

could understand. Through an investigation of the Greek and Jewish influences on his own Christology, this thesis attempts to not only discuss Justin and his work, but to examine the example he sets for present theologians. In order to promote a Christology that provides relevant language that fits our own worldview and understanding, Justin Martyr serves as an example of how the Christian experience can be articulated in certain historical language and concepts and still remain relevant and true to the gospel experience. Thus, we can be open to new ways of understanding the Christ event, and our articulation of our experience does not need to be limited to the *Logos* Christology that continues to dominate Christological language.

## HONORS SCHOLARS PROGRAM

### JACKSON KEARNS - ENGLISH WRITING

**A New Modern Language: The Medium of Film in the Evolution of Linguistics**

### JONATHAN SIAPERAS - POLITICAL SCIENCE/PSYCHOLOGY

**Just Another Day**

A young man on a quest of self-identity will encounter various individuals who will try to guide him while representing different aspects of psyche and philosophy. The guidance they deliver will provide some reflection on the choices he will be forced to make. The story is a reflection upon coming to age in a world where free will and destiny collide.

## DEPARTMENT OF LANGUAGES AND LITERATURE

### RICHARD NIÑO - ENGLISH

**What Words? An Exploration of Temporality and Language through Poetry**

This is my first attempt to unify my poetry. This collection of poems is especially concerned with language, time, and dream states; they are divided into these three themes respectively. These poems serve primarily as an exploration of me as a poet and the poets that have inspired my work, namely T.S. Eliot and Octavio Paz. Thus, each section is prefaced by a brief explication of how the poems have been influenced by Eliot and Paz and how the themes connect to one another.

### NEWELL ROCHE - ENGLISH LITERATURE & WRITING

**Burnout & other stories**

My thesis consists of a collection of three short stories that I have written, revised, and rewritten over the past year and a half. These stories are all set in a mythical small town in Montana called Rainey and deal with characters that have hit crossroads and/or difficult times in their lives.

## DEPARTMENT OF MATHEMATICS, ENGINEERING, & COMPUTER SCIENCE

### JOHN FOWLER - MATHEMATICS/CHEMISTRY

**Magnetohydrodynamic Simulations of Convective Forces on Buoyant Flux Tubes in the Sun**

Buoyant flux tubes of magnetic energy in the sun rise through powerful and turbulent convection to penetrate the sun's photosphere and produce sunspots. The question studied in this research paper is: How do magnetic flux tubes rise through this violent convection to the solar surface without being destroyed? We analyze data in  $128 \times 128 \times 300$  arrays generated from supercomputer simulations of three-dimensional magnetized gas in order to investigate the sensitivity of flux tube survival time to different parameters describing the magnetic field strength of the tubes, the viscosity of the solar fluid, and the magnetic diffusivity. We also calculate the standard deviation of magnetic energy density within the arrays to set a scale that quantitatively describes flux tube coherence. Both quantitative and qualitative measures indicate that increased magnetic field strength and increased viscosity greatly expand the time of the flux tubes' survival, whereas increased magnetic diffusivity minutely inhibits flux tube survival time.

## DEPARTMENT OF NATURAL SCIENCES

### ANDREW BROWN - BIOLOGY

**Wetland Characteristics Associated with Reproductive Activity of *Rana sylvatica* in Denali National Park, Alaska**

Habitat characteristics have a large impact on the distribution of amphibians. While *Rana sylvatica* has been extensively studied in Northeastern United States and Southeastern Canada, relatively little is known about the characteristics of its habitat in Alaska. *Rana sylvatica* is the northernmost amphibian in North America and the only one found in the study area. I studied the effects of habitat characteristics on reproductive activity of frogs near Wonder Lake in Denali National Park and Preserve, Alaska during the summer of 2004. *R. sylvatica* tadpoles were found in 98 of 219 randomly sampled wetland sites. A higher proportion of breeding activity was observed for ponds having: intermediate surface area, minimum isolation, higher amounts of riparian woody vegetation, maximum water depth between 1-2m, intermediate levels of emergent vegetation, and presence of alders. No correlation was observed between reproductive occupancy and elevation. These habitat associations may have consequences concerning climate change as *R. sylvatica* distribution may change if current climate trends continue. Future research will focus on expanding the study area, testing additional habitat factors, and accounting for yearly variation in distribution patterns.

