Abstracts for Oral Presentations

Montana Academy of Sciences Annual Meeting
Sessions 1-4
April 12, 2014

Session #1 (Copper Lounge)

9:45-10:00
Evolution of Receptor-Isoform Signaling Specificity in the Activin Signaling Pathway

Kayla Baisch[1], Brennan Zotovich[1], Nathan Elmore[2], Andrew Wildenberg[2], and Philip A. Jensen.
[1]Department of Biology and [2]Department of Computer Science
Rocky Mountain College, Billings, MT.

Multicellular organisms are composed of cells that communicate via signaling pathways. One signaling pathway found in all animals, the Activin pathway, utilizes extracellular ligands and transmembrane receptors. In *Drosophila*, the lone Activin receptor encodes three functionally distinct isoforms that bind different extracellular ligands. We analyzed forty-six species' genomes in several animal phyla in order to determine the level of conservation of this isoform-based mechanism for signaling specificity. Bioinformatics tools, including a new technique for finding well-conserved signatures in Activin receptors, were used to document the evolution of receptor isoforms and other key players of the pathway. Receptor-isoform-based signaling specificity in the Activin pathway is widespread in arthropods but is also found in a single species of annelid, raising questions about whether the mechanism has arisen multiple times throughout animal evolution.

10:00-10:15
Response and Resilience of Rivers in the Greater Yellowstone Ecosystem: A Repeat Photography Analysis

Heidi M. Clark[1] and Duncan Patten[1]
[1]Montana State University

Repeat photographs provide a glimpse of the past and thus tell a story of how time has shaped the landscape. With the use of repeat photography of on-the-ground oblique photos, this study investigated how historical natural resource uses(e.g., logging, mining, ranching, and dam building) have affected headwater rivers of the Greater Yellowstone Ecosystem (GYE). These rivers included the Gallatin, Madison, Snake, Yellowstone, Wind, and Green Rivers. Oblique photo pairs or series of photos were

compared using three types of analyses: quantitative pixel comparisons, rank order statistics, and individual descriptions to identify changes in riparian vegetation cover, sinuosity, bankfull, and flood plain area. Additionally, a stream reach of the upper Yellowstone River in Paradise Valley, Montana, allowed for an aerial comparison to quantify vegetation cover and sinuosity within photo frame wedges of corresponding oblique photos. The results of the comparisons revealed 1) increased riparian vegetation where anthropogenic perturbations had ceased, indicating resilience and recovery, 2) decreased riparian vegetation and sinuosity where impacts intensified, and 3) little change in riparian vegetation where human natural resource use continued at a similar intensity. Application of this methodology to more photo points and other regions will provide a better understanding of the extent of previous threats and how river systems have responded or continue to counter ongoing anthropogenic impacts.

10:15-10:30
Identifying K-Mers that Contribute Strongly to Effective Classification of Metagenomic Samples

Russell Kaehler
Dept. Computer Science, The University of Montana, Missoula, MT

A Graphics Processing Unit (GPU) is a relatively inexpensive way to increase the parallel processing capability of a standard workstation; a single GPU can increase the number of cores in a workstation by hundreds or thousands. Metagenomic datasets are typically extremely large and require efficient algorithms in order to analyze the samples in a timely fashion. Central processing units in a typical workstation normally have less than ten cores that can be used to analyze data sets. Using a GPU to increase the number of processing cores should reduce the time required to analyze metagenomic samples in a parallel system. This research presentation will report the results of a proof of concept experiment that uses a GPU to parse metagenomic datasets for classification by machine learning algorithms.

Session #2 (Copper Lounge)

10:45-11:00
Nurses' Commitment and Motivation to Improved Personal Health: The Role of Hospital Administration

Carey Phelan.
Baccalaureate Nursing Student, Carroll College, Helena, MT.

