Colorado State University – Pueblo

and the

College of Science and Mathematics

present their

12th Annual Science and Mathematics
Student Research Symposium

Thursday, October 20, 2016
12:00 – 2:00 p.m. Poster Presentation
Life Sciences Foyer

Table of Contents

______=presenter
*=Undergraduate student

An Investigation of the Relative Migratory Aptitude of Phenyl and Substituted Phenyl Groups in the Baeyer-Villiger Reaction

Beth Withrow *, Jackie Killen*, Megan Bissell* and Dr. David Dillon

Department of Chemistry

Research Project #1 – ABSTRACT

The Baeyer-Villiger (B-V) oxidation of ketones is an important reaction for synthesis of esters that may be difficult to obtain by other synthetic routes, but it is not covered in many laboratory textbooks and may even receive less attention in the lecture course. While B-V oxidation of aldehydes typically yields carboxylic acids, benzaldehydes substituted with certain highly electron-donating groups (EDGs) give formate esters, often undergoing hydrolysis under the reaction conditions to substituted phenols. We have used the B-V oxidation of benzaldehyde and acetophenone in the undergraduate organic chemistry laboratory to explore the known relative migratory aptitude of groups, and also to explore the well-documented anomalous migration of *p*-methoxyphenyl groups. We explore this effect in our undergraduate laboratories as an application of the effect of EDGs on aromatic systems, and present our students with an extended ranking for B-V migratory aptitude.

Traditional relative migratory aptitude: hydrogen > 3° alkyl > phenyl ~ 2° alkyl > 1° alkyl > methyl

Extended relative migratory aptitude: *p*-methoxyphenyl > hydrogen > 3° alkyl > phenyl ~ 2° alkyl > 1° alkyl > methyl

As part of enrichment efforts for our undergraduate laboratory curriculum, we are investigating the outcome of B-V reactions on *p*-anisaldehyde, *p*-tolualdehyde, benzaldehyde, acetophenone, and *p*-nitroacetophenone using Oxone(R) and *m*CPBA as oxidants. We continue to explore the effect of other EDGs and other oxidants.

Manipulation of Host Cell Metabolism during SINV Infection

Jessica Costlow*, Erika Krow*and Dr. J. Jordan Steel

Department of Biology

Research Project #2 – ABSTRACT

Viruses are completely dependent on the host cell for nutrients, metabolism, and energy to successfully replicate. As a result, many viruses manipulate the host cell metabolism to enhance the viral replication capacity. Alphaviruses are plus strand RNA viruses that replicate in the cytoplasm of the host cell. Alphaviruses cause significant disease in animals and humans and there are currently no specific treatment options that are available to reduce the suffering and mortality due to infection. Sindbis virus (SINV) is an Alphavirus that causes mild symptoms and is the prototype Alphavirus used in research settings. SINV has a similar genome and replication mechanism as some of the more virulent Alphaviruses (Chikungunya, western equine encephalitis, Venezuelan equine encephalitis, etc) and is regularly used as the model virus system. Alphaviruses have been shown to be dependent on host cell glycolysis, but the direct mechanisms are unknown. We are working with SINV to better understand the alteration in host cell metabolism that occurs during Alphavirus infection. We hypothesize that Alphaviruses induce a specific change in metabolism that may lead to novel treatment options or therapeutic mechanisms to regulate host cell metabolism. We are monitoring glucose uptake in SINV- infected baby hamster kidney (BHK) cells and evaluating the viral dependence on glucose through viral replication assays with varying amounts of glucose. There is a strong correlation linking the MOI and increased glucose uptake. We are also investigating the use of metabolic inhibiting compounds as potential drugs that can be used to reduce viral replication.

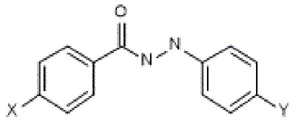
Cytotoxicity and Minimal Inhibitory Concentration Evaluation of Synthesized Benzohydrazide Derivatives