## 21st ANNUAL HONORS CONVOCATION CARROLL COLLEGE

### LINDSAY CARLILE - BIOLOGY

#### Localization of the Late Endosome Marker Rab7 in the Freshwater Sponge *Ephydatia Muelleri*

The green alga, *Chlorella*, exists in a symbiotic relationship with the freshwater sponge, *Ephydatia muelleri*. *Chlorella* is taken up by phagocytosis and incorporated into phagosomes. However, the phagosomes containing the algae fail to fuse with lysosomes, resulting in a sustained symbiotic relationship. One possible explanation for the retention of algae in non-lysosomal vacuoles is that the phagosomes do not acquire the surface proteins needed for fusion with lysosomes. Among these proteins is Rab7, which has been suggested to regulate the transition from phagosome to lysosome. I hypothesized that the vacuole containing the symbiotic algae is early endosome-like and thus Rab7 is not present on the algal-containing vacuole membrane. Western blot analysis was used to establish the specificity of the antibody, and immunocytochemistry was used to localize Rab7 in the sponge tissue. The results of both the Western blots and immunocytochemistry were inconsistent. Banding in the Western blots was faint and the pattern of staining varied with the concentration of the primary antibody. Similarly, localization of Rab7 by immunocytochemistry was inconclusive. The inconsistency in both the Western blots and immunocytochemistry indicates that more research is needed to clarify the role Rab7 plays in establishing the symbiotic relationship between algae and sponge.

### JESSICA DAVIS - BIOLOGY

#### The Effects of Soil Copper Concentration on the Activity and Diversity of Microbial Communities

Bacteria are an essential component of soil ecosystems, assisting in nutrient cycling and degradation of organic materials that maintain a healthy environment for growth of plants and other microorganisms. Stable levels of bacterial activity and diversity are indicative of a fully functional environment. Contamination with heavy metals, including copper, has been shown to adversely affect stability of soil microcosms through reduction of bacterial activity and diversity. Therefore, research was conducted to measure the microbial activity in soils a year after contamination with 0, 12.5, 25, and 50 mM copper using arginine ammonification and dehydrogenase activity assays. Also, bacterial diversity was examined through the extraction, cloning, and sequencing of DNA fragments from the bacterial 16S ribosomal gene. The sequences obtained were matched to accession numbers to determine the number of unique sequences. The sequences were aligned and used to construct phylogenetic trees. It was concluded that: 1. a marked decrease in activity resulted from increased copper contamination, 2. in soils with higher levels of copper contamination a larger percentage of the soil community was copper tolerant and 3. bacterial diversity was not significantly affected in overall number of unique sequences, however small changes were exhibited in bacterial community

### JESSICA HILBORN - CHEMISTRY

#### Approaches Towards the Syntheses of New Molybdenum Complexes as Models for the Active Site in Nitrogenase Enzymes

The present study aims to mimic the catalytic properties of the Mo center in the active site of the nitrogenase enzyme. The phosphorous-sulfur ligands PS3, PS3' and PS3\* were used to synthesize Mo-thiolate complexes of the formula  $[\text{Mo}(\text{PS}_3)\text{L}_2]$  where L is NO, N2 or a related molecule. The starting material  $[\text{Mo}(\text{NO})_2\text{Cl}_2]$  allows for the study of structure and reactivity at the Mo center via IR spectroscopy of the NO region. Reactions of the starting material in various solvent systems to form complexes of the formulation  $[\text{Mo}(\text{NO})_2\text{Cl}_2\text{L}_2]$  confirmed the stationary nature of the cis NO ligands. Reactions with PS3 and PS3' worked best in methanol, giving clean spectra with two NO peaks, as expected for a cis conformation; the reaction with PS3\* worked best in THF. A crystal structure of air-stable  $[\text{Mo}(\text{NO})_2\text{Cl}_2(\text{C}_2\text{H}_5\text{CN})_2]$  was successfully obtained and analyzed using X-ray crystallography. The bond angles in the structure compare favorably to accepted octahedral complexes.