Obesity leads to increased morbidity and mortality, while decreasing the quality of life of individuals and adding enormous fiscal burdens to an employer. Health care systems are especially feeling the encumbrance of increasing costs. Healthier hospital staffs have less absenteeism, are more productive, make fewer mistakes and report greater

overall satisfaction. The health of nurses affects the overall effectiveness of health systems. The goal of the research was to ascertain the most efficient interventions in which employers could institute to motivate nurses to increase their physical health. The study methodology incorporated a mixed design. Subjects were given a theoretical case study involving Nurse X, who desired to improve her/his health status. The participants were asked to transpose themselves as Nurse X and rate (on a Likert Scale) which of the given scenarios would best motivate and gain their commitment to increase their health status.
Results indicated that over half (51.9%) of the 139 subjects were either overweight or obese. Triangulation was used to bridge the qualitative and quantitative data. From this, six themes emerged which related to barriers nurses face to optimal health: lack of time, difficulty with twelve hour shifts, physical demands of nursing, lack of a supportive work environment, nurse's belief that employers only care about the bottom line, personal accountability and obese nurses believing that their excess weight was a benefit for their careers. Furthermore, employers should emphasize interventions on the overweight group. The obese group was the least motivated and least committed towards improving their health.

11:00-11:15
Pregnancy Rate and Metabolites in Bighorn Sheep (Ovis canadensis) at the End of Breeding Season and the First Trimester of Pregnancy

M. R. Herrygers[1], R. Garrott[2], C. Butler[2], J. G. Berardinelli[1]
[1]Dept. of Animal and Range Sciences, [2]Dept. of Ecology, Montana State University, Bozeman, MT, USA,

Objectives were to evaluate pregnancy rates, and energy-related metabolites in bighorn ewes at the end of the breeding season and first trimester of pregnancy. Samples were collected from herds in Jackson (JWY), Mt. Everts (MEMT), NE Yellowstone (NEYMT), Taylor Hilgard (THMT), and Tom Miner (TMMT). Capture events occurred mid-December (end of breeding season) for THMT, MEMT, and TMMT herds and late January (first trimester for pregnancy) for JWY and NEYMT herds. Capture methods differed among locations including drop net, net gun, and ground darting. Samples (n = 75) were assayed for progesterone (P4), pregnancy specific protein B (PSPBs), glucose, and NEFA. Cyclicity was defined as > 1.5 ng/mL of P4 and pregnancy classified as a positive PSPBs test. Percentages of ewes cycling at the end of the breeding season differed ($P < 0.05$) among herds; apparently due to TMMT ewes of which 14.3% were cycling. Cyclicity of ewes didn't differ among the other herds and was 92%. Pregnancy rates (PR) at the end of the breeding season and the first trimester of breeding season differed ($P < 0.05$) among herds. Those herds sampled at the end of the breeding season (THMT, MEMT, and TMMT herds) had lower PR than the herds sampled in the first trimester of pregnancy (JWY and NEYMT), 15.8% and 85% respectively. Glucose, but not NEFA, were greater ($P < 0.05$) in non-pregnant ewes than pregnant ewes. PR differ among herds primarily due to time during the year at

which they were sampled and the fact that TMMT ewes were not cycling by the end of the breeding season. Lower PR in some herds was apparently caused by sampling at the end of breeding season and PSPBs may not have increased for a positive test. These ewes may have been pregnant and failed detection. Glucose in pregnant ewes may have differed because a majority of pregnant ewes were captured by ground darting and net guns, which decreases stress.

11:15-11:30
Properties of Water and Their Effects on the Rate of Decomposition

Samantha Jones and Nate Bickford
University of Great Falls

This investigation was designed to test the effects of water depth, temperature, and current on decomposition. The data was recorded by determining the mass of the pigs before, during, and after the six week study. Expected outcomes were that colder temperatures, slower flow rates, and greater depths would decrease the rate of decomposition and preserve the decaying matter for longer periods of time. Faster flow rates were expected to erode the pig remains, and higher temperatures with more light exposure were expected to provide more energy for microorganisms, which will in turn result in faster decomposition. The data supported the expectations, and suggested that a seasonally warm, shallow aquatic environment results in faster decomposition, while a seasonally cold, deep aquatic environment slows the rate of decomposition. These results, when compared to studies of terrestrial decomposition, may provide a better understanding of how a body should appear after intervals of time submerged in water, and may help determine a more accurate time of death when a body is discovered in an aquatic environment.

