**2015 Fall Research Symposium Abstracts**

**Presentation Abstracts**

**Kelle Nett**

***Optogenetic activation of A2A receptors in the dorsal medial striatum and its effect on ethanol-seeking, anxiety-like and depressive-like behaviors***

Advisor: Dr. Doo-Sup Choi, Mayo Clinic

Areas: Biochemistry/Molecular Biology, Neuroscience

6:00 pm, NHS Auditorium

Adenosine receptors, particularly adenosine A2A receptors (A2ARs), are expressed primarily in the striatum. The dorsal medial striatum (DMS) is involved in goal-oriented behaviors and is a part of an extensive circuit associated with addictive behaviors. Presently, the specific mechanism of adenosine-mediated signaling in this brain region and its contribution to ethanol-seeking, anxiety-like and depressive-like behaviors remains unclear. It has been shown previously that mice lacking ENT1 consume excessive ethanol, which appears to be driven in part by reduced A2AR activity in the DMS. Mice lacking ENT1 also exhibit reduced anxiety-like behavior in the open-field test and increased depressive-like behavior in the forced swim test. This study looks at the effect of transient activation of A2AR in the DMS on ethanol-seeking behaviors, anxiety-like behaviors and depressive-like behaviors in mice using optogenetic light activation of a rhodopsin-A2AR chimera (opto-A2AR) in ENT1 KO and WT mice during open-field test, forced swim test and drinking in the dark. Light activation of A2ARs in the DMS increased anxiety-like behaviors in KO and WT mice and decreased average velocity in an open-field test. Additionally, transient activation of A2ARs in the DMS decreased ethanol-seeking behaviors in WT mice. Overall, these data suggest that A2AR receptor signaling in the DMS plays a role in the anxiety-like, locomotor, and binge alcohol drinking behaviors in mice.

**Morgan Timm**

***Characterization of lipooligosaccharide binding to polystyrene nanoparticles***

Advisor: Dr. Jennifer Fiegel, University of Iowa

Areas: Biochemistry/Molecular Biology, Biochemical Engineering

6:25 pm, NHS Auditorium

Polymeric nanoparticles are currently being investigated as a method of drug delivery to multiple organ systems, including the lungs and respiratory passages. In order to function as an effective pulmonary delivery method, nanoparticles must first penetrate through the mucosal layer secreted by lung epithelial cells, then stimulate cellular uptake and release their contents inside the cell. Nanoparticles usually have a relatively low rate of cell invasion on their own; however, organisms such as the bacterium nontypeable *Haemophilus influenzae* stimulate cellular uptake as a mechanism of infection. Recently, researchers have functionalized lipooligosaccharide (LOS) from the bacterium nontypeable *Haemophilus influenzae* (NTHi) onto polystyrene nanoparticles, successfully granting the nanoparticles the unique cellular invasion properties of NTHi. The present study aimed to optimize the concentration of LOS used to coat the particles in order to maximize the number of LOS molecules bound to the surface of 200 nm polystyrene nanoparticles. Isothermal titration calorimetry was used as the main quantification method, while dynamic light scattering and laser Doppler velocimetry were used to confirm and characterize the effects of LOS-nanoparticle binding. It was found that a titration concentration of 50 μg/mL LOS produced maximum LOS adsorption onto the surface of the nanoparticle. Since this is a slightly higher concentration than has been used in previous cell studies of LOS-coated particles, these results suggest that nanoparticle-cell binding might be improved by altering the concentration of LOS used during the coating process.

**Poster Abstracts**

**7:00 – 8:00 pm, 3rd Floor NHS**

**Mahmoud AbuEid**

***A comprehensive understanding of cleft lip and palate care in the Middle East and North Africa***

Advisor: Dr. John Van Aalst, Middle East Craniofacial Care Institute/United Palestinian Appeal