### HANNAH JARVIS - BIOLOGY

#### Immunocytochemical Localization of Rab5 in Perialgal Vacuoles of a Freshwater Sponge

*Chlorella* sp. is a green alga that exists in endosymbiotic relationships with a number of freshwater invertebrates including the sponge, *Ephydatia muelleri*. Algal cells enter sponge cells through phagocytosis, but unlike most cells taken up by this process, the algal cells are not degraded. The mechanism by which *Chlorella* escapes degradation is currently unknown. One hypothesis is that the vacuoles containing algal cells do not progress along the degradative pathway, but instead, are maintained in an immature, pre-lysosomal state, displaying the early endosomal marker Rab5. In order to test this hypothesis, I localized Rab5 in sponge cells using immunocytochemistry. Two antibodies against human Rab5 were first shown by Western blotting to bind to a sponge protein having a molecular weight similar to that of mammalian Rab5. Both antibodies also recognized some higher molecular weight proteins. From these results, I concluded that there was sufficient cross reactivity to use the antibodies for immunocytochemistry. I was unable to localize Rab5 in cells using one of the antibodies; however, with the other, I detected antibody bound to algae-containing vacuoles. This latter result suggests that vacuoles containing symbiotic algae may express Rab5 and that maturation of the vacuoles may be hindered.

**TYNER KUEHN - BIOLOGY****Effects of 17- $\beta$ -Estradiol and Tamoxifen on the Stretch and Failure Load of the Medial Collateral Ligament of Prepubescent Female Rats**

The purpose of this project was to test whether the effect of 17- $\beta$ -estradiol on the medial collateral ligament (MCL) would reproduce previous studies in which it increased laxity and if the effects would be mimicked by the use of a synthetic form of estrogen (tamoxifen) at pharmacological doses. My hypothesis was that pharmacological levels of both 17- $\beta$ -estradiol and tamoxifen would increase the laxity of the MCL without affecting the breaking point as compared to controls.

Mechanical tests on the isolated MCL of prepubescent female rats were performed to test the stretch and breaking point weight after treatment with the equivalent of peak human levels of estradiol. Mechanical tests were also conducted on the isolated MCL of prepubescent rats treated with tamoxifen. Increased laxity in the MCL of the estradiol and tamoxifen treated rats, when compared with the control group, was observed. It was also determined that increased levels of estradiol and tamoxifen did not affect the breaking point weight of the MCL.

**KATHERINE LANGE - BIOLOGY****Effect of the condensed tannin containing hay, sericea lespedeza, on natural and experimental challenge *Haemonchus contortus* infection in lambs**

Parasitic infection is one of the leading economic scourges for sheep and goat production. This problem is exacerbated as the resistance of nematode populations to chemical treatment (anthelmintics) becomes increasingly common. Condensed tannins (CT) containing plants used as forage and CT extracts mixed in processed feeds have become a growing focus of research aimed at finding alternative solutions to the problem of nematode infection and chemotherapy resistance. This study was conducted to evaluate the effect of the CT containing forage, sericea lespedeza (SL), fed as hay, on *Haemonchus contortus* infection in gulf coast native sheep. Twenty-eight naturally infected lambs were removed from pasture and maintained in cement floored pens. Lambs were divided into four groups (seven animals each): Group 1) control, natural infection and fed bermudagrass hay; Group 2) dewormed and fed bermudagrass hay; Group 3) natural infection and fed SL hay; Group 4) dewormed and fed SL hay. All animals received trickle infections of 1000 L3 (infective stage) *H. contortus* larvae three times a week for three weeks. SL hay feeding was stopped after seven weeks and three animals from each group were necropsied at nine weeks to determine effects on worm numbers. SL effect on ovine health (resilience to infection) and egg output (worm fecundity) were determined by weekly measurements of packed cell volume (PCV) and fecal egg count (FEC) for each sheep. Reduction in FEC for both groups 3 and 4 remained