11:30-11:45
The Acetate/Mevelonate pathway of *Borrelia burgdorferi* is required for viability not virulence factor gene expression

Crystal L. Richards[1], Kevin A. Lawrence[2], Vinod Nair[2], Daniel P. Dulebohn[2] and Frank C. Gherardini[2]

[1]Department of Biological and Physical Sciences, Montana State University Billings, Billings, MT.

[2]Laboratory of Zoonotic Pathogens, National Institutes of Health, Rocky Mountains Laboratories, Hamilton, MT.

Borrelia burgdorferi, the agent of Lyme disease, survives in an infectious cycle where spirochetes transit between *Ixodes* ticks and small vertebrae hosts. During tick-

transmission the Rrp2-RpoN-RpoS signaling cascade coordinates the expression of genes required for *B. burgdorferi* to transition between these environments. In response to environmental cues, the Rrp2-RpoN-RpoS signaling cascade is activated through phosphorylation of the response regulator Rrp2. Phosphorylated Rrp2 associates with the sigma factor RpoN and RNA polymerase and activates the expression of the alternative sigma factor RpoS. RpoS is required for expression of critical virulence factors. Investigations have attempted to identify the phosphate donor of Rrp2 and acetyl-phosphate has been implicated in the direct regulation of this signaling cascade. Genome analysis has identified only one pathway that will generate acetyl-P in *B. burgdorferi*: the acetate/mevalonate pathway that synthesizes the lipid undecaprenyl phosphate (C_{55}-P, lipid I). Since this is the only pathway that allows *B. burgdorferi* to utilize acetate and synthesize acetyl-phosphate, mutations in *ackA* (AckA converts acetate to acetyl-P) or *pta* (Pta converts acetyl-P to acetyl-CoA) would allow us to generate spirochetes unable to produce acetyl-P or acetyl-CoA. Using these mutants we were able to directly assess the role of acetyl-P in the activation of the Rrp2-RpoN-RpoS signaling pathway. We have demonstrated that the loss of *ackA* and *pta* had no effect on acetate-, temperature-, cell density- or pH-dependent regulation of the Rrp2-RpoS-RpoN regulatory pathway. These data suggest that acetyl-P does not directly play a significant role in Rrp2 activation.

11:45-12:00
Detection of Biologically Produced Hydrogen using Platinum Nanoparticles and an Oxidizing Agent

Gereint P. Sis, Jessica Hayes, and Mark Osterlund
Department of Biology, Rocky Mountain College 1511 Poly Drive Billings, MT59102

Although some bacteria intrinsically produce minute amounts of hydrogen gas (H_2), there are no established methods of detecting that hydrogen that are both inexpensive and time efficient. The complications with detecting hydrogen stem from its colorless and odorless properties. The intent of this research is to create a high-throughput assay for hydrogen detection at a cost effective price. Our model assay uses a catalyst in combination with an oxidizing agent to lower the pH of a solution when hydrogen is present. Current results show a dramatic color change in an aqueous solution of potassium ferricyanide and platinum nanoparticles when H_2 is added. We believe the hydrogen dissociates into hydrogen atoms when the gas interacts with the platinum catalyst. The potassium ferricyanide likely strips the electron from the hydrogen atom, producing hydrogen ions (H^+), which in turn cause a measurable pH change. The resulting acidic solution seems to be responsible for a chemical change in the ferricyanide that creates a blue precipitate in the yellow solution. We are currently working on integrating this detection method into a solid agar for growing bacterium. We hope to observe a localized color change in the presence of trace amounts of biologically created hydrogen gas.

Session #3 (Big Butte Room)

1:00-1:15
Identifying Water Endmembers and Comparing Groundwater Surface Water Interactions for Three Water Years in the Upper Boulder River, MT

John Anderson and Glenn Shaw.
Department of Geological Engineering, Montana Tech, Butte, MT.
This project is an examination of groundwater and surface water interactions in the Boulder River. We are using end member mixing, stable isotopes, anions, and cations to separate out the groundwater end member in the river system. Over the past year, samples and field measurements have been taken in one-month intervals. The data appears to indicate a groundwater endmember, a snowmelt endmember, and a lateral inflow that may be high in DIC.

1:15-1:30
Installation of Distributed Temperature Sensing (DTS) Fiber Optic Cable to Measure Temperature Profiles in Underground Geothermal Water Shafts and Drifts

Sarah Chappell and Mary MacLaughlin.
Departments of Geological Engineering, Montana Tech, Butte, MT.