Area: Biology

Cleft lip and palate is one of the more highlighted craniofacial malformation that people suffer from birth, in which patients with no immediate care suffer from lifelong challenges such as; speech imparities and food intake hardships depending on the severity of the case. A comparative study of the cleft lip and plate care in different countries in the Middle East and North Africa. Deep analysis of literature and current data shows little to no attention to craniofacial malformation such as cleft lip and plate in the Middle East and North Africa, individual analysis of each country and each region has been carried out in order to further investigate the countries and their care. There is a huge absence of a formal birth registry and lack of public health services makes collecting CLP data difficult in those regions. care provided at each country varies some relies heavily on foreign surgeons for care missions led by humanitarian organizations, such as Smile Train and other depend on local expertise mostly in private sectors. There is no accurate, longitudinal method of documentation for CLP patients in most of the Middle East countries. Most studies were retrospective and based on data retrieved from the medical records at the hospitals, not direct examination of patients. Therefore, results obtained from these investigations may have some deficiencies. These deficiencies are the result of bias in sampling a narrow pool of patients in regards to size and region. A new methodology of treatment will be discussed in order to improve the cleft lip and palate care in the region. In the future, a comprehensive conference will be held to present these data and suggestions will be made to improve the cleft lip and palate care in the Middle East and North Africa.

**Mikaela Algren and Cole Raisbeck**

***Characterizing the acoustic radiation force of ultrasound: modeling the output of ultrasound transducers***

Advisor: Dr. Tom Huber, Gustavus Adolphus College

Area: Physics

Every object vibrates in a characteristic way that depends on its structural properties. The study of this characteristic vibration is called modal analysis, and its uses include investigation of the structural integrity of objects, noise reduction in machinery, and sound quality optimization in instruments. For researchers performing modal analysis, there are many methods for exciting vibration in objects; of these methods, the ultrasound radiation force is ideal in many ways. The primary advantages of the ultrasound radiation force as a method of excitation are that it is non-contact, highly focused, and can have a very broad bandwidth for excitation. The goal of this project has been to develop a simple and repeatable method for determining the output force distribution of ultrasound transducers used for radiation force excitation experiments. The method involves measuring an edge-spread vibrational velocity distribution with a scanning laser Doppler vibrometer as an ultrasound transducer is moved across the face of a small brass cantilever. Preliminary results indicate that distributions determined using this method are consistent with profiles taken by the transducer manufacturer using specialized, and costly, ultrasound measurement equipment.

**Emilie Benson**

***Electrostatic gating of MBE-grown NdTiO3 thin films***

Advisor: Dr. Bharat Jalan, University of Minnesota

Area: Materials Science

With the emergence of ionic gel gating in an electric double-layer transistor (EDLT), materials that could not be easily chemically doped, or had significant structural changes upon being doped, can now be examined. (NTO) is a Mott-Hubbard antiferromagnetic insulator, with the insulating state being sensitive to doping and chemical distortions. This experiment explores the use of ionic gel gating in order to investigate the insulator-to-metal transition in NTO thin films using electrostatic doping. Single crystalline, epitaxial NTO films were grown onto an insulating substrate using a hybrid molecular beam epitaxy technique. The device was patterned using two shadow masks, one for etching with ion milling and the other to deposit metal contacts with sputtering. The ion gel, 1-ethyl-3-methylimidazolium-bis (trifluoromethylsulfonyl) imide (EMI-TFSI), was placed on top of the patterned NTO films and electronic measurements were taken in a Physical Property Measurement System (PPMS). The influence of ionic gel on the electronic transport of NTO films was determined by performing measurements before and after the placement of ionic gel. Voltage-dependent leakage current through the ionic gel was established, which allowed for calculation of injected charge. Temperature-dependent resistivity measurements were performed for each gate bias.

**Chandra Bouma**

***Photodegradation of imazethapyr on soy and corn plant surfaces***

Advisor: Dr. Amanda Nienow, Gustavus Adolphus College

Area: Chemistry

The goal of this project was to study the degradation of the imazethapyr herbicide on soy and corn plant surfaces, and compare the rate of photolysis on these surfaces to photolysis of imazethapyr in aqueous solution and on wax models. Imazethapyr was applied to corn and soy leaves in ten 15 μL drops per leaf; the concentration of the solution matched field conditions for the application of imazethapyr. The plants were irradiated in a solar simulator equipped with two 340 nm-UVA lamps over the course of several days, with samples taken at various time points. The remaining imazethapyr was extracted using 5 mL of pH 7 phosphate buffer, and samples were analyzed with HPLC using 80% HPLC-grade acetonitrile/20% pH 3 phosphate buffer solution for the solvent, a Supelco Ascentis C8 column (10 cm x 4.6mm), a 1 mL/min flow rate with a run time of 10 minutes, and detection wavelengths of 254 and 220 nm. Aqueous solutions and wax plate samples were irradiated and analyzed under the same conditions. The rate constants were 0.0019 1/hour for imazethapyr degradation on soy and 0.0013 1/hour for imazethapyr degradation on corn. The aqueous solution rate constant (0.2003) was two orders of magnitude faster than the intact plants, and the soybean wax rate constant (0.0552) was one order of magnitude faster, suggesting these matrices do not provide realistic models of imazethapyr photodegradation in the field.

