occurs when cells intercalate to form a long band of tissue along an axis. When Aqp3b is inhibited, convergent extension does not occur normally. My project is aimed at understanding whether it is the water permeability or the permeability to other small solutes that allows Aquaporin 3b to regulate convergent extension. In order to address this question, I will inhibit Aqp3b expression in Xenopus embryos using morpholino oligonucleotides specific for Aqp3b. Explants from these embryos will not show any convergent extension. Then I will rescue convergent extension by co-injecting the aqp3b-morpholinos with mRNAs for various aquaporins: first with aqp3b, which should rescue convergent extension; and then with aqp1, which is only permeable to water, and with aqp7, which is also an aquaglyceroporin. If the explants are unable to converge with just an aquaporin, that means it is some other small solute that passes through Aqp3b that is required for convergent extension.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Megan Wilhelms: Microbiology & Immunology
Mentor: Sandra Halonen - Microbiology & Immunology
Cultivation and development of detection and isolation methods of Naegleria fowleri

Naegleria fowleri is a thermophilic, free-living amoeba found in freshwater that can infect healthy adults or children. The amoeba attaches to the nasal mucosa, moves by locomotion into the brain with the trophozoite stage feeding on neuronal cells, causing primary amoebic meningoencephalitis (PAM) which is quickly fatal. N. fowleri has been detected from geothermal soaking areas in Yellowstone and Grand Teton National Parks (Y/TNP) indicating visitors to these areas are at risk. With a fatality rate of over 97%, having detection methods to assay its presence in the environment and established culture protocols are key initial steps in research for N. fowleri. In this study N. fowleri, Nf 69 strain, was used to standardize detection methods and in vitro cultivation methods for N. fowleri. Results established that Nelsons Media with 2% fetal calf serum supports axenic replication of N. fowleri trophozoites at 37°C with logarithmic and stationary phases of growth occurring at 24h and 96h post-inoculation respectively. N. fowleri was tested in the non-nutrient agar/E. coli assay (NNA/E.coli) a standard environmental assay for free-living (FLA). Characterisitics of N. fowleri amoeba tracks in this assay were defined, enabling the use of NNA/E.coli assay for detection of N. fowleri from Y/TNP. Finally, motile forms, which we termed, 'swimmers', appeared in high-density trophozoite cultures (>107 trophzoites/ml) which may be amoeboflagellates, the infective stage that appears in warm waters. This lead to the hypothesis that parasite density stimulates the amoeboflagellate stage via a factor secreted by the amoeba. To test this hypothesis, amoeba at low density were incubated with supernatants from stationary phase cultures and assayed for appearance of the amoeboflagellate stage. Identification of amoeba density as a trigger for the amoeboflagellate stage would contribute to our understanding of environmental conditions that foster transition to the infective stage of this emerging human parasitic infection.

Emma Williams: Cell Biology & Neuroscience
Mentor: Kalli Decker - Health & Human Development
Identifying Family-Centered Early Intervention professional development and training opportunities for rural occupational therapists, speech pathologists and other practitioners

Interactions with early intervention professionals (i.e. speech language pathologists, physical therapists, and occupational therapists) are crucial for many infants and toddlers with developmental delays and disabilities. However, our research indicates that families' experiences with these individuals varies widely among professionals and agencies in the state of Montana. This poster will focus on a recent study of familiesâ€™ experiences of receiving early intervention services, including overall satisfaction level with services received and whether or not early intervention services continued. Furthermore, as an extension of our recent study with families, this poster will also include a discussion of a current and ongoing study with early intervention therapists. In order to gain a more direct perspective of early intervention services in Montana, including how these services are supporting the most rural children in our state, we have been collaborating with early intervention therapy agencies across Montana in order to collect observational data of early intervention therapists with children and families they are currently seeing. This work will set the ground for transcription, coding, and rating of early intervention therapists in action via the HOVRS-A+, a strength-based rating-scale that focuses on professionalsâ€™ relationships and interactions with both children and their families. Our current project will allow for identification of outlying early intervention professionals and determination of exceptional practices from both a family and first-hand perspective. The interview questions and innovative Swivl technology being used to collect these data will be presented, as well as video examples from data collection.

Acknowledgements: Brooklyn Stern (MSU Undergraduate Student) – Early Childhood Education & Child Services, Jacie Meldrum (MSU Undergraduate Student) – Health & Human Development, Amanda Belleville (MSU Undergraduate Student) – Health & Human Development

COLLEGE OF NURSING

Julia Wellham: Nursing
Mentor: Agnieszka Rynda-Apple - Microbiology & Immunology
Effects of social status on susceptibility to influenza virus infection

Recent research has begun to explore the effects of class and social status on vulnerability to infectious disease. This project tests the relationship between social status and susceptibility to influenza virus infection to determine whether dominant mice experience reduced susceptibility to infection compared to subordinate mice. Social hierarchies were established across five cages of 3-5 mice per cage using two types of previously published measurements: competition tests (chocolate and water challenges) and long-term observation of mice for dominant/subordinate behaviors. Chasing and biting were considered dominant while squeaking and upright posture were considered subordinate. Sleeping positions, activity level, and socialization were also recorded, as these were the main behaviors observed. Following assessment of their social hierarchy, mice were infected with influenza virus. Morbidity (determined by percent of initial body weight loss) and mortality resulting from influenza virus infection were assessed daily for each mouse. These measures were used to evaluate if there was a relationship between social status and ability to fight and survive influenza virus infection. Dominant mice were more likely to be loners, sleep on the top of the pack, and be less active. Conversely, subordinate mice were more likely to be social, sleep on the bottom of the pack or side-by-side, and be more active. Furthermore, dominant mice lost weight more gradually and on average maintained a slightly higher body weight than subordinate mice. Although dominant mice demonstrated slightly less morbidity, continued research is needed to clarify the relationship between social hierarchy and susceptibility to influenza virus infection.

Acknowledgements: Laura L. Johns (MSU Faculty Member) – Microbiology & Immunology, Neha John-Henderson (MSU Faculty Member) – Psychology, IDeA Network of Biomedical Research Excellence (INBRE)

UNIVERSITY STUDIES

Kevin Surya: University Honors Program
Mentor: Chris Organ - University Honors Program
Which Phylogeny Better Fits Species Trait Data: Time or Molecular Tree?