Distributed Temperature Sensing (DTS) fiber optic cables can be used to monitor temperature changes along the entire length of the cable. Temperature profiles are measured using an Omnisens Ditest Sta-R fiber optic analyzer, which utilizes the linear relationship between Brillouin frequency and temperature to calculate temperature at 0.1 meter sampling intervals. In February 2014, over 6000' of DTS fiber optic cable was installed in the Underground Mining Education Center at Montana Tech to monitor geothermal water temperature at the Orphan Boy shaft. Air temperature in the drift will also be monitored. The Orphan Girl shaft temperature profile will be monitored and compared with the Orphan Boy shaft. Air temperature is expected to change due to ventilation or surface temperature variations. Prior to field installation, laboratory calibration experiments, installation design, and a trial field install were completed. Calibration of the DTS fiber optic cables is required prior to field installation in order to define the linear relationship between Brillouin frequency and temperature, and use it to

back calculate temperature. There are two temperature regions in which the cable must be calibrated over, because the linear relationship changes at a temperature of approximately 29°C. The temperatures seen at the UMEC are both above and below 29°C, so it is imperative that the calibration tests are accurately representing the two regions. Scheduled automatic measurements will be taken with the Omnisens fiber optic analyzer. These measurements will be taken from February to April, and data interpretation will continue throughout this time.

1:30-1:45
Fabrication and Characterization of Nanoscale Sensors Made via Electrospinning

Joshua Beisel and Jack Skinner.
Departments General Engineering, Montana Tech, Butte, MT.

The ability to synthesize conductive nanoscale fibers from non-conductive polymers with a robust fabrication method allows for a broad utilization of electrospun fibers. To synthesize the conductive fiber, solution electrospinning is being researched. Solution electrospinning uses a solution of polymer in solvent. Particularly, Poly(vinyl alcohol) (PVA) in water is used to synthesize the fibers that are subsequently pyrolyzed (heated to high temperature in the absence of oxygen) to increase the conductivity. Two PVA solutions were used; one solution was a stabilized 4wt% 100,000 M_w PVA, the other solution was a 5wt% 146,000 186,000 M_w PVA. Initial trials resulted in a beaded fibrous mat. Subsequent steps include the pyrolysis of the PVA fiber mat and conductivity tests.

1:45-2:00
Developing a Predictive Model for the Plastic Deformation of Friction Welded Tubing

Andrew Erickson and Bruce Madigan.
Department of General Engineering, Montana Tech, Butte, MT.

Friction welding has been successfully used on solid and thick walled tubing in a factory setting for some time. The principal is to use heat generated by friction for coalesce two metal pieces. The parts are axis symmetric and require rotation and then compression to complete the weld. The metals never enter the liquid state so there is no fusion taking place. This lack of fusion mitigates the need for shielding gases or fluxes as well as reduces the required heat input to the material. The purpose of this research project is to expand on this technology to develop a joint design which could be used in the oil pipeline and drilling industry. The focus is on limiting the amount of flash or deformed material which enters the interior of the pipe. This would reduce post-weld machining

required to create a smooth interior of the joint. The project also determines the effects of using internal joint bracing as a mechanical means of influencing the development of flash.

2:15-2:30
Synthesis of Supramolecular Nanoparticle Structures

Ryan Hensleigh and Jack Skinner.
Department of General Engineering, Montana Tech, Butte, MT.