**Morgan Evenson, Bri Malecha, and Alora Smith**

***SAR study targeting the KIX domain***

Advisor: Dr. Scott Bur, Gustavus Adolphus College

Area: Chemistry

Derivatives of 3,4-dichlorophenylacetic acid and 2-(2-thienyl)-1,3-thiazole-4-carboxylic acid were synthesized and tested for binding activity in an SAR study targeting the protein binding domains of the KIX protein. An expression protocol for the KIX protein was developed wherein fluorinated tyrosine replaces the tyrosine in wild-type protein, and binding was determined using Protein Observed Fluorine NMR where the chemical shift of the tyrosine-631 (Y-631) peak was compared to compounds known to lack binding and others known to bind. No significant binding was observed in (2-bromophenyl)acetic acid (GAALS1), (3-bromophenyl)acetic acid (GAALS2), (4-bromophenyl)acetic acid (GAALS3), nor 2-phenyl-1,3-thiazole-4-carboxylic acid (GABRM1); however, 2-(benzamido)-1,3-thiazole-4-carboxylic acid (GAMLE1) showed significant binding at both the Y-631 site and the Y-650 site. From a binding curve, non-linear regression yielded a binding constant (Kd) of 2.1 +/- 0.5 mM, compared with 5.3 +/- 0.9 mM for 2-(2-thienyl)-1,3-thiazole-4-carboxylic acid.

**Brian Hastings and Halie Ostberg**

***Reproductive senescence has negative effects on early egg development and embryonic viability in* Drosophila**

Advisor: Dr. Margaret Bloch Qazi, Gustavus Adolphus College

Area: Biology

Female fecundity (the number of eggs laid), and fertility (the number of viable offspring) in Drosophila melanogaster decrease with increasing age. To investigate the cause of these declines, developmental progression of eggs and embryos were compared between young and old female flies. The total amount of eggs and ovarioles (tubules that contain the developing eggs) were also compared. We found a significant difference in the number of immature (pre-vitellogenic) eggs between old and young females. On average older females contained 20% fewer immature eggs than young females. Older females also exhibited more variance in the number of mature eggs than young females. There were no significant differences in the number of ovarioles or the total amount of eggs. Post-oviposition, the embryos of young and old females having only one reproductive episode, and old females having multiple reproductive episodes were collected and stained to visualize nuclei. Embryos were then categorized by developmental stage. Old females had 24% more abnormal embryos than young females, with 65% of abnormalities occurring during the preblastodermic phase of development. These findings suggest that a source of the decrease in fecundity is a failure to maintain early (pre-vitellogenic) egg development. The decline in fertility appears to result from abnormal embryonic development during the formation of the blastoderm. During this phase mitotic divisions are primarily under maternal control, meaning mistakes in development may result from the mother's failure to properly provision developing eggs.

**Tara Hoverstad**

***Can children learn like adults? The impact of a memory aid on pattern learning in children***

Advisor: Dr. Patricia Reeder, Gustavus Adolphus College

Area: Psychology

Starting in infancy, children implicitly learn a lot about the world and use this information to make decisions about how to behave. Deciding how to behave can become difficult when faced with inconsistencies in one’s environment. Typically, children use a strategy called *maximizing*. In this strategy, children ignore inconsistencies and form a rule about how to behave. Adults, on the other hand, typically follow a strategy called *probability matching*. In this strategy, learners mirror the regularities and inconsistencies in their environment. Another strategy available would be to form rules based on irrelevant information. We call this strategy *low choice*. Memory constraints are a possible reason why children might form a different strategy from adults. To test this hypothesis, we provided memory aids to children while they were faced with learning in an inconsistent environment. In the current study, children were asked to predict the location of a hidden object. The object’s true location was determined based on a series of probabilities. Despite the memory aid, most of the children used a low choice strategy, or did not display any kind of pattern in their choices. This could be the result of conducting the research in a distracting environment of the children’s museum.