Phylogenetic comparative methods (PCMs) have become a sophisticated suite of techniques for analyzing trait evolution. The most powerful PCMs incorporate branch length information. Branch lengths are usually measured in time or genetic substitutions. An identical set of taxa might have molecular and temporal branch lengths that are proportional to one another (as would be the case for a homogeneous molecular clock). Strong deviations from clock-like molecular change are common and are especially notable for "living fossils". Ideally, branch length should be good representations for trait variation under comparative study. Researchers often use time trees for PCMs, but branch lengths of such phylogenies may poorly fit the data. This study aims to test which type of branch lengths better fits commonly analyzed trait data. We hypothesize that molecular branch lengths are more appropriate for PCMs since they quantify evolutionary change. We are collecting time and molecular trees with identical topologies for five vertebrate groups (fishes, amphibians, reptiles, birds, and mammals) plus ~100 trait datasets. We then fit homogeneous and variable rates models for both tree types (plus cladograms for comparison). The variable rates model stretches branch lengths to better represent trait variation. Best fit models are determined with Bayesian Information Criterion (BIC) scores. We also measure how much the branch lengths change in the variable rates model (branch lengths that change less fit the data better). This work will hopefully improve comparative studies by refining how phylogenies are employed in PCMs.

Acknowledgements: Sigma Xi Grants-in-Aid Research

Corinne Moss: University Studies
Mentor: Jia Hu, Claire Qubain - Ecology
Plant Photosynthesis of Native Versus Nonnative Plants on San CristÃ³bal, Galapagos Islands

Invasive species have been found to outcompete native species in many different environments, especially in island ecosystems. One example where invasive pant species have taken over islands is on San Cristobal Island in the Galapagos Islands, Ecuador. Invasive species in the Galapagos spread faster and wider than the native species, and the physiological differences between native and invasive plants remain relatively unknown. In December 2017, differences in photosynthetic rates between native and invasive plants across an elevational gradient on San Cristobal were analyzed. Photosynthetic rates of native and invasive species do not significantly differ at each elevation at ambient CO2 levels, until the highest elevation, El Junco, where the rates of photosynthesis do significantly differ. The climate at El Junco is distinctly more humid than at the lower elevation sites, which may contribute to the differences between the species at the El Junco. However, although the photosynthetic rates of the native and invasive plants are similar across lower elevations, the nitrogen content in the leaves and soil may explain why El Junco plants show different rates. I am currently processing plants and soil nitrogen data and these results will help understand why native and invasive plants have similar photosynthetic rates at the lower elevations, but different rates at the highest elevation.

MONTANA INBRE NETWORK STATEWIDE SYMPOSIUM PRESENTERS

Amanda Berens: Wildlife & Fisheries (Salish Kootenai College)
Mentor: Janene Lichenberg, Co Carew, Antony Berthelote – Wildlife & Fisheries
Examining the effectigveness of using canines to locate invasive species of interest in western Montana

Superior, innate abilities of animals have contributed to the forging of unique working relationships between them and humans throughout history. Human-Dog teams are very effective at locating specified items. Properly trained canines have the ability to alert their handlers of plant presence at early stages prior to being visible to handlers. Control of Dyer's Woad, an invasive plant of concern in Montana, is being detected by Canines. Continued training has resulted in canine detection surpassing human detection (particularly at early stages of plant development). Results indicated that the presence of Dyer's Woad on Mt Sentinel has declined significantly since canines began assisting in detection for control.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Steven Houtz, Heather Cox: Biochemistry (Flathead Community College)
Mentor: Ruth Wrightsman – Biology
Antibiotic Potential of Flathead Valley Flora and Fungi

Over-prescription of available antibiotics has resulted in the selection of antibiotic-resistant bacteria. As a result, there are now bacterial strains which are resistant to nearly all antibiotics. The crisis of antimicrobial resistance adds an enormous burden to the cost of healthcare in the United States. In 2013, the Centers for Disease Control and Prevention estimated that treating infections due to antibiotic-resistant organisms added over 20 billion dollars to direct healthcare costs and an additional 35 billion dollars in lost productivity. To combat this growing issue, one research focus is testing natural sources, such as fungi and lichen for the presence of antibiotic compounds. The biology undergraduate research group at Flathead Valley Community College has focused on testing extracts from lichens, ferns, fungi, and liverworts collected in the Flathead Valley in northwest Montana. Extracts were tested for their ability to inhibit the growth of four Gram-positive and two Gram-negative bacterial species with the hope of finding new antimicrobial agents present in local flora and fungi. The ultimate goal of this research is to identify the antimicrobial compounds present in the extracts displaying inhibition of bacterial growth. To date twelve of forty-eight species tested in Kirby-Bauer disk diffusion assays have exhibited antibacterial activity.

Acknowledgements: Mirabai McCarthy (Flathead Community College Faculty Member) – Botany, Glenn Morden, Skye Hatfield, IDeA Network of Biomedical Research Excellence (INBRE)

Megan Gordon, Wil Horn, Aidan Higgins, Jolynn Running Wolf: General Math & Science (Blackfeet Community College)
Mentor: Betty Matthews - Math & Science
Defining Sense of Belonging in the Blackfeet Community to Pattern Relationship to Resilience and Susceptibility to Disease

2016 data conducted by Blackfeet Community College interns showed sense of belonging correlated with stress levels in the Blackfeet community. That data, however, inadequately defined sense of belonging. Since we will be retesting stress levels within the community in 2018, we need to establish precise terminology. We plan to recruit from around the Blackfeet Reservation and ask a set of questions about their sense of belonging. We will form three age-based focus groups to better understand what sense of belonging means to the community. In breaking

down the 2016 data, age wasn't a factor. Upon finding the correlation of stress and sense of belonging, we hypothesized that different generational experiences could be significant. The questions come primarily from a section in the 2016 survey that were reframed from yes or no to be open-ended. Their responses will generate productive questions in our next survey. With improved surveying in place, we hope to develop a more complete understanding of resilience in the Blackfeet community.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Kyle Montgomery: Paramedicine
Mentor: Ruth Wrightsman, Mirabai McCarthy – Biology, Botany
Cytotoxicity Testing of Mammalian Culture Cells Using Lichen and Byrophyte Extracts

Ongoing student research at Flathead Valley Community College has focused on testing the viability of extracts from local lichen, fungi, and bryophytes as potential antibiotics. In order to further characterize the potential of these compounds, additional testing procedures are being developed to test the selective toxicity of these extracts against mammalian host tissues. The purpose for this additional testing is twofold: 1) selective toxicity of an extract against microbes compared to host tissue is a key requirement of an antibiotic and 2) selective toxicity against host tissue could be indicative of anticancer uses. The initial problems proposed by research of this nature is establishing an active mammalian cell line for testing the cytotoxic nature of the extracts and then establishing a method for measuring the viability of the cells following exposure. Over the course of the past year, a mouse 3T3 cell line was re-established and a method for determining cell viability by measuring metabolic activity using resazurin reagent was implemented. In order to measure the changes in viability of the cell line following exposure to extract, a microtiter assay is performed using standardized cell concentrations to ensure accurate comparisons of cell viability. Now that an experimental procedure has been established and tested for comparing viability between cultures exposed to different compounds, the next step of this project is to begin testing the isolated extracts with a focus on testing extracts already shown to exhibit antimicrobial properties.