Supramolecular nanostructures are assemblies made of nanomaterials, such as nanoparticles, which take on arrangements of interest. One method for building such structures involves using surface chemistry of nanoparticles dispersed with organic ligands. Variation of the physical or chemical properties of surface ligands gives rise to a multitude of possible nanostructure assembly methods. These structures can be viewed as a form of nanoparticle-organic framework consisting of repeating monomeric units of metallic centers, the nanoparticles, cross-linked by organic ligands. These structures can extend into 1, 2, or 3 dimensions, giving rise to a diverse set of plausible structures. The self-assembly depends on several parameters, including temperature, pH and concentration. If these parameters can be determined, and desired nanoparticle assemblies can be consistently controlled and formed, this could create a multitude of opportunities for applications to many fields including, biosensors, plasmonics, and medicine. In order to establish the conditions for desired supramolecular nanoparticle structures, hydroxyapatite nanoparticles were used as the metallic center, with citric acid and aminoethylphosphate (AEP) as the ligands. The effects of dilution on structure formation between the electrostatic attractive forces between citric acid and AEP dispersed particles was chosen as the variable for structure formation. Synthesis of citric acid dispersed hydroxyapatite was completed successfully with nanoparticles exhibiting shard morphology approximately 45nm in the longest dimension. Synthesis of AEP dispersed hydroxyapatite has been unsuccessful by several methods with further methods, focusing on pH conditions, to be attempted. Once completed, studies of structure formation by combining these two monomers can be attempted.

2:30-2:45
Joint Roughness Comparison Using Tilt Testing, Laser Screening, and Laboratory Direct Shear Testing

Mariah McCormick and Mary MacLaughlin.
Department of Geological Engineering, Montana Tech, Butte, MT.

Montana Tech graduate student, Shannon Smith, identified that standard direct shear tests performed on rock joints underestimate the friction angle and overestimate the cohesive strength acting on the shear surface. This project will attempt to reproduce Ms. Smith's results and provide further evidence of this important flaw in the standard direct shear testing procedure. Direct shear tests will be performed on 4 different, but similar specimens. The results of three different tests at different normal stresses will be compared to the standard test in which the specimen is sheared three times. The hypothesis is that the friction angle of the joints measured using the individual tests will be higher than that measured using the standard test.

2:45-3:00

A Study of the Fluorescent Properties of Nanoapatite Particles under Externally Applies Magnetic Fields

Heidi Reid and Jack Skinner.
Department of Mechanical Engineering, Montana Tech, Butte, MT.

The multiphysics magnetic and fluorescent responses of magnetically doped apatite nanoparticles in the presence of an externally-applied magnetic field and ultraviolet light have not been fully characterized. The purpose of this project is to observe and characterize the responses of magnetically doped nanoparticles when exposed to ultraviolet light and externally-applied magnetic fields. The fluorescent responses were characterized using a spectrometer coupled to a probe station; the magnetic responses were characterized by pattern repeatability and studied via a wide range of magnifications using the probe station lens and camera system. Applications of this research include optical/magnetic modulators and sensors, tunable optical polarizers, and trackable nanoscale particle locomotion.

3:00-3:15

Temperature Effects on the Synthesis of Nanohydroxyapatites and Lanthanum Silicates

Jessica Taylor and Michael Klem.
Departments of Chemistry and Geochemsitry, Montana Tech, Butte, MT.

This study will investigate the colloidal synthesis of multi-functional nanoapatite particles and lanthanum silicate nanoparticles as a function of temperature. Recent synthetic attempts have used one standard temperature that results in metastable colloidal solutions that precipitate over a short time period. It is hoped that by tuning the temperature the particles are made at, we can achieve colloidal suspensions that exhibit

extended stability, increase the level of dopant ion in the case of multi-functional nanoapatites, shorten the total synthesis time from days to potentially hours, promote a higher degree of crystallinity in the final products, and achieve a single phase product in the lanthanum silicate synthesis. With this study, we look to understand how the reaction temperature controls the final morphology, crystallinity, stability, and physical properties of both nHA and lanthanum silicate nanoparticles. We also aim to incorporate a recently acquired Dynamic Light Scattering (DLS) instrument into our experimental design to be able to monitor the evolution of particle size pre/post synthesis. It is hoped that any changes in the interactions between the crystallization event driver (citric acid) and the final nanostructured material (nHA or lanthanum silicate) will be reflected in changes of the materials Zeta-potential, a measure of the surface charge on the nanoparticle.

3:15-3:30
An Algebraic Method using Finite Groups of Optimization of Hearts

Dennis J. Moritz and Rick Rossi.
Departments of Mathematics and Statics, Montana Tech, Butte, MT.