**Nathan Huber**

***Enhanced mobility in an insulator capped 2DEG at SrTiO3 (100) surface***

Advisor: Dr. Ludi Miao, Penn State University

Area: Physics

Two-dimensional electron gases (2DEGs) at oxide surfaces and interfaces have attracted much attention due to their fascinating exotic properties such as superconductivity, large magneto-resistance, and ferromagnetism. (STO) based 2DEGs are a typical example. These include 2DEGs at the interface of /STO heterostructures and on STO surfaces. With their high mobility and high dielectric constant at the ground state, these 2DEGs are promising in developing next generation all-oxide devices including field effect transistors and spintronic devices. In this study we have created 2DEGs at STO (100) surfaces by Ar+ ion irradiation. We found that a capping layer on the 2DEG surfaces significantly decreased surface resistance while no effect was observed for other oxide capping layer tests (MgO, , and STO). Specifically the electron mobility of the capped channel had an eight-fold increase relative to uncapped 2DEG at 1.8 K. The bare channel had a resistance ratio (/) of 85 compared with the capped channel ratio of 625; this indicates significantly better metallic behavior for capped channels. Our results open a path to create 2DEGs with high mobility in an effective and economic way.

**Alec Iverson**

***Emittance measurements of ion source injectors at the NSCL using Allison Emittance Scanners***

Advisor: Dr. Michael Syphers, Michigan State University

Area: Physics

Preliminary diagnostic measurements of ion beam emittance for the electron cyclotron resonance (ECR) ion source injectors, the Superconducting Source for Ions (SuSI) and ARTEMIS, have been carried out at the Michigan State University (MSU) National Superconducting Cyclotron Laboratory (NSCL). The injectors are comprised of the ion source, corresponding beam transport line used to inject various ion species into the K500-K1200 Coupled Cyclotron Facility (CCF), and beam diagnostics for beam tuning and optimization. The main diagnostic tool being used is the Allison Emittance Scanner (AES), a device that scans through the beam to provide high resolution characterization of beam quality before delivering beam to the cyclotron. Furthermore, the resulting 4-dimensional phase space characterization will guide beam and accelerator physicists to further understand and optimize beam properties. These emittance measurements and their implications will be discussed.

**William Jons**

***Analysis of the heterogeneity of Mesp1+ mesoderm by single-cell RNA-seq***

Advisors: Dr. Sunny Chan and Dr. Michael Kyba, University of Minnesota

Areas: Biology, Computer Science

Mesp1 is a transcription factor that patterns mesoderm into multiple lineages (Chan et al., 2013). Previous work showed that Mesp1 promotes both hematopoietic and cardiac differentiation via a common Flk-1+ (aka Kdr) PDGFRa+ population. We reason that there are at least two subpopulations within Mesp1+ mesoderm, with some cells primed for hematopoietic and some cardiac. To probe for this heterogeneity, we performed single-cell RNA-seq to look for novel genes distinguishing between hematopoietic- and cardiac-primed cells. We first grouped individual cells based on expression of Kdr or Pdgfra. Groups were then compared on the expression of other genes using two approaches. One approach compared the mean expression levels of each gene among groups. The other approach involved ranking the cells in each group based on their relative gene expression among all cells. We found a set of genes that may be involved in hematopoietic or cardiac development of Mesp1-induced mesoderm.

**Anna Krieger**

***Iron and cadmium binding in metalloprotein II and myohemerythrin from* Nereis diversicolor**

Advisor: Dr. Brandy Russell, Gustavus Adolphus College

Area: Biochemistry/Molecular Biology, Chemistry

In this work, metal binding in two highly similar metalloproteins is being characterized. Myohemerythrin (myoHr), a non-heme di-iron oxygen transport protein, and metalloprotein II (MPII) are both found in the polychaete annelid *Nereis diversicolor*. Despite a very high sequence identity, myoHr and MPII are bound in vivo to two different metals—iron and cadmium respectively—suggesting different specificities. Unlike many other cadmium-binding proteins, both proteins are low in sulfur content. Characterizing the mechanism of metal-binding specificity in proteins is of particular interest for its applicability in industrial methods, specifically protein catalysis. UV-Vis spectroscopy, ICP-MS, ESI-MS, and native PAGE results suggest that both proteins can bind either iron or cadmium atoms in vitro. Additionally, both proteins bind cadmium preferentially if the metal-free protein is exposed to a mixture of iron and cadmium. Further characterization focuses on the relative binding affinities of both proteins for iron and cadmium, and the cadmium-binding site.