Acknowledgements: IDeA Network of Biomedical Research Excellence (INBRE)

Raser Powell, Ceronica Farrier, Skye Hatfield: Plant Sciences & Plant Pathology (Flathead Valley Community College)
Mentor: Mirabai McCarthy, Ruth Wrightsman - Plant Sciences & Plant Pathology, Cell Biology & Neuroscience
The Antibiotic Potential of Flathead Fungi and Flora

Widespread use 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 and 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 our research is to determine whether locally occurring fungi, lichens, bryophytes, and pteridophytes have antibiotic potential against several pathogenic bacteria. One-hundred-and-fifty-six 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 seven lichen, one bryophyte, and two pteridophyte species inhibited growth of Staphylococcus epidermidis and Staphylococcus aureus, 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 results.

Acknowledgements: Dan Karvey – Plant Sciences & Plant Pathology, Jake King – Plant Sciences & Plant Pathology, IDeA Network of Biomedical Research Excellence (INBRE)

Alphabetical Listing of Student

Student, Mentor, Project	Poster Session
Trenton Aiello: Earth Sciences Mentor: Kevin Hammonds -- Civil Engineering *Surface hoar: finding a secondary source of water vapor and its effects*	pm
Kirina Amada: Microbiology & Immunology Mentor: Margaret (Mari) Eggers -- Microbiology & Immunology *Creating an effective public health campaign regarding the potential health risks of Chronic Wasting Disease*	pm
Rebekah Anderson: Chemical & Biological Engineering Mentor: Brent Peyton, Rebecca Mueller -- Chemical & Biological Engineering, Center for Biofilm Engineering *Microbial Characterization and Biotechnological Enzyme Discovery in Hot Springs of Yellowstone National Park*	am
Danny Anduza: Earth Sciences Mentor: David Varricchio -- Earth Sciences *How Might Spinosaurids Have Caught Fish? Testing Behavioral Inferences Through Comparisons With Modern Fish-Eating Tetrapods*	pm
Zoe Benedict: Mechanical & Industrial Engineering Mentor: Roberta Amendola -- Mechanical & Industrial Engineering *Thermal and Environmental Barrier Coating (TEBC) on SiC*	pm
Kegen Benson: Animal & Range Sciences Mentor: Craig Carr -- Animal & Range Sciences *Plant Species Diversity and Short Term Impacts of Road Rehabilitation in the Northern Mixed Grass Prairie*	pm
Lilianna Bento: Plant Sciences & Plant Pathology Mentor: William Dyer, Barbara Keith -- Plant Sciences & Plant Pathology, Land Resources & Environmental Sciences *Experimental Methods Development for Avena fatua In Vitro Growth Assays*	am
Amanda Berens: Wildlife & Fisheries Mentor: Janene Lichenberg -- Wildlife & Fisheries *Examining the effectigveness of using canines to locate invasive species of interest in western Montana*	pm
Luke Berry: Chemistry & Biochemistry Mentor: Brian Bothner -- Chemistry & Biochemistry *Mass Spectrometry-Based Structural Analysis of MoFe and FeFe Nitrogenase to Elucidate the Role of Structure-Function in Nitrogen Reduction*	pm
Kendra Bertrand: Microbiology & Immunology Mentor: Agnieszka Rynda-Apple -- Microbiology & Immunology *Confirmation of direct molecular interaction between TLR2 and P22-capsid via proximity-based labeling techniques*	am
Evan Bilbrey: Microbiology & Immunology Mentor: Eric Boyd -- Microbiology & Immunology *Attempted Isolation and Preliminary Characterization of a Putative Acetogen from Hyperalkaline Fluids in the Samail Ophiolite, Oman*	pm

Rae Birdhat-Howe: Community Health Mentor: Suzanna HeldMark SchureSarah Allen -- Heath & Human DevelopmentHealth & Human Development *Counting Coup: Development of an Indigenous goal-setting tool*	HHD Special Topics
Taylor Blossom: Chemical & Biological Engineering Mentor: Ross Carlson -- Chemical & Biological Engineering *Medical Microorganism Robustness Study*	pm
Eric Bohrnsen: Chemistry & Biochemistry Mentor: Brian Bothner -- Chemistry & Biochemistry *Real-Time Metabolomics and Cellular Responses to Stress*	pm
Nicholas Bonham: Physics Mentor: Charles Kankelborg, Roy Smart -- Physics *Characterization of the ESIS Diffraction Gratings*	pm
Mason Bowditch: Civil Engineering Mentor: Ellen Lauchnor -- Civil Engineering *Plants Ability to Remove Varying Levels of Nitrate*	pm
Terry Bradley: Education Mentor: Jioanna Carjuzaa -- Education *Storytelling: Building Relationships to Improve Student Success*	pm
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*	pm
Brianna Bull Shows: Microbiology & Immunology Mentor: Suzanne Held -- Health & Human Development *Importance of healthy patient provider interactions*	pm
Joseph Carey: Cell Biology & Neuroscience Mentor: Renee Reijo-Pera, Ninuo Xia -- Cell Biology & Neuroscience *Stem Cell Therapy For Multiple Sclerosis*	pm
Jason Carr: Physics Mentor: Rufus Cone, Charles Thiel -- Physics *Flux-Growth Procedure for Rare-Earth-Doped YVO4 and NaCl Single Crystals*	am
Jacob Carter-Gibb: Civil Engineering Mentor: Connie Chang -- Chemistry & Biochemistry *Measuring Oxygen Distribution in Bacterial Biofilms*	pm
Jacob Cavon: Cell Biology & Neuroscience Mentor: Benfang Lei -- Microbiology & Immunology *Cloning of Group A Streptococcus C5a Peptidase ScpA Gene and Preparation and Characterization of Recombinant ScpA Protein*	pm
Dankota Chapman: Physics Mentor: Brian D'Urso -- Physics *Improved Quadrant Photodiode Detector*	pm
Sage Chase: Microbiology & Immunology Mentor: Doug Kominsky -- Microbiology & Immunology *Defining the Mechanism of Salmonella Virulence Modulation by CD73 in the Intestinal Epithelium*	pm
Ryan Clarke: Mechanical & Industrial Engineering Mentor: Dr. Renee Reijo Pera, Dr. Shelly Hogan -- Other, McNair Scholars Program *Is germ cell differentiation limited by lack of SMAD expression?*	pm
Katelyn Claunch: Health & Human Development Mentor: Selena Ahmed, Carmen Byker-Shanks -- Health & Human Development	pm