Alisha Mason*, Sarah Thompson*, Dr. J. Jordan Steel and Dr. David L Dillon

Departments of Biology and Chemistry

Research Project #3 – ABSTRACT

Substituted benzohydrazides, 1, have been shown to have antimicrobial activity and are synthesized via acylation. This interdisciplinary project, involving organic synthesis, microbiological determination of antimicrobial activity, and cytotoxicity, focused on investigation of the effect of various substituents at the N' and aryl positions on biological activity. The cytotoxicity of these compounds is not well studied. Derivatives **1a,b** were previously found to have minimal or slight activity against tested bacteria. Preliminary results of the cytotoxicity have shown certain concentrations of the compounds have high viability for eukaryotic cells. Drug administration was evaluated at different time points using resazurin/Alamar Blue cell viability assays to monitor cytotoxicity in cultured eukaryotic cells with different concentrations. In previous work, antimicrobial activity was examined using Kirby Bauer and measuring zones of inhibition around discs loaded with the compound. The Minimal Inhibitory Concentration is now being evaluated to better understand the concentrations needed to inhibit microbial growth. Exposure times of the compounds were evaluated in an attempt to determine the therapeutic indices for these compounds and investigate their utility as a potential novel treatment option against bacterial pathogens.



1a: X = NO_2; Y = H
1b: X, Y = NO_2

.

Reactions of 3,6-bis-(2-pyridyl)-1,2,4,5-tetrazine and First Row Transition Metal(II) Triflates

Jillian Manikoff* and Dr. Matthew Cranswick

Department of Chemistry

Research Project #4 – ABSTRACT

Tetrazines are highly-colored, electron-deficient organic molecules that exhibit a two electron reduction. We are working toward developing metal-tetrazine complexes as photocatalysts in the reductive catalysis of small molecules (e.g. reduction of carbon dioxide to methane). We are currently attempting to purify the crude products isolated from the reaction between 3,6-bis-2(pyridyl)-1,2,4,5-tetrazine (bptz) and first-row transition metal(II) triflates, M(OTf)2, (M= Co, Mn or Fe), along with synthesizing asymmetrically-substituted s-tetrazines. The characterization of these complexes and future directions will be discussed.

Synthesis of Fluoroamides by Electrophilic Addition Reactions of Alkenes

Andrea Trimble* and Dr. Mel Druelinger

Department of Chemistry

Research Project #5 – ABSTRACT

The selective introduction of fluorine into organic molecules often increases biological activity. This project focuses on enhancing preliminary studies on a clean and straightforward synthesis for β-Fluoroamides and β-Fluoroamines. The primary strategy is to use the fluorinating agent F-TEDA (Selectfluor ™) in the presence of anhydrous acetonitrile to yield a useful approach in the synthesis of these classes of compounds. The synthesis of these compounds was explored using a research-grade microwave system that has the potential to significantly reduce reaction times and improve yields over more traditional thermal methods. The results under microwave conditions were compared to those carried out under thermal conditions. The microwave conditions appear to give higher yields of the desired products.

Preliminary Characteristic Analysis of Cassin's Sparrow Territories in Southeastern Colorado

Austin Reed*, Clark Jones and Dr. Claire Ramos

Department of Biology

Research Project #6 – ABSTRACT

Cassin's Sparrows are a significantly understudied shortgrass prairie species, which leads to little being known about habitat selection in this species. Cholla (Cylindropuntia fulgida) and Rabbitbrush (Chrysothamnus nauseosus) are thought to act as means of cover on the short-grass prairie for the Cassin's Sparrow during the breeding season and thus may be an important component of habitat selection. We examined the average territory size and the amount of vegetation inside and outside of Cassin's Sparrow Territories and investigated the correlation among Cholla numbers and territory size for both. Birds were captured using mist nets and distinct color band combinations were applied to the birds' legs in order to allow for easy re-sighting of the individuals banded. Birds were followed and their territories boundaries marked via GPS unit. The number of Cholla was counted in 100m2 random sampling areas and a correlation test was performed to determine the relationship between cover density and territory size. The average number of Chollas in the territory was compared to that of randomly sampled areas where no sparrows were observed and a paired t-test was used to evaluate a difference among the averages. A weak correlation between territory size and Cholla number does exist and it is positive, but likely due to small sample size this effect is not significant. Further research is needed to confirm the relationship between cover density and territory size.