**Anna Krieger and Ian Hill**

***The effect of initial culture addition on the fermentation time of kombucha***

Area: Chemistry

Kombucha is a fermented tea drink that has gained popularity as a probiotic alternative to soda, and has become widely available at grocery stores across the country. The fermentation is performed by a symbiotic culture of yeast and bacteria (SCOBY) that converts the sugars in sweetened tea to acetic acid and carbon dioxide, yielding a sour and fizzy beverage. The current study has looked at how the acidity and time to completion change as a function of initial solid SCOBY culture and initial kombucha liquid added. The pH of the empirically determined point of completion of all studies lies in the range of 2.6 - 2.9, with expected contributions from both acetic acid and carbonic acid in the fermented tea. The time to brew completion has shown a dependence on the initial amount of SCOBY added, but little dependence on the amount of initial kombucha liquid added, however, the relative effect of each of these parameters has not been fully determined.

**Russell Krueger**

***Testing the validity of δD in leaf waxes as a proxy for paleoprecipitation***

Advisor: Dr. Susan Lang, University of South Carolina

Area: Geology

Studies attempting to reconstruct paleoclimates have intensified in an effort to give climate modelers the best available data. The stable isotope ratio of hydrogen (δD) for leaf waxes in the sediment record has been used as a proxy for precipitation, but its use has not been thoroughly investigated. A negative relationship was expected between leaf wax δD and precipitation amount. Leaf waxes were extracted through column chromatography from sediment trap samples collected in Cariaco Basin, Venezuela during the Cariaco Ocean Time Series Program. The δD value was measured for each sample using gas chromatograph isotope ratio mass spectrometry (GC-IRMS). Results indicate that the relationship was verified, but that only changes in precipitation amount could be observed. Different precipitation time intervals were compared against δD to investigate the possibility of a residence time effect – an amount of time the leaf waxes spent on land before their transport to the basin. These comparisons indicated that a three month average for precipitation correlated best to δD (R2 = 0.56).

**Eli Larson**

***Triglyceride hydrogenation in a platinum nanoparticle packed bed reactor in-line with two-dimensional high performance liquid chromatography***

Advisor: Dr. Ian Hill

Areas: Chemistry, Materials Science

Olive oil is one of the most valuable food-grade oils, and also the world’s most adulterated product. No effective or fast way to assess the purity of olive oil currently exists. High performance liquid chromatography can offer powerful lipid separation, and the ability to separate compounds after the initial separation by using a second dimension. The separation ability can be further increased using a platinum nanoparticle packed bed reactor to hydrogenate the lipids between the first and second dimension, which can change polarity of the model triglyceride, triolein. Platinum nanoparticles were synthesized by incipient wetness impregnation followed by the degradation of chloroplatinic acid ligands through high temperature treatment. X-Ray diffraction has shown the average size of our nanoparticles to be 4.5 nm. Catalytic studies to date have shown that our packed bed reactor will preferentially hydrogenate acetonitrile over the model triglyceride. Offline reactions of our sample have indicated that basic conditions and a saturated triglyceride sample provide the best separation.

**Rayna McLouth**

***Oleaginous yeast fermentation: green solvent extraction and metabolite analysis***

Advisor: Dr. Praveen Vadlani, Kansas State University

Areas: Chemistry, Environmental Science

*Trichosporon Oleaginosus* yeast was cultivated for biodiesel fuel production experimentation. The lipid extraction efficiency of various environmentally friendly organic solvent systems were tested on the oleaginous yeast cells and compared to that of the chloroform:methanol control system. Cyclopentyl methyl ether (CPME), 2-methyl-tetrahydrofuran:water (2-MeTHF:H2O), and tert-butyl methyl ether (TBME) were all found to have normalized efficiencies above that of chloroform:methanol. Also, pthalic acid esters were found to be present in the supernatant fermentation broth which was analyzed via GC-MS for metabolites of industrial use.