Perceptions of the Digestibility and Effects of Cricket Based Protein Powder in the Body Compared to a Whey Based Protein Powder	
Eleni Comstock: Earth Sciences Mentor: Julia Haggerty -- Earth Sciences *Understanding Research Fatigue in Rural Energy Boom Communities*	pm
Cory Counts: Psychology Mentor: Neha John-Henderson -- Psychology *Childhood socioeconomic status and risk in early family environments: Predictors of global sleep quality in college students*	pm
Peter Crawford-Kahrl: Mathematical Sciences Mentor: Bree Cummins, Tomas Gedeon -- Mathematical Sciences *Comparison of two combinatorial models of global network dynamics*	pm
Andrea Creel: Agricultural Economics & Economics Mentor: Mark Anderson -- Agricultural Economics & Economics *Estimating Willingness to pay for Un-Hunted Yellowstone Grizzly Bears*	pm
Evan Crittenden: Plant Sciences & Plant Pathology Mentor: Jamie Sherman -- Plant Sciences & Plant Pathology *Genetic Dissection of Malt Quality*	am
Chase Dart: Ecology Mentor: Scott Creel -- Ecology *The influence of prey attributes on variation in antipredator responses for a natural ecosystem with multiple predators and prey*	pm
Clarissa DeLeon: Electrical & Computer Engineering Mentor: Brock LaMeres -- Electrical & Computer Engineering *Improving Spatial Intelligence Through Minecraft*	pm
Sarah A Devaney: Earth Sciences Mentor: David Mogk -- Earth Sciences *Geoheritage Sites in Montana - Service Learning Project in the Earth Science Department*	pm
Audrey Dickinson: Health & Human Development Mentor: Kris Juliar, Renee Erlandsen, Amy Royer -- INBRE *Factors affecting life expectancy in rural Montana*	pm
Jessica Donahoo: Health & Human Development Mentor: Renee Erlandsen, Bill Stadwiser -- Other, INBRE *Repeating Parenthood: Grandfamilies*	am
Matthew Doran: Computer Science Mentor: Clemente Izurieta -- Computer Science *Visualizing Historical Data with Augmented Reality*	am
Robert Dorsey: Mechanical & Industrial Engineering Mentor: David Claudio -- Mechanical & Industrial Engineering *Rural Healthcare Improvement in a Native American Community: Fitting Together Service and Expectations by Reducing Value Gaps*	am
Will Dumm: Mathematical Sciences Mentor: Bree Cummins -- Mathematical Sciences *Modeling disease transmission: incorporating family cliques in exponential random graphs*	pm
Lauren Dupuis: Chemistry Mentor: Matthew Cook -- Chemistry & Biochemistry *A Convergent Synthesis of Diazonamide A*	McNair Sessions
Thayne Ekness: Chemical & Biological Engineering Mentor: Brent Peyton -- Chemical & Biological Engineering	am

Examining the Response of Diatomic Algal Species Growth and Development with Supplemental Iron Concentrations	
Emily Entz: Chemistry & Biochemistry Mentor: Diane Bimczok, Gary Stoner -- Microbiology & Immunology, Cell Biology & Neuroscience *Using the Suzuki Cross-Coupling Reaction to Synthesize Functionalized Tin Reagents*	pm
Maria Clara Fernandes Martins: Microbiology & Immunology Mentor: Eric Boyd -- Microbiology & Immunology *Riding the microbial ferrous wheel with a chemolithoautotroph Archaeon from a hot spring in Yellowstone National Park*	am
Kendra P. Fischer: Chemistry & Biochemistry Mentor: Timothy K. Minton -- Chemistry & Biochemistry *Effect of Cation and Anion Structure on the Scattering Dynamics of Atomic Oxygen on Imidazolium-Based Ionic Liquids*	am
Gia Fisher: Cell Biology & Neuroscience Mentor: Christopher Organ -- Microbiology & Immunology *How is Cancer Incidence Driven by Stem Cell Division Rate?*	pm
Kenneth Flagg: INBRE Mentor: Lillian Lin, Megan Higgs -- INBRE *Statistical Consulting and Research Services: Past, Present and Future*	pm
Kenneth Flagg: Statistics Mentor: Andrew Hoegh, Megan Higgs, John Borkowski -- Mathematical Sciences *Inferring Spatial Point Intensity of Geomagnetic Anomalies From Transect Sampling*	Math Special Topics
Emma Folkerts: University Honors Program Mentor: Wendy Stock, Franke Wilmer -- Agricultural Economics & Economics, Political Science *The Impact of Human Trafficking Legislation on Identification and Prosecution*	pm
MUSE 383 Foundations of Assessment: Music Mentor: Kristin Harney -- Music *Setting Goals + Monitoring Goals = Meeting Goals: An Examination of Individual Music Practice Among Undergraduate Music Students*	pm
Amanda Fuchs: Chemistry & Biochemistry Mentor: Valerie Copie, Mary Cloud B. Ammons -- Chemistry & Biochemistry, Other *NMR Metabolomics Analysis of Human Macrophages Co-Cultured with Pseudomonas aeruginosa Biofilms*	pm
Callum Gannon: Mechanical & Industrial Engineering Mentor: Berk Knighton -- Chemistry & Biochemistry *Development of Flight Termination System for High Altitude Balloons*	am
Jacob Gardner: Earth Sciences Mentor: Christopher Organ -- University Honors Program *The Evolutionary Dynamics of Vertebrate Genome Size*	pm
Jacob Gardner: Earth Sciences Mentor: Christopher Organ -- University Honors Program *The Evolution of Culture and the Rise of Civilizations in Eurasia*	Macroevolution Session
Britney Gibbs: Cell Biology & Neuroscience Mentor: Brendan Mumey, David L. Millman -- Computer Science, Computer Science	pm