>75% through week seven. After SL hay feeding stopped, FEC reduction dropped substantially to 35-50%. Necropsy results indicate that SL had a lethal effect on established worm populations but little or no effect on the survival of incoming larvae.

**CHRISTINA MARCHION - BIOLOGY/SPANISH****Distribution of Sibling Species of the Black Fly, *Simulium arcticum*, is Correlated with Elevation**

The cytogenetics of *Simulium arcticum* complex was studied at Boulder River drainage. Conventional methods for collection, morphological classification, and preparation and analysis of polytene chromosomes were used. Three sites were chosen on the Boulder River to determine if a correlation existed between distribution of siblings and elevation: Cardwell (low elevation), High Ore (intermediate elevation), and Bison Creek (high elevation). Moreover, as part of a coordinated effort, results of this study were compared to the results obtained by two other students at two separate drainages under the assumption of the same hypothesis. Results showed that the low elevation site at Cardwell was exclusively *S. apricarium* with an absence of *S. arcticum sensu strictu* and that *S. arcticum s. s.* was dominant at the intermediate elevation site and had a significant presence at the high elevation site. Additionally, results showed an increase in IIL standard individuals with increasing elevation. These observations, at least for these siblings in this drainage, suggest a correlation between genetic diversity and the elevation or temperatures at which these flies emerge.

**LAURA MIRCH - BIOLOGY****Detection of K-ras Colorectal Point Mutations Using Endonuclease V/AK16D Ligase and Ligase Detection Reaction Assays**

This research investigates the benefits of utilizing PCR/Ligase Detection Reaction multiplexing coupled with endonuclease V/AK16D ligase treatment in the detection of known and unknown point mutations within DNA. The research focused specifically on the K-ras gene, implicated in the development of certain cancers including colorectal cancer. Identification of point mutations within this gene could lead to early detection of cancer, as well as identify those with a predisposition to develop cancer. An LDR technique was utilized to identify specific, known mutations within the gene sequence, while the endonuclease/ligase treatment identified unknown mutations within the gene sequence. Capillary electrophoresis and slab gel electrophoresis were employed to distinguish the products of both EndoV/ligase and LDR, respectively, based on the fragments' size differences. These methods have been found to be highly sensitive, and have high throughput. Further research should explore the potential to transfer the gel electrophoresis separation to a microelectrophoretic device with the potential for clinical applications.

## 21st ANNUAL HONORS CONVOCATION CARROLL COLLEGE

### R. DAWN PAUL - CHEMISTRY

#### **Perturbation of Triple-Helix Structure in Mutant Collagens Examined by Subnanosecond Local Dynamics of Tryptophan: An Application of Time-Resolved Fluorescence Anisotropy**

Time-resolved fluorescence anisotropy can provide information about the local dynamic properties of a molecule at sub-nanometer resolution on the nano- and picosecond time scales. To help explain perturbation(s) of the triple-helical structure of collagen induced by a mutation, and to facilitate an understanding of mutations associated with diseases like scurvy, an examination of synthetic collagen-like peptides was conducted. Results indicate that the extent of local motion increases near a mutation, demonstrating that the change in the amino acid interrupts the helical structure. Local motion, however, remains unchanged several amino acid residues away from the indole side chain of the tryptophan residue. In addition, the perturbation of the helical structure is asymmetric as there is an increase in the local motion of the indole side chain farther to the C-terminal side of the mutation.