**Kelly Neubauer and Xiaoqi Yu**

***Using a Michelson interferometer to characterize the hysteresis of a piezoelectric actuator***

Advisor: Dr. Steve Mellema, Gustavus Adolphus College

Area: Physics

The piezoelectric effect describes a linear interaction between the mechanical stress on a material and the voltage added on or produced by the material. Using this property, a piezoelectric actuator can extend linearly as voltage is added, which is ideal to move objects by a small increment. However, because of the configuration of the actuator with a series of parallel wafers connected together, there may be a delay between the change of voltage across the actuator and the displacement of the actuator. Therefore the actuator may not be able to move linearly. Such delay is called a hysteresis effect. In the experiment, we used the interference of a laser beam to measure the displacement of an actuator, and characterized the hysteresis of the piezoelectric actuator.

**Reina Nielsen**

***Lichen coverage and morphology on different aged basaltic lava flows***

Advisor: Dr. Christine Parent, University of Idaho

Area: Biology

Lichens are an important first step of community assembly, as they are able to survive in extreme environments, weather rock into soil allowing for plant establishment, and provide food and shelter for wildlife. The basaltic lava flows that comprise Craters of the Moon National Monument and Preserve (CRMO) in southern ID, USA are considered extreme environments due to high daily and seasonal temperature fluctuations, high winds, and seasonality of precipitation. Lichens have been observed at CRMO on flows ranging from approximately 2,000-12,000 years of age. I hypothesized that due to the different ages of flows at CRMO, a correlation between the percent cover observed with lichen and plants, as well as lichen morphologies, may be present. I used transects of 15m and 30m to calculate percent cover of lichen and plants as well as characterize lichen morphologies. My results indicate that percent cover of lichen was negatively related to flow age (r2 = 0.62, p = 6.27e-05). Additionally, the linear regression model that best explained lichen morphology (as determined by a step wise regression) included percent of plant cover and the sites at which they were found, but did not include flow age. I found that lichen morphologies are negatively correlated to plant cover and can be site specific (r2 = 0.612, p = 0.007051). Lichen is an integral player in community assembly. By understanding how lichen contributes to these early stages of community formation, it can be better understood the timeline and feasibility of community establishment in a given area.

**Zachary Rehnelt**

***Sustained monitoring of a restored tallgrass prairie***

Advisor: Dr. Pamela Kittelson, Gustavus Adolphus College

Area: Biology, Environmental Science

The restored Coneflower Prairie located in St. Peter, Minnesota has served as important educational and ecological site since its creation in 2008. It was designed to support five habitats in order to maximize the number of native species on a 75 acre plot that was previously tiled for agriculture. In 2012 the prairie was censused to determine how many of the 163 planted species established and determine the cover of both native and non-native species. Spraying of pesticides, mowing, hand removal, and burnings have been used to control non-native species and with this recensus the effect of this management can be more accurately determined. More effective management of the five regions can be guided by this survey which had a high presence of invasives and poor native establishment in the wet regions compared to the drier regions despite long term management. In the future management will need to include a replanting of the previously designated wet regions with dry native species as the wet native species have not taken and the region has had more invasives than the other regions. Invasive removal will need to continue to prevent nonnative species from further establishing on the prairie.

**Lindsey Reiners and Tanner Eischen**

***From Mesoproterozoic to Eocene: stromatolite variances through time and space***

Advisor: Dr. Julie Bartley, Gustavus Adolphus College

Area: Geology

Stromatolites are organosedimentary structures formed by the interaction of microbes and sediment, and provide key details in ancient environments. Stromatolite growth patterns are dependent on the environmental conditions in which they grow, producing different structural and textural forms. By observing the particular growth features of a stromatolite, we can better understand ancient ecosystems and their environments. Crucial to this process, though, is an inventory of the types of stromatolite forms and textures, situated within well-understood modern and ancient environments.

In this study, we examine stromatolites from a range of environments and a variety of ages. The Sibley formation (Mesoproterozoic), and the Shakopee formation (Ordovician) have provided us with significant connections between ancient microbialite environments. In the summer of 2015, samples from The Green River formation (Eocene) were collected, and will hopefully provide a link between ancient and modern microbialites.