Organizing and Analyzing Diverse Biofilm Data Types Using Ontology and Bayesian Networks (TRIO)	
Jaxen Godfrey: Physics Mentor: Jennifer Fowler -- Other *Examining Change in Planetary Boundary Layer Height during the Total Solar Eclipse over South-East Wyoming*	pm
Megan Gordon: Math & Science Mentor: Betty Matthews -- Math and Science *Defining Sense of Belonging in the Blackfeet Community to Pattern Relationship to Resilience and Susceptibility to Disease*	pm
Tristan Gray: Electrical & Computer Engineering Mentor: Wataru Nakagawa -- Electrical & Computer Engineering *Characterization of Optical Nano-Polarizers using a Broadband Spectral System*	pm
Nicolette Green: Psychology Mentor: Matthew Vess -- Psychology *True Self Alienation and Mind Wandering: The Relationship*	pm
Brady Griffith: Physics Mentor: John Sample -- Physics *GEANT Modeling of FIREBIRD*	pm
William Griffiths: Liberal Studies Degree Mentor: Mark Fiege -- History & Philosophy *Our Last Cast: The Future of Fly Fishing in the American West*	pm
Benjamin Grodner: Chemical & Biological Engineering Mentor: James Wilking -- Center for Biofilm Engineering *Chickensplash! Analysis of droplet distribution during splashing*	pm
Dieter Grosswiler: Computer Science Mentor: Clemente Izurieta -- Computer Science *ThreeEZ: A 3D Graphics Engine*	pm
Katelin Hancock: Microbiology & Immunology Mentor: Lauren Kerzicnik -- Plant Sciences & Plant Pathology *Density and diversity of spiders in conventional and IPM-managed apple orchards in western Montana*	am
Kazi Hasan: Computer Science Mentor: Indika Kahanda -- Computer Science *An Automated Case Notes System for Psychiatrists Using Machine Learning*	pm
Kazi Hasan: Computer Science Mentor: Indika Kahanda -- Computer Science *An Automated Case Notes System for Psychiatrists Using Machine Learning*	pm
Kendra Hergett: Chemical & Biological Engineering Mentor: Anja Kunze -- Electrical & Computer Engineering *Neuronal growth under microfluidic confinement*	pm
Elizabeth Herman: Computer Science Mentor: Clemente Izurieta -- Computer Science *Cricket Farming Automation*	pm
Katherine Hernandez: History & Philosophy Mentor: Amanda Hendrix-Komoto -- History & Philosophy *British Expansion through the Tales of the Fictitious*	pm
Taylor Herzog: Microbiology & Immunology Mentor: Mensur Dlakic -- Microbiology & Immunology *Natural and partially randomized peptides preventing the activity of Cytolethal Distending Toxins*	pm
Leidy Hooker: Chemistry & Biochemistry	pm

Mentor: Sharon Neufeldt -- Chemistry & Biochemistry *Catalyst-Controlled Selectivity in Nickel-Catalyzed Cross-Coupling*	
Steven Houtz: Biochemistry Mentor: Ruth Wrightsman, Mirabai McCarthy -- Biology *Antibiotic Potential of Flathead Valley Flora and Fungi*	am
Caden J. Howlett: Earth Sciences Mentor: Andrew Laskowski -- Earth Sciences *Detrital zircon U-Pb geochronology and GIS terrain analysis to determine provenance of gold placer deposits of the Pioneer District, Flint Creek Range, SW Montana.*	am
Rudolph Hummel: Earth Sciences Mentor: Chris Organ, Jacob Gardner -- Earth Sciences *Origin and Dispersal of Gorgonopsia: A Phylogenetic Approach to Permian Therapsid Biogeography*	pm
Joseph Jensen: Plant Sciences & Plant Pathology Mentor: Jamie Sherman -- Plant Sciences & Plant Pathology *Developing Acid Tolerance Screening for a Breeding Program*	am
Timothy Johnson: Chemical & Biological Engineering Mentor: Jeff Heys -- Chemical & Biological Engineering *Mathematical Model of Microbial Growth on Various Substrates*	pm
Frankie Johnston: Other Mentor: Joseph Barlow, Brenda Canine, Angela Des Jardins -- Chemistry, Biology, Physics *Isolating and Determining the Growth Rate of the Probiotics Present in Kombucha Tea*	pm
Derek Judge: Electrical & Computer Engineering Mentor: Anja Kunze -- Electrical & Computer Engineering *Immunomagnetic Cell Sorting in a Microfluidic Environment*	pm
Morgan Julian: Health & Human Development Mentor: Mary Miles -- Health & Human Development *The effect of acute aspartame intake on blood glucose, interleukin 6, cortisol, and substrate utilization during high intensity interval exercise.*	pm
Kayla Keepseagle: Chemical & Biological Engineering Mentor: Joseph Seymour -- Chemical & Biological Engineering *Measuring Oxygen Distribution in Bacterial Biofilms*	am
Madeline Kelly: Physics Mentor: Sachiko Tsuruta, Ken'ichi Nomoto, Marcus Teter -- Physics *Ambipolar Heating on the Thermal Evolution of Magnetars Under Semi-Exact Methods*	am
Whitney Kieffer: Chemical & Biological Engineering Mentor: Ellen Lauchnor -- Civil Engineering *Remediation of Mine Tailings Using Microbially Induced Calcite Precipitation*	pm
Scott Killian: Cell Biology & Neuroscience Mentor: Susy Kohout -- Cell Biology & Neuroscience *Localizing Endogenous Voltage Sensitive Phosphatase in Xenopus laevis and tropicalis*	am
Sophia Koopmeiners: Health & Human Development Mentor: Selena Ahmed -- Health & Human Development *Consumer Preference and Nutrient Content of Aquaponically Produced Vegetables*	am
Melisa Kral Yilmaz: Chemical & Biological Engineering Mentor: David Hodge -- Chemical & Biological Engineering	pm

Biomass Fractionation by Using Organic Solvent	
Debra Kraner: Health & Human Development Mentor: Selena Ahmed -- Health & Human Development *An Exploration of Indigenous Food Environments and Cultural Practices in Southeast Guizhou Province, China*	pm
Casey Krueger: Business Mentor: Kara Johnson, Dr. Laura Periman MD -- Mathematical Sciences *Intense Pulsed Light Decreases Metalloproteinase 9 (MMP9) in the Meibomian Gland Dysfunction Patient: A retrospective analysis*	pm
Abigail Lake: English Mentor: Gretchen Minton -- English *Shakespeare's Spaces and Places in Montana's Rural Reservation High Schools*	am
Fei San Lee: Chemical & Biological Engineering Mentor: Paul Sturman, Diane Walker -- Center for Biofilm Engineering, Center for Biofilm Engineering *Growing a Mixed Species Biofilm with Modification to an ASTM International Standard Test Method*	am
Savanah Leidholt: Ecology Mentor: David Willey, Tom Shultz -- Ecology, Other *Variation in Genetic Composition of O. annularis and O. franksi and their Symbionts by Depth*	pm
Courtney Linder: Computer Science Mentor: Clemente Izurieta -- Computer Science *Phone App for better facilitation of communication between students and the respective offices of interest in writing thank yous to scholarship donors*	pm
Lori Lindgren: Health & Human Development Mentor: Darcy Hunter -- Health & Human Development *What Barriers Prevent Early Prenatal Entry into the WIC Program ?*	am
Peter Lucier: Political Science Mentor: David Parker -- Political Science *Why They Fight: Congressional Blocks of Foreign Military Sales*	pm
Oscar Machado: Cell Biology & Neuroscience Mentor: Christa Merzdorf -- Cell Biology & Neuroscience *Determining the Place of aqp3b in the Wnt/Ca2+ Noncanonical Pathway*	am
Zachary Maguire: Ecology Mentor: Lindsey Albertson -- Ecology *Legacy Effects of Abandoned Ecosystem Engineering Structures on Stream Hydraulics*	am
Josephine Maley: Mechanical & Industrial Engineering Mentor: Sarah Codd -- Mechanical & Industrial Engineering *Exploring Large Amplitude Oscillatory Shear (LAOS) by means of Rheology*	pm
Anna Martinson: Chemical & Biological Engineering Mentor: Adrienne Phillips, Guneycan Dicle Beser -- Civil Engineering *Effect of MICP and EICP Additives on the Mechanical Strength of Concrete*	am
Adrian Massey: Ecology Mentor: Michael Ivie -- Plant Sciences & Plant Pathology *Elmidae of Montana*	pm
KaeLee Massey: Chemical & Biological Engineering Mentor: Matthew Fields, Heidi Smith, Anna Zelaya -- Center for Biofilm Engineering *The Role of Environmental Isolates in Cycling Heavy Metals in Groundwater Ecosystems*	pm