The card game Hearts has grown to become well recognized since its inclusion as part of the standard set of programs packaged with the Windows operating system. The game is remarkably easy to learn and play, and with a little time a new player can learn to defeat the standard artificial intelligence "players" on a regular basis. Hearts is a trick-taking game, with an interesting rule called "shooting the moon". Shooting the moon is taking all 13 of the possible tricks, and results in each of the other players receiving numerous penalty points. With the potential impact of "shooting the moon" on the game's outcome, the focus of this research has been in understanding when a player can potentially shoot the moon and when a player cannot be stopped from shooting the moon. With a criterion for various hands which either could or must "shoot the moon," the probabilities of being dealt such hands were calculated.

Session #4 (Copper Lounge)

1:00-1:15
Optimizing the Lipid Production of *Chromulina freisburgensis*

R. Samuel Hall and Douglas Cameron.
Department of Chemistry and Geochemistry, Butte, MT.

Algae, particularly microalgae, are being investigated worldwide as a source for biofuels. Microalgae have many advantages over other sources for biofuel because they do not require agricultural land, grow in wastewater and can fix atmospheric

carbon, making them nearly carbon neutral and they do not produce harmful toxins. This project is a continuation and more focused study of URP from past years on the use of algae lipids as biofuels. The goals of the research are to determine the optimum nutrients, light cycles, pH and temperature that create maximum lipid production. Currently, the algae are cultured in an aspirator bottle of modified acid medium (MAM). Past research has shown that reducing the nitrogen and phosphorous concentration yields a higher percentage of lipids per algal cell. Based on this knowledge, we will work to optimize lipid production with minimum cell growth times. Lipid production will be measured using the fluorescence techniques developed in the URP work by John Kelly and the lipid production and chemical speciation will be checked periodically using GC/MS. For *Chromulina freiburgensis*, it is known that pH, temperature, and light cycle affect the growth rate; however, it is not known how these variables affect the lipid production and distribution. Using the fluorescence techniques and GC/MS, these three variables will be studied individually, starting with the light cycle, then pH and finally temperature. Optimizing the lipid content is the goal to maximize the amount of biofuel that can be produced from the minimal amount of algae.

1:15-1:30

Developing a Testing Method for Repeated Lipid Analysis and Maximizing Lipid Production of Algae for Biofuels

Dylan Uecker and Douglas Cameron.
Department of Chemistry and Geochemistry, Butte, MT.

The goal of this project is to characterize the growth rate and lipid production of a new, not yet identified species of algae. This species is believed to originate from a sample from the Berkley Pit and was discovered after an attempt to regrow a culture of *Chromulina freiburgensis* from the previous year. This new species of interest is a green algae and has been preliminarily identified as *Chlorophyta stichococcus.* It is desirable to continue the project with this new species of green algae, which also grows in acidic waste water, to determine if it produces a sufficient amount of lipids to qualify as a source for biofuels. An initial quantitative calibration procedure has been completed by for the use of the Nile Red stain and fluorescence spectroscopy to quantify lipids in algae cells, however the process needs to be optimized. This coming year focus on completing a calibration curve and a preliminary test of the effects of nutrients, light and dark cycles, temperature, and pH on the lipid production of the apparent *Chlorophyta stichococcus*. Ideally the use of fluorescent spectroscopy will allow the creation of a timeline displaying both cell counts and lipid concentration to determine the maximum production of lipids for each growth medium. The lipid distribution is also analyzed by gravimetrically extracting the lipids, transesterifying them, and then analyzing them with gas chromatography and mass spectrometry.

1:30-1:45

Infection Rate of NC64A *Chlorella variabilis* by PBCV-1 in the Presence of Iron-doped Hydroxyapatite Nanoparticles

Casey McConnell and Katie Hailer.
Department of Biological Sciences, Montana Tech, Butte, MT.

Viruses represent the absolute bottom of the trophic cascade, and therefore any disturbance of the virus/host balance could be responsible for destabilizing the entire trophic system. In previous studies completed by myself and other students at Montana Tech, it was observed that a synthetic nanoparticle, specifically iron-doped nano apatite (Fe-HA NP), did not negatively affect bacterial cell survivability or growth rates, but significantly enhanced viral (bacteriophage) infections of bacteria *in vitro*. Nanoparticles of differing composition are widely used in commercial industry, and are present in synthetic materials ranging from paint to textiles. Improper and unregulated disposal of nanoparticles could be cause of many detrimental outcomes for the environment. Gaining an understanding as to the degree and mode of increased rate of viral infection is critical to our possibility of managing and mitigating related environmental impacts. This project served to expand on the previously studied iron-doped hydroxyapatite nanoparticle-mediated enhancement of viral infection of host cells, of the eukaryotic domains of algae and mammals.