### MARCUS SIMONICH - BIOLOGY

#### **Long Term Effects of Heavy Metal Contamination on Bacterial Communities in the Upper Clark Fork River Canyon**

Microorganisms and their activities drive most ecosystems and therefore must be assessed in order to study ecosystem stability. Heavy metal contamination is known to have adverse effects on soil bacteria. In this study, bacterial populations from polluted and non-polluted soils were compared in order to better understand soil resiliency, ecosystem stability, and the long-term effects of heavy metals have on bacteria. Biological parameters of soil quality including diversity, structure, activity, and heavy metal tolerance were compared and assessed. The numbers of Zn and Cu tolerant bacteria were determined by spread plating diluted soil samples onto agar plates containing 0.5, 2, and 10 mM concentrations of the metals. Arginine and iodonitrotetrazolium assays were used to measure the extent of ammonification and dehydrogenase activity in the soil. And, 16S rDNA cloning and sequencing was used to identify 60 individual microorganisms from both the non-polluted vegetated (NV) and polluted vegetated (PV) soils. Phylogenetic trees, constructed with the 16S rDNA clones, were then used to analyze differences in bacterial diversity and community structure. I hypothesized that the population in the non-polluted soil would: 1) have higher activity levels, 2) be more diverse, 3) contain fewer metal tolerant microorganisms, and 4) show a different community structure than the bacterial population isolated from the polluted soil. All hypotheses were supported by this study to be correct except for the hypothesis addressing the diversity of the two soils. It was found that both soils, the NP and the PV soils, were very diverse in bacterial species and that 60 clones from each soil was not a big enough sample size to address the differences in diversity between the two bacterial populations isolated from the two soils.

### EMMA SWINGLE - BIOLOGY/SPANISH

#### **Water Quality Survey of Nitrate Levels and Coliform/Coliphage Presence in the Helena Valley Compared with Helena City Water**

The well water of the Helena Valley has shown several significant problems in recent years. High nitrate levels and/or the presence of coliform and coliphage have been identified in numerous wells. These problems are likely the result of a combination of faulty sewage systems and regional agriculture. To effectively monitor and evaluate problem wells, data were collected and then statistically compared from thirteen Helena Valley wells with nine city water samples. The highly monitored city water contained minimal nitrate concentrations and no microbial contamination while the Helena Valley samples showed great diversity in contamination levels. Additionally, no correlations were evident between high nitrate levels and bacterial or viral presence in Helena Valley wells. Larger, more detailed studies of the region are needed to continue monitoring problem wells and to search for links between coliform and coliphage presence and nitrate concentration.

### JOSHUA SYKES - BIOLOGY

#### **The Effect of Varying Concentrations of Zinc on Bacterial Tolerance and Diversity in Artificially Amended Soils**

Controlled experiments in laboratory settings examining the effect of zinc pollution on bacterial communities in soil often neglect metal exposure over a period of time. Increasing levels of soil-zinc have been shown to increase the zinc tolerance, decrease diversity, and change community structure of bacterial populations. Since soils are a critical component of terrestrial systems, the soil must be able to recover from a pollution event in order to maintain the quality of natural and agricultural systems. This study analyzed bacterial tolerance and diversity in soils containing 0, 12.5, 25, and 50 mM after a year of incubation in a laboratory setting. Approximately 50 clones were sequenced and fit into a phylogenetic tree for each of the three microcosms analyzed (0, 25, and 50 mM). There was an increase in tolerance with increasing zinc amendment and there was also an increase in tolerance from a year previous. Both the arginine and dehydrogenase assays showed a decrease in activity with increasing Zn concentration. The diversity of the communities changed little with 40 unique species in the control and 37 and 36 unique species in the 25 and 50 mM Zn amended soils, respectively. The structure of the communities also exhibited a small change as clades that were present changed with Zn concentration.