The Use of Flow Cytometry to Identify Yeast Mutants with Cell Cycle Deficiencies

Courtney Ewing* and Dr. Dan Caprioglio

Department of Biology

Research Project #7

The cell cycle is the process through which a cell divides, and cancer occurs when the process is not properly signaled which causes growth to continue when it should have been terminated. In previous studies, M1 aminopeptidase gene deletion mutations caused changes to cell cycle in yeast. The M1 aminopeptidase gene homologs have been correlated to cell cycle based diseases such as cancer. In work done by Scott Rolaff, several yeast genes were shown to have major changes in regulation due to M1 aminopeptidase gene knockouts. A subset of these genes were used to determine if any had direct effects on the yeast cell cycle. These genes were ino4, nup100, yox1, bem2, YLR112w, bzz1, gas1, rcy1, jsn1, cts1, and GDH1. Knockouts of these genes were obtained and given the following gene designations DC421, DC422, DC423, DC424, DC425, DC426, DC427, DC428, DC429, DC430 and DC431 respectively. Using a flow cytometer, the DNA content of individual cells from each yeast strain population during log phase growth was measured. The amount of the population in 1N and 2N state was determined, and from that data G_1/G_2M ratios was calculated. Most of the knockout strains showed major shifts to the G2/M phase of the cell cycle pointing to a delay in the G2/M phase. This is consistent with the previous research with M1 aminopeptidase genes in higher eukaryotes and may point to possible mechanisms of the role of M1 aminopeptidase genes in cancers and other cell cycle based diseases.

Increasing the coordination kinetics of the acetylene hydratase (AH) model complex via pseudo-hydroxylation with *t*-butoxide

Travis Marshall*, Ellie Vergunst, B. Trujillo and Dr. Matthew Cranswick

Department of Chemistry

Research Project #8 - ABSTRACT

Mononuclear tungsten and molybdenum metalloenzymes play significant roles in the global carbon, nitrogen, and sulfur cycles, and are found in countless organisms. Tungsten is the only known 3rd row transition metal currently found in metalloenzymes and all tungstoenzymes known to date are found in anaerobic, thermophilic bacteria and hyperthermophilic archaea. Acetylene hydratase (AH) is a tungsten-containing enzyme that catalyzes the nonredox hydration of acetylene (C_2H_2) to acetaldehyde (CH_3CHO). AH is unique in several aspects: (1) it is the only known nonredox Mo/W enzyme, (2) it is the only known enzyme to use C_2H_2 as its native substrate, and (3) these organisms use C_2H_2 as their sole carbon and energy source, for which AH catalyzes the first step in carbon/energy acquisition. The crystal structure of AH suggests that the oxygen derived ligand is either a hydroxo or aqua ligand. Previously we have utilized the model complex, $[Et_4N]_2[W^{IV}(O)(mnt)_2]$ to determine the kinetics of coordination of bulky acetylene derivatives such as diethyl or dimethyl acetylenedicarboxylate (DEAD or DMAD). These reactions were run for appreciably long collection times, upwards of 48 hours. While these studies were able to elucidate the associative mechanism of this model complex, it is hypothesized that formation of a hydroxylated complex should substantially increase the rate of coordination of the acetylenic compounds. After several failed attempts to produce a stable complex with the formula $[W^{IV}(OR)(mnt)_2]^-$ or $[W^{IV}(Solv)_2(mnt)_2]^-$, current efforts are underway to produce and characterize $[W^{IV}(O^tBu)(mnt)_2]^-$ and to test its coordination kinetics in relation to $[W^{IV}(O)(mnt)_2]^{2-}$ in order to further our understanding of the possible identity of the oxygen-derived ligand of AH, and how the identity of this ligand affects the reaction kinetics.

Influence of Oxidative Stress on Sindbis Virus Replication

Juan Rodriguez*, Elicia Vigil*, and Dr. J. Jordan Steel

Department of Biology

Research Project #9 - ABSTRACT

Viruses manipulate many pathways and cellular processes during infection. Flaviviruses have been shown to alter cellular oxidative stress levels during infection to favor viral replication. Alphaviruses are positive strand RNA viruses that replicate within the cytoplasm of the host cell. There are reports of increased oxidative stress during alphavirus infection, but the level and impact of oxidative stress on a cellular level has not been described. Our study is working to determine the role of cellular oxidative stress in alphavirus infection. Sindbis virus is the prototype alphavirus and is being used in this analysis as an indicator for other Alphaviruses that are currently causing worldwide infection and disease (ie: Chikungunya virus). Using a double subgenomic reporter alphavirus expressing fluorescent reporter proteins (mCherry and GFP), we have found evidence of a correlation between infection levels and increasing amounts of oxidative stress in the host cells. Treatment with antioxidants or oxidants significantly altered viral replication, indicating that an intricate redox balance must be maintained for successful viral replication.