1:45-2:00
Analysis of Volumetric Space between the Brain and the Inner Neurocranium in Relation to Highest Level of Education Achieved

Joslyn Reisinger and Michael Masters
Department of Liberal Studies, Montana Tech, Butte, MT.

Little is known about the relationship between education level and the space between the brain and the inner neurocranium. The focus of this study is how the brain fits within the confines of the human skull, and how variation in the amount of space between the frontal lobes and skull relate to attained education level. The hypothesis tested is that greater packing of the frontal cortex into the confines of the skull is positively correlated with highest level of education attained, which in this study is measured by the final degree obtained and year completed in school. Sophisticated neuroimaging programs AMIRA and BrainSuite were used to isolate and quantify the anatomical Regions of Interest. Specifically, volumetric measurements of the space between the outer cortex of the frontal lobe and the inner skull were taken at 5mm intervals moving laterally, out from the center of the corpus callosum. This resulted in a total of 7 sampling points on each side of the brain for a total of 14 slices across the anterior portion of the frontal cortex. The relationship between these variables will be analyzed using linear regression analysis and ANOVA.

2:15-2:30
E. coli as a Model System to Determine the Essential Genes Involved in Recognition and Repair of Chromium Mediated DNA Damage

Alexandra Weinheimer, Robert West and Katie Hailer.
Departments of Chemistry and Geochemsitry, Montana Tech, Butte, MT.

Guanine is the most easily oxidized base and, when Cr(VI) reacts with DNA, the oxidized guanine base 7,8-dihydro-8-oxo-2'-deoxyguanosine (8-oxoG) has been speculated to be the major product. The reaction of Cr(VI) complexes with DNA containing the 8-oxoG lesion has shown further oxidation exclusively at the 8-oxoG site. The further-oxidized lesions formed were determined to be spiroiminodihydantoin (Sp) and guanidinohydantoin (Gh), both shown to be significantly more mutagenic than 8-oxoG. These lesions are known to be recognized and repaired by a variety of base excision repair (BER) proteins found in both bacterial and eukaryotic cells. Previous research has shown that the *E. coli* BER protein endonuclease VIII or *nei* is potentially the most important protein in recognition and repair of these chromium induced lesions. *E. coli* containing single-deletion of genes within the *nei* operon were obtained from the Keio collection. These strains were then modified by removing an additional gene to produce several strains of double knock outs of individual genes within the *nei* operon. These strains were tested for sensitivity to chromium induced DNA damage alongside a single knockout and wild-type strains. This was done using growth assays over a 24-hour period, where the strains were exposed to various concentrations of chromium (VI). During the experiment, low nitrogen conditions were found to affect the growth of certain strains, causing some resistance to Cr(VI). Therefore, a series of nitrogen limiting experiments were begun and the growth of a strain is observed in various concentrations of nitrogen with increasing concentrations of chromium.

2:30-2:45
Optimum Protein for Optimum Performance

Brittney Robbins, Chrissie Carpenter, and Nate Bickford
University of Great Falls

There are many different components that combine in order to create the optimum athletic performance. According to nutritionists, individuals must portion their intake of calories, watch the amount of carbohydrates and maximize the amount of protein they consume on a daily basis (protein). One thing that is rarely asked in new age diets is to limit the amount of protein an athlete is consuming. A common problem with the intake

of protein in the new age of working out and training is which protein to take, a supplement, a powder, or consuming more protein. There are hundreds of choices in the protein world, but which protein is truly best to provide the highest possible performance from an athlete? Synthesized proteins are said to include everything a body wants and needs in order to produce the highest results but natural protein has better effects on health and energy levels than the synthesized protein chemicals (Protein). For this experiment mice will be used and separated based upon gender and protein source to be tested. Each protein source will have a male and female test group, giving six groups, three female groups containing a control, a synthetic protein, and the natural protein groups, the males will be divided the same way. We will use the Control-Pause (CP) test, a CP test would help to measure the amount of energy through breathing and body oxygen levels (Exercise). Each mouse tested individually, will be placed in the CP test unit for half an hour and the CO_2 produced in that time will be recorded and analyzed.

