

Clinical Application of Liquid Biopsy and Mate Pair Next Generation Sequencing for Oropharyngeal Cancer Patients

Sarah Clark

Biochemistry, Biology, Chemistry

- Background: Circulating tumor DNA (ctDNA) can be distinguished from other cell-free DNA in the body due to its unique mutations. Next generation sequencing and digital PCR have allowed detection of ctDNA to become a more commonly used tool, and because it can be detected directly out of blood, is called the liquid biopsy. Liquid biopsy has the ability to monitor cancer in real time. Mate pair sequencing minimizes the amount of sequencing needed to find the unique cancer-specific DNA breakpoints necessary for liquid biopsy. This research aims to investigate the clinical use of mate pair next generation sequencing and liquid biopsy in oropharyngeal squamous cell carcinomas (OPSCCs). Methods: Mate pair next generation sequencing (10 gigabases per sample) was used to find unique tumor DNA breakpoints. Sanger sequencing was then used to validate these junctions. This was followed by RT-PCR to test the primers and fluorescent probes before running the samples on the RainDance digital droplet PCR platform. Results: Using sanger sequencing, we were able to validate 16 out of 18 of the junctions detected by mate pair next generation sequencing. We are now testing these validated primers to detect ctDNA corresponding to these tumors. Future: Liquid biopsy has the potential to greatly impact the clinical treatment of OPSCC. The use of mate pair sequencing, rather than traditional whole genome sequencing, could accelerate the acceptance of liquid biopsy into clinical practice.

Using Advanced Oxidation Methods for the Degradation of Bisphenol A

Cristian Zamora

Chemistry

- Bisphenol A (BPA) is a substance used in the plastics industry for the production of fire retardant plastics, epoxy resin and polycarbonate plastics. This endocrine disrupting chemical (EDC) arrives from effluent wastewater and contaminates aquatic environments. This report reviews two distinct methods of advanced oxidation for the degradation of BPA, and concludes with a look at a synthesis of both methods. UV/O₃ is the first technique examined since it has an achieved degradation of 70-100% (Umar et al., 2013). Secondly, degradation using UV/H₂O₂ is examined because of its achieved degradation of approximately 85% (Sharma et al., 2015). Finally, a look at the synthesis of UV/O₃ and H₂O₂ shows that the combination of both degradation methods does not produce higher yields of degradation (Felis et al., 2011). This research is novel since it is a comparison between highly productive methods of degradation. Currently, the research still needs a closer examination of causes of low degradation yield when both degradation methods are synthesized. This research is applicable to for the removal of BPA in effluent waters in an effort to reduce the amount of BPA and EDC exposure in aquatic environments. Sharma, J., Mishra, I., & Kumar, V. (2015). Degradation and mineralization of Bisphenol A (BPA) in aqueous solution using advanced oxidation processes: UV/H₂O₂ and UV/S₂O₈(²⁻) oxidation systems. *Journal of Environmental Management*, 156, 266-275. doi:10.1016/j.jenvman.2015.03.048 Umar, M., Roddick, F., Fan, L., & Aziz, H. A. (2013). Application of ozone for the removal of bisphenol A from water and wastewater - A review. *Chemosphere*, 90(8), 2197-2207. doi:10.1016/j.chemosphere.2012.09.090 Felis, E., Ledakowicz, S., & Miller, J. (2011).

Degradation of Bisphenol A Using UV and UV/H₂O₂ Processes. *Water Environment Research*, 83(12). doi:10.2175/106143011x12989211841214

Identifying the Spermatogonial Stem Cell using Oct4 as a lineage marker

Samuel Hassel

Biochemistry, Biology, Chemistry, Integrative Health Sciences

- The goal of the research was to identify the Spermatogonial Stem Cell in mouse testes using Oct4 as a marker. Transgenic mice containing the genes coding for the Tamoxifen-Inducible Cre recombinase MerCreMer in the 3' UTR of Oct4 and the double fluorescent marker gene mT/mG in the ROSA26 locus were injected with Tamoxifen for three days before their testes were harvested on the fourth day. When viewed under a microscope, the unrecombined cells appeared red under the red fluorescent light, but do not give any noticeable signal under green fluorescent light while recombined cells will give a signal under the green fluorescent protein light. The testes were then frozen into blocks of Optimal Cutting Temperature gel (OCT), and later cut into 10 micrometer sections using the cryostat before being stained with 4',6-diamidino-2-phenylindole (DAPI), a DNA-targeting fluorescent stain used to find nuclei, and dry mounted. This experiment was novel because Oct4 is still a relatively newly discovered marker for stem cells, so using it to identify characteristics of cells is a relatively unexplored process. While the steps required to analyze the cells have been completed, no definitive results have been produced as a result of this experiment, likely as a result of an issue with the tissue samples. As a result of being frozen for a considerable amount of time, the small amounts of water present in the tissues caused many of the cells to lyse before they were viewed, decreasing the number of viable cells per section. The broader impact of this experiment is showing that Oct4 is an acceptable marker of stem cells, and that characteristics unique to stem cells can be better studied using Oct4 to identify them in vitro.