**Ray Sajulga**

***Simulation of sample matrix effects in liquid chromatography with large injection volumes***

Advisor: Dr. Dwight Stoll, Gustavus Adolphus College

Area: Chemistry, Computer Science

A variety of approaches have been described in the chromatographic literature to simulate the movement of analyte bands in chromatographic columns. These approaches were adopted and manipulated computationally to accurately predict the behavior of low molecular weight molecules (100 – 300 Daltons) analyzed in small sample volumes. When larger injection volumes are used, the correct behavior is still predicted qualitatively, but with less quantitative accuracy. In this presentation we describe how we have augmented existing models to account for non-idealities encountered in real chromatographic experiments to improve the accuracy of the model. By sharing this development with the chromatographic community through user-friendly platforms (i.e. a website, java program, and program code publication), further understandings of chromatographic behavior will result. Predicting chromatographic results can increase the efficiency of experimental design, and decrease resource usage by knowing what to expect.

**Matt Sorenson**

***The preservation of DNA using magnetic ionic liquids***

Advisor: Dr. Jared Anderson, University of Toledo

Area: Biochemistry/Molecular Biology, Chemistry

Deoxyribonucleic acid (DNA) is an extensively studied biomolecule that contains unique genetic information for every living organism. Due to its importance in research across the scientific community, DNA samples must be handled with care and stored under conditions that minimize degradation or mutation. Although low temperature and low moisture conditions are commonly utilized for the long-term storage of DNA, contamination of samples with endonucleases poses a threat to the stability of the nucleic acid. In this study, magnetic ionic liquids (MILs) were employed as novel solvents for the storage and preservation of DNA. Two hydrophobic MILs, namely trihexyl(tetradecyl)phosphonium tetrachloroferrate(III) () and benzyltrioctylammonium bromotrichloroferrate(III) (), were used as solvents for DNA storage. Both MILs successfully preserved genomic and plasmid DNA (pDNA) for up to 1 week at room temperature, as determined by agarose gel electrophoresis and polymerase chain reaction (PCR). Furthermore, the and the MILs were investigated for their ability to protect DNA from enzymatic cleavage by deoxyribonuclease I (DNase I). No degradation of genomic DNA or pDNA was observed for up to 1 week upon spiking DNA-enriched MIL with 20 units of DNase 1, demonstrating a convenient and effective method for storing DNA in the presence of an endonuclease. The MIL preservation medium eliminates the need for refrigeration of DNA samples, providing an economical advantage over conventional storage methods. In the future, MILs may also be used as DNA extraction solvents to diminish the risk of sample contamination during sample transfer.

**Emily Syverud**

***Improving MRI scans of perfusion fixed en bloc heart-lung specimens***

Advisor: Dr. Paul Iaizzo, University of Minnesota

Area: Biology

MRI scans of perfusion fixed en bloc heart-lung specimens have historically been accompanied by a multitude of complications. Air that remains in the lungs can create artifacts in the scans that disrupt clarity. The air can also cause the lungs to float out of their attitudinally correct position and distort the atria while the Phytoblend© gel is solidifying. Multiple prototypes were tested to hold the lungs in place and to ensure the gel completely filled the heart. In the first round of prototypes, which involved constraining the lungs with rubber tubing, the lungs were still displaced. Some artifacts and disruption were visible, possibly due to a chemical shift or the consistency of the gel. The second round of prototypes were rendered obsolete due to an error in the scanning process. The third and final prototypes were successful and resulted in clear, usable images. 3D models were created from the MRI scans using MIMICS software to validate prototype success. Future prototypes will be assessed in an attempt to limit displacement.

**Rochelle Widmer**

***Computer graphics for connecting facial motion to emotional intent***

Advisor: Dr. Stephen Guy, University of Minnesota

Area: Computer Science

Despite advances in computer graphics, generating realistic, expressive, real-time facial animations remains a challenging problem. This is partly because there is little work analyzing how dynamic elements of facial motion connect to emotional intent. Here, we present a new approach for the creation and analysis of synthetic facial expressions directed at understanding the emotional content of various expressions. We discuss how the results can help improve techniques for improving children's emotional processing, and assisting in developing new facial reconstruction techniques that maximize functional expressiveness post surgery.