2:45-3:00

Phenotypic and Genetic Characterization of a Hybrid *Phoxinus* Community in a Montana Prairie Stream

Brennan T. Zotovich[1], James N. Barron[2], and Philip A. Jensen[1]
[1]Department of Biology, Rocky Mountain College, Billings, MT 59102
[2]Department of Biological and Physical Sciences, Montana State University Billings, Billings, MT 59102

Two sexually reproducing cyprinid fish, the redbelly (*Phoxinus eos*) and finescale dace (*P. neogaeus*), hybridized to form an all-female, asexual species (*P. eos-neogaeus*). These asexual females reproduce though gynogenesis, generating diploid eggs that are activated by redbelly or finescale sperm. Such a mechanism should alleviate the reproductive cost of males and should result in the hybrids outnumbering the coincident redbelly population. However, in Montana, redbelly and hybrids coexist in similar ratios. Sometimes, hybrid eggs fertilized by redbelly sperm can produce sexually reproducing offspring that resemble redbelly dace morphologically, but not genetically; because the original mother in the redbelly-finescale hybridization event was finescale, all hybrids, as well as all of their offspring, have finescale mitochondrial DNA. Sexually reproducing redbelly dace from hybrid mothers are called "cybrids" and can be distinguished from true-breeding redbelly dace by their finescale mitochondrial DNA. Dace were collected from Currant Creek in the Musselshell drainage in south-central Montana and were characterized both phenotypically and by analyzing nuclear and mitochondrial DNA by Polymerase Chain Reaction (PCR). Finding dace with nuclear redbelly DNA and

finescale mitochondrial DNA would allow the construction of a model explaining how hybrids repopulate the "redbelly" population and exist in similar ratios.

3:00-3:15
Factors promoting coexistence in a sexual/asexual minnow complex

James N. Barron[1], T.J. Lawson[1], P.A. Jensen[2] and B. Zotovich2
[1] Department of Biological and Physical Sciences, Montana State University - Billings, Billings, MT.
[2]Rocky Mountain College, Billings, MT.

The Northern Redbelly Dace (*Phoxinus eos*) and the Finescale Dace (*P. neogaeus*) form an all-female, asexual hybrid (*P. eos-neogaeus*). The hybrid produces diploid ova that initiate development upon contact with sperm from males of one of the parental species (in this case, *P. eos*). The sperm genome is discarded, however, producing clones of the maternal hybrid (gynogenesis). Because all resulting hybrid offspring are females, the hybrid population can grow twice as quickly as the sexual population, potentially resulting in local extinction of the sexuals and therefore extinction in the hybrid population itself for lack of a sperm source. However, in this system, gynogenesis is not perfect; occasionally sperm fertilize the diploid, hybrid ova producing triploid females. These females contain two copies of the *P. eos* genome, and one copy of the *P. neogaeus* genome. Triploids reproduce by discarding the *P. neogaeus* genome and producing haploid ova containing only *P. eos* nuclear DNA that are then fertilized resulting in male and female nuclear *P. eos*. In other words, the asexual lineage continually produces occasional males that can serve as a sperm source. These apparently "pure" nuclear *P. eos* can be identified by molecular techniques because they carry mitochondrial DNA from *P. neogaeus* (the original hybridization event involved a female *P. neogaeus*). This research examines three hypotheses for the maintenance of the sexual/asexual complex including: male discrimination against hybrid females, fecundity differences between sexual and asexual females, and production of nuclear male sexuals from the asexual lineage.

Results suggest that male *P. eos* do not discriminate against asexual females, and both sexual and asexual females have similar fecundities. Computer simulations of population growth indicate that sexual populations of *P. eos* are quickly replaced by asexuals. Further, that the males necessary for maintenance of the asexual lineage are produced by the triploids, resulting in a population of apparent "pure" *P. eos* that all carry *P. neogaeus* mtDNA. Molecular work with fish collected in Montana support the modeling results: all male *P. eos* were found to have *P. neogaeus* mtDNA.