Katherine McCahan: Microbiology & Immunology Mentor: Amy Trowbridge -- Land Resources & Environmental Sciences *Analysis of physiological and chemical changes due to drought stress in PiÃ±on pines*	am
Carter McIver: Mechanical & Industrial Engineering Mentor: Randy Larimer, Shelly Hogan -- Electrical & Computer Engineering, McNair Scholars Program *Positioning and Testing of Inertial Measurement Units*	pm
Sarah McKnight: Mathematical Sciences Mentor: Mark Greenwood -- Mathematical Sciences *Creating a Student and Sports-Based University Ranking System With Structural Equation Modeling*	am
Jacie Meldrum: Education Mentor: Kalli Decker -- Health & Human Development *Family-Centered Early Intervention Services in Montana*	am
Uriel Menalled: Land Resources & Environmental Sciences Mentor: Timothy Seipel -- Land Resources & Environmental Sciences *Understanding the Interaction of Crop Management System and Crop Identity on biologically-mediated Plant-soil Feedbacks*	pm
Heather Merkouris: McNair Scholars Program Mentor: Renee Reijo Pera, Shelly Hogan -- Other, McNair Scholars Program *Is germ cell differentiation limited by lack of SMAD expression?*	pm
Jennifer Mikkelson: History Mentor: William Stadwiser, Jill Holder -- INBRE *Youth Educational Programming at the Gallatin Valley Food Bank*	pm
Prasaad Milner: Chemical & Biological Engineering Mentor: Ryan Anderson -- Chemical & Biological Engineering *Three-Dimensional Computational Modeling of PEM Fuel Cells*	pm
Youra Moeun: Chemical & Biological Engineering Mentor: James Wilking -- Chemical & Biological Engineering *Quantifying a Drug Composite Breakup using a Hydrophone*	am
Hannah Monaghan: Microbiology & Immunology Mentor: Margaret Eggers, Christenson Lori -- Center for Biofilm Engineering, Other *Investigation of on-site wastewater treatment system suitability for floodplains*	pm
Kyle Montgomery: Paramedicine Mentor: Ruth Wrightsman, Mirabai McCarthy -- Botany *Cytotoxicity Testing of Mammalian Culture Cells Using Lichen and Byrophyte Extracts*	pm
Aitana Moore: Microbiology & Immunology Mentor: Diane Bimczok, Gary Stoner -- Microbiology & Immunology, Cell Biology & Neuroscience *Evaluating the Antimicrobial Effects of Extracts from Oregon Blackberries & Black Raspberries on Relevant Strains of Helicobacter Pylori*	pm
Julie Morgan: Chemistry & Biochemistry Mentor: Valerie CopieBrian Eilers -- Chemistry & Biochemistry *Illuminating the Metabolic Reprogramming of Human Neutrophils upon Phagocytosis of Staphylococcus Aureus*	pm
Marie Morin: Computer Science Mentor: Clemente Izurieta -- Computer Science *A Longitudinal Study of Technical Debt in Gaming Systems*	pm
Corinne Moss: University Studies	pm

Mentor: Jia Hu, Claire Qubain -- Ecology *Plant Photosynthesis of Native Versus Nonnative Plants on San CristÃ³bal, Galapagos Islands*	
Shannon Muenchow: Civil Engineering Mentor: Kathryn Plymesser, Nolan Platt -- Civil Engineering *A Study Testing the Accuracy of the USGS Midsection Method When Measuring Discharge Through a Denil fishway.*	am
Michelle Narayan: Cell Biology & Neuroscience Mentor: Brock LaMeres -- Electrical & Computer Engineering *Mechanisms of Calcium-mediated Polymyxin B resistance in Pseudomonas aeruginosa*	am
Brady Neiberger: Ecology Mentor: Wyatt Cross -- Ecology *Effects of thermal regimes on life history traits of aquatic insects*	pm
Robert Nerem: Physics Mentor: Rufus Cone, Charles Thiel -- Physics *Spectroscopic Investigation of Europium Doped Crystals for Quantum Information Applications*	pm
Erienne Norton: Chemistry & Biochemistry Mentor: Mary Cloninger, Martin Lawrence -- Chemistry & Biochemistry *Truncated Galectin-3: Constructs of Interest for Cancerous Tumor Inhibition*	am
Justin O'Dea: Computer Science Mentor: Shelly Hogan, Dave Millman, Brittany Fasy -- McNair Scholars Program, Computer Science *Covariance in the Human Brain*	am
Ryan Odstrcil: Mechanical & Industrial Engineering Mentor: David Miller -- Mechanical & Industrial Engineering *Neat Resin Coupon Manufacturing*	pm
Hitomi Okada: Ecology Mentor: Andrea Litt -- Ecology *Characteristics of Bear Rub Trees in Yellowstone National Park's Northern Range*	am
Timothy Olsen: Chemical & Biological Engineering Mentor: James Wilking -- Chemical & Biological Engineering *Developing a Method for Freeze Drying Microbial Loaded Hydrogels*	pm
Mariana Olsen: Psychology Mentor: Keith Hutchison, Sara Waller, Frank Marchak -- Psychology, History & Philosophy, Psychology *Does Increased Task Difficulty Reveal Individual Differences in Executive Function in Domestic Dogs?*	am
Siri Orser: Electrical & Computer Engineering Mentor: Anja Kunze -- Electrical & Computer Engineering *Soft-gel Integration of Micro Channels to Study Brain-like Neural Dynamics*	pm
Rowen Oswald: Physics Mentor: Alan Craig -- Physics *Design of a Magneto Optical Trap to Achieve Sympathetic Electron Cooling*	pm
Burcu Ozay: Chemical Engineering Mentor: Stephanie McCalla -- Chemical & Biological Engineering *Ultrasensitive MicroRNA Amplification for Disease Diagnosis*	Engineering Special Topics
Christiane Parrish: Health & Human Development Mentor: Suzanne Held -- Health & Human DevelopmentYes *Selection and co-development of a new topic area of focus in a community-based research project: Improving Healthy Relationships*	pm