Prevalence of West Nile Virus Antibodies in Birds Collected from the Fountain Creek Region

Alyssa Torres*, Dr. J. Jordan Steel and Dr. Claire Ramos

Department of Biology

Research Project #10 - ABSTRACT

West Nile Virus (WNV) is a positive strand RNA virus (Flaviviridae) that is transmitted by mosquitoes (Culex species). The virus is normally maintained and amplified in avian reservoir hosts, but infected mosquitoes will also bite humans, horses, and other vertebrates and can result in the transmission of the virus. WNV infections have been reported all over North America, including recent infections in Colorado. Mosquitoes are routinely sampled for the presence of WNV, but bird populations are more difficult to trap and analyze. In a collaborated effort, birds have been trapped, banded, and blood samples were collected from birds in the Fountain Creek Region of Colorado in summers of 2014-16. Blood samples are now being screened for mercury levels using a DMA 3000 Mercury analyzer and for WNV antibodies using an indirect ELISA. (enzyme-linked immunosorbent assay). Initial screening results show multiple birds being positive for WNV antibodies. Over 700 bird blood samples have been collected over the last 3 years and will be analyzed for WNV antibodies. Geographic location, bird species, bird age, mercury levels, and WNV antibody titer data will be gathered and analyzed for any correlations between WNV exposure and the other parameters.

Direct Laser Writing of Palladium Metal in Two Dimensions as a Precursor to Three-Dimensional Fabrication of Metal Structures

Jorge Medina* and Dr. Richard Farrer

Department of Chemistry

Research Project #11 - ABSTRACT

While lasers tend to find a home as light sources for spectroscopic instrumentation, the narrow frequency produced by most lasers is excellent at providing energy to initiate chemical reactions. Typically, the radiation produced by the laser has a frequency that is absorbed by a chemical (the photoinitiator) in the reaction mixture, and, in turn, the excited photoinitiator commences a chemical reaction. While laser-induced reactions have been employed in several areas of chemistry, this research employs such a process to produce two-dimensional metal structures. The lasers are employed to excite the plasmon resonance of metal nanoparticles, which causes the temperature of the metal nanoparticle to increase dramatically. As the metal nanoparticles begin to heat, any molecules (capping agents) that are electrostatically coupled to the surface of the nanoparticles are release from the nanoparticles, leaving the bare metal surface of the nanoparticles susceptible to interactions with other chemicals present in the solution. In this research the solution is a plating solution that contains metal ions that are prepared to be reduced to metal atoms. The metal surface of the warm nanoparticle acts as a catalyst for the reduction of the metal ions in the solution. The rapid addition of the metal atoms to the surface of the metal nanoparticles cause significant growth in the nanoparticle, and when the concentration of the nanoparticles is high enough, the particles will expand and couple with neighboring nanoparticles. By controlling the nanoparticle solution and the laser intensity, two-dimensional metal structures can be produced. Previously, this lab has presented similar work using gold nanoparticles. In this recent work, we hope to show that less expensive metals could also be employed with similar results. The intention of this research is to produce a system the can be utilized to produce conductive, three-dimensional metal structures on the microscopic scale.

Development of an Inquiry-based Undergraduate Inorganic Laboratory

David Clair*, Andrew Pacheco*, and Dr. Matthew A. Cranswick

Department of Chemistry

Research Project #12 – ABSTRACT

Most inorganic lab pedagogy consists of students following a tried-and-true experimental procedure from a laboratory notebook or the past literature to explore concepts in inorganic chemistry. Although this gives students experience in synthesis techniques, kinetics and/or spectroscopy, it fails to give a genuine research experience. This project looks to form an inquiry-based inorganic laboratory that focuses on familiarization with the literature and chemistry search engines, non-traditional organic synthesis, experience with air-and moisture-free manipulations and inorganic synthesis, characterization techniques, and kinetic experiments. This inquiry-based laboratory is divided into four major sections: (1) literature search and project development, (2 & 3) synthesis purification and characterization of ligands and metal complexes, and (4) comparing the oxygen-atom transfer (OAT) kinetics of these metal complexes using UV-vis spectroscopy. It is our hope that this inquiry-based inorganic laboratory will reinforce students' previous laboratory skills and lecture content, develop their abilities to design and perform an experiment, pique interest in undergraduate research and prepare students for a career in chemistry. Our current efforts to develop an inquiry-based inorganic laboratory around the synthesis, characterization and OAT reactions of TpR2MO2Cl (where R = methyl, trifluoromethyl, phenyl, isopropyl; M = Mo, W) complexes will be presented.