Daniel Perry: Mathematics Mentor: David Ayala -- Mathematical Sciences *Contact Homotopy Groups of Three-Dimensional Contact Manifolds*	Math Special Topics
Garrett Peters: Microbiology & Immunology Mentor: Seth Walk -- Microbiology & Immunology *Characterizing Nutrient Metabolism of Resident Escherichia Coli*	pm
Mikayla Pitts: Community Health Mentor: Suzanne Held -- Health & Human Development *Messengers for Health Baá nnilah program: Understanding community context when recruiting study participants in an American Indian community*	HHD Special Topics
Carie Pointer: Computer Science Mentor: David Millman -- Computer Science *Share Code: An Active Learning Tool for Computer Science*	pm
John Pommer: Physics Mentor: Rufus Cone, Charles Thiel -- Physics *Tunable Littrow-configuration ECDL for spectroscopy applications*	pm
Mark Poston: Mathematical Sciences Mentor: Ryan Grady -- Mathematical Sciences *Dynatomic Curves over Finite Fields and Preperiodic Zeta Functions*	pm
Raser Powell: Plant Sciences & Plant Pathology Mentor: Mirabai McCarthy, Ruth Wrightsman -- Plant Sciences & Plant Pathology, Cell Biology & Neuroscience *The Antibiotic Potential of Flathead Fungi and Flora*	am
Joseph Prior: Mechanical & Industrial Engineering Mentor: Megkian Doyle, Thomas Jungst – TriO Retention Specialist, Mechanical & Industrial Engineering *Enriching the Ingenuity of Youths: An Engaging and Enlightening Engineering Program for the Next Generation*	am
Levi Rak: Computer Science Mentor: David Millman -- Computer Science *Reacting to Events on the Blockchain*	pm
Mohammed Refai: Chemistry & Biochemistry Mentor: Brian Bothner -- Chemistry & Biochemistry *Proteomic analysis of the role of thiol switches in the metabolic transition between aerobic and anaerobic conditions in E. coli.*	pm
Benjamin Rhuman: Computer Science Mentor: Clemente Izurieta -- Computer Science *NuMo - A Better Diet a Better Life*	pm
Dean Ricker: Chemical & Biological Engineering Mentor: Christa Merzdorf -- Cell Biology & Neuroscience *How Does Aqp3b Orchestrate Neural Tube Closure?*	am
Abigeal Riddle: Psychology Mentor: Michelle Meade -- Psychology *Social Contagion of Memory and Age Differences in Self-Initiated Relative Judgments*	am
Sophie Rogers: Ecology Mentor: Wyatt Cross -- Ecology *Interactive effects of temperature and nutrient availability on primary producer community structure.*	pm
Sarah Rubin: Earth Sciences Mentor: Colin Shaw, Bushra Hussaini, Ruth O'Leary -- Earth Sciences	am

A Project of Paleozoic Proportions: Strategies for Curation, Digitization, and Outreach of the Royal H. Mapes Invertebrate Paleontology Collection	
Alpha Scheel: Cell Biology & Neuroscience Mentor: Benfang Lei -- Microbiology & Immunology *Effects of Platelet-Activating Factor on Expression of Leukocyte Adhesion Molecules in Human Umbilical Vein Endothelial Cells*	am
Riley Scherr: Civil Engineering Mentor: Michael Berry -- Civil Engineering *Non-Proprietary Ultra-High Performance Concrete*	am
Tavin Schneider: Plant Sciences & Plant Pathology Mentor: Mike Giroux -- Plant Sciences & Plant Pathology *Reduced Height Alleles (Rht) Significantly Impact Bread Making Factors in Wheat*	pm
Liam Scott: Chemistry & Biochemistry Mentor: Brian Bothner -- Chemistry & Biochemistry *Metabolomic Profiles of Antibiotic Treated Staphyloccoccus aureus Biofilms*	pm
Joel Seeley: Mechanical & Industrial Engineering Mentor: Roberta Amendola -- Mechanical & Industrial Engineering *Investigation of hybrid coatings for hot corrosion protection in coal fired boilers*	am
Matthew Selensky: Microbiology & Immunology Mentor: Eric Boyd, Daniel Colman -- Microbiology & Immunology *Quantification of microbial DNA extraction yields in the presence of minerals*	pm
Seth Severa: Computer Science Mentor: Clemente Izurieta -- Computer Science *A Social Approach to Music*	am
Veronika Shchepetkina: Cell Biology & Neuroscience Mentor: Frances Lefcort -- Cell Biology & Neuroscience *Investigation of the nervous system in a mouse model for Familial Dysautonomia*	am
Erin Shervey: Earth Sciences Mentor: Jean Dixon -- Earth Sciences *The Behavior of Fallout Radionuclides in the Course and Fine Fraction of Mineral and Organic Soil Particles*	pm
Heidi Sielbach: Microbiology & Immunology Mentor: Jovanka Voyich, Fermin Guerra -- Microbiology & Immunology *Investigating the role of Staphylococcal peroxidase inhibitor on human myeloperoxidase during neutrophil phagocytosis*	pm
Tiana Smith: Computer Science Mentor: Clemente Izurieta -- Computer Science *AutoArt*	pm
Melinda Smith: Health & Human Development Mentor: Mary Miles -- Health & Human Development *Inflammatory effects of the Food Distribution Program on Indian Reservations (FDPIR)*	am
Melissa Soddy: Plant Sciences & Plant Pathology Mentor: MacDonald Burgess -- Plant Sciences & Plant Pathology *Dry Bean Variety Trial*	pm
Jordan Sparr: Computer Science Mentor: Clemente Izurieta -- Computer Science *Analyzing popular text media for gender bias*	am
James Stangeland: Chemical & Biological Engineering Mentor: Phil Stewart -- Chemical & Biological Engineering *Measurement of Bacterial Growth Rates Using 13C Incorporation*	pm
Karen Stengel: Cell Biology & Neuroscience	am

Mentor: Susy Kohout -- Cell Biology & Neuroscience *Determining the Multimerization State and Functionality of the Voltage Sensing Phosphatase*	
Brooklyn Stern: Health & Human Development Mentor: Kalli Decker -- Health & Human Development *Family-Centered Early Intervention Services in Montana*	am
Anna Stone: Music Mentor: Gregory Young -- Music *Refinement of "Rocky Mountain Elk: A Suite for Orchestra"*	am
Nathan Stouffer: Computer Science Mentor: Brittany Fasy -- Computer Science *Generating Data for Prostate Cancer Diagnosis*	am
Megan Strain: Education Mentor: Ann Ewbank -- Education *Non-academic K-12 Learning Factors in the United States and Finland: A Comparative Analysis*	pm
Natalie Sturm: Land Resources & Environmental Sciences Mentor: Selena Ahmed -- Health & Human Development *Comparison of the Effects of Organic Versus Conventional Agricultural Management Practices on Nutrient and Phytochemical Profiles of Ancient Grains in Montana*	pm
Laura Sullivan-Russett: Computer Science Mentor: Clemente Izurieta -- Computer Science *HP Remote Graphics System: Performance Data Collecting*	am
Kevin Surya: University Honors Program Mentor: Christopher Organ -- University Honors Program *Which Phylogeny Better Fits Species Trait Data: Time or Molecular Tree?*	am
Kasey Sweeney: Animal & Range Sciences Mentor: Rachel Endecott -- Animal & Range Sciences *The immunological and economic effects of utilizing local anesthesia during branding of pre-weaned angus-cross calves*	pm
Hans Swenson: Chemistry & Biochemistry Mentor: Nicholas Stadie -- Chemistry & Biochemistry *Measuring the Extent of Helium Adsorption in Highly Microporous Carbon Materials*	am
Hannah Szafraniec: Chemical & Biological Engineering Mentor: Connie Change -- Chemical & Biological Engineering *Characterization of Influenza A using Microfluidics*	am
Kole Tison: Cell Biology & Neuroscience Mentor: Steven Stowers -- Cell Biology & Neuroscience *Neurotransmitter phenotyping in the Drosophila visual system*	pm
Allison Theobold: Statistics Education Mentor: Stacey Hancock -- Mathematical Sciences *Aligning Statistical Computing Education with Expectations for Data Practitioners*	Math Special Topics
Alycia Thomas: Psychology Mentor: Neha John-Henderson -- Psychology *Daily Experiences of American Indian students and sleep quality at Four-year university.*	pm
Zariah Tolman: Cell Biology & Neuroscience Mentor: Frances Lefcort -- Cell Biology & Neuroscience *Nodose Petrosal Ganglia in mouse models of Familial Dysautonomia*	am

Angus Tomlinson: Computer Science Mentor: Clemente Izurieta, Brittany Fasy, David Millman -- Computer Science *Representing Music with Simplicial Complexes*	pm
Grace Trytten: Chemistry & Biochemistry Mentor: Brian Bothner -- Chemistry & Biochemistry *Structural characterization of oxygen sensitive hydrogenase from Thematoga maritima using surface labeling approach*	pm
Megan Tsosie: Psychology Mentor: Michelle Meade -- Psychology *Age Differences in Collaborative Memory*	pm
Kyle Tweedy: Chemistry & Biochemistry Mentor: Mary Cloninger -- Chemistry & Biochemistry *Synthesis and Study of TF Antigen Functionalized Dendrimers*	am
Lazaro Vinola: Earth Sciences Mentor: David Varricchio -- Earth Sciences *First Record of Balistes (Actinopterygii, Tetraodontiformes) from Cuba and a Reassessment of Problematic Balistid Taxa*	pm
McCall Voy: McNair Scholars Program Mentor: Clem Izurieta -- Computer Science *The influence of prey attributes on variation in antipredator responses for a natural ecosystem with multiple predators and prey*	pm
Jocelyn Waggoner: Cell Biology & Neuroscience Mentor: Christa Merzdorf -- Cell Biology & Neuroscience *Regulation of Convergent extension by Aquaporin 3b*	pm
Vanessa Walsten: Health & Human Development Mentor: Selena Ahmed -- Health & Human Development *Progression of microbial growth in vegetable fermentation*	pm
Xuying Wang: Computer Science Mentor: Clemente Izurieta -- Computer Science *Modeling Effective Interactive Technology for Education*	am
Qi Wang: Music Mentor: Gregory Young -- Music *composition and mixing of an album*	pm
Theodore Warthen: Chemical & Biological Engineering Mentor: Christa Mezdorf -- Cell Biology & Neuroscience *Connexin expression and function in Xenopus laevis embryos*	pm
Mary Watson: Microbiology & Immunology Mentor: Agnieszka Rynda-Apple, Kelly Shepardson, Kyle Larson -- Microbiology & Immunology *Determining direct and indirect antibacterial effects of P22-capsid*	pm
Julia Wellham: Nursing Mentor: Agnieszka Rynda-Apple -- Microbiology & Immunology *Effects of social status on susceptibility to influenza virus infection*	pm
Timothy Wells, Tessa Kier, Kevin Nolan, Tyler Weil, Connor MacKinney: Film & Photography Mentor: Dennis Aig, Andrew Nelson, Cindy Stillwell -- Film & Photography *Lucid*	Film Special Topics
Timothy Wells, Michael Petty, Colter Peterson, Seth Wyberg, Jacob Robinson, Mac Palin: Film & Photography Mentor: Dennis Aig -- Film & Photography *The Territory's Best*	Film Special Topics

Paul Wison-Harmon: Statistics Mentor: Mark Greenwood, Laura Hildreth -- Mathematical Sciences *Institutional classification systems, such as the Carnegie Classifications, are used to delineate groups of institutions with similar characteristics and by administrators to guide policy decisions. However, the Carnegie Classifications are marked by seve*	Math Special Topics
Summer Whillock: Psychology Mentor: Michelle Meade -- Psychology *Age Differences in Collaborative Memory*	pm
Sean White: Computer Science Mentor: Clemente Izurieta -- Computer Science *DLGIN: A Deep Learning Approach to Defining Musical Genre*	pm
Megan Wilhelms: Microbiology & Immunology Mentor: Sandra Halonen -- Microbiology & Immunology *Cultivation and development of detection and isolation methods of Naegleria fowleri*	pm
Emma Williams: Cell Biology & Neuroscience Mentor: Kalli Decker -- Health & Human Development *Identifying Family -Centered Early Intervention professional development and training opportunities for rural occupational therapists, speech pathologists and other practitioners*	am
Jaclyn Wing: Mechanical & Industrial Engineering Mentor: Scott Monfort -- Mechanical & Industrial Engineering *Establishing initial reliability of a clinical tool for measuring gait stability and variability*	pm
Hayden Woods: Music Mentor: Gregory Young -- Music *Musical Emotion: A meta-analysis on the connection of music and human emotion*	pm
Amber Yates: Education Mentor: Megan Wickstrom -- Mathematical Sciences *Mathematical Modelling: Analyzing Students' Notions of Mathematics in Primary Education*	McNair Sessions
Mark Young: Chemical & Biological Engineering Mentor: Joseph Seymour, Sarah Codd -- Chemical & Biological Engineering, Mechanical & Industrial Engineering *NMR Investigation of the Microphysical Structures of Ice-Regolith Mixtures*	am