Insertion Reactions of a Ruthenium Hydride Complex

Joseph Koll

Chemistry

- Reduced metal complexes having hydride ligands are commonly observed in a number of catalytic processes. In this project, a multi-step synthesis was followed from the literature to produce a ruthenium dihydride complex, (PMe₃)₄RuH₂. The ultimate goal of this research is to determine how benzyne compounds with different substituents react with the ruthenium dihydride complex. Specifically, the intent is to probe how the electronic properties of the substituent affect the selectivity of benzyne insertion into the Ru-H bond. Bromobenzene compounds are first treated with dimethylzinc at low temperature to generate highly reactive benzyne intermediates. Benzynes often undergo random, non-selective reactions. In this case, however, the attached groups on the bromobenzenes (such as fluoro, nitro, acetyl, etc) may help to guide the reactivity of the benzynes with the ruthenium dihydride complex. The result of this experiment will provide insight into the behavior of highly reactive hydrocarbons and other organic species on reduced metal surfaces.

Using Advanced Oxidation Methods for the Degradation of Bisphenol A

Cristian Zamora

Chemistry

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Denaturation of DNA-labeled Molecular Beacons with Fluorophores and Quenchers

Wendy Osei-Bonsu

Biochemistry, Biology, Chemistry, Integrative Health Sciences

- The focus of my research is the denaturation of double-stranded DNA (dsDNA) using fluorescence spectroscopy. The dsDNA, which contains 12 base pairs, has one 5' strand labeled with fluorescein (FAM) – 5'-/56-FAM/TCC ACC TTC CCT-3' – and a complementary 3' strand labeled with Black Hole Quencher I (BHQ I) – 5'-AGG GAA GGT GGA/BHQ1-3'. The dsDNA, if annealed correctly, should emit little fluorescence given the proximity of the quencher to the fluorophore. As the DNA denatures on the addition of urea, a fluorescence emission is recorded. We are attempting to determine the thermodynamic stability of the 12mer and possible derivatives. We used fluorescence spectroscopy to analyze the conditions necessary to denature a 12-mer of DNA as a function of [urea]. These data were then used to calculate the K_{eq} and the ΔG^0 for the denaturation of the 12mer. This research could be applied to DNA of differing base pairs, lengths, backbone strength and composition and solvent composition.

A Reductive Amination Approach Involving Chiral Amino Acids to Selectively Set a New Chiral

Niesha Ford

Biochemistry, Undergraduate Research

- A Reductive Amination Approach Involving Chiral Amino Acids to Selectively Set a New Chiral

Effect of polyethylene glycol-coated magnetic nanoparticles on the catalytic activity of myoglobin

Alexander Charbonneau

Chemistry

- Abstract Iron oxide nanoparticles have attracted a great deal of scientific and technological interest due to their unique structural and chemical optical properties. As a result, MNPs are used in an array of clinical applications such as cancer therapy, gene delivery, and as contrast agents for magnetic resonance imaging (MRI). The catalytic activities of myoglobin (Mb) in presence and absence of magnetic nanoparticles were studied in terms of oxidation of o-phenylenediamine (OPD) by hydrogen peroxide (H₂O₂). The oxidation catalyzed by both myoglobin and myoglobin-MNPs followed the Michaelis-Menten kinetics. The presence of magnetic nanoparticles significantly affected the kinetic parameters, k_{cat} and K_M of myoglobin. Both the k_{cat} and K_M of myoglobin decreased with increasing MNPs concentrations.

Identification of new inhibitors for low molecular weight protein tyrosine phosphatase isoform A

Maxwell Olson

Biochemistry, Chemistry

- Low molecular weight protein tyrosine phosphatase (LMW-PTP), an 18 kDa acid phosphatase with two unique isoforms (IFA and IFB), is ubiquitous and active in the regulation of many important cell proliferation pathways including JAK-STAT, PDGF, and EPHA2. IFA overexpression is observed in early cancer cell proliferation, and reduced expression of IFA in later stages of cancer has been found to contribute to cell migration through the RhoA pathway. Novel inhibitors of LMW-PTP could prove to have therapeutic value by controlling dysregulation of this key enzyme. Inhibition of LMW-PTP IFB is more widely studied, but the development of IFA-specific inhibitors has largely been ignored. The National Cancer Institute Diversity Set III was screened for compounds with similar docking scores to pyridoxal-5'-phosphate (PLP), a known inhibitor of LMW PTP with a competitive inhibitor dissociation constant K_i of 7.6 μM. NCI compounds with comparable or higher docking scores were tested via bioassays on IFA, after which inhibition constants were determined via IgorPro software. Four of these compounds demonstrated significant inhibition (K_i < 75 μM) for IFA, representing new possible therapeutic leads for LMW-PTP IFA dysregulation.

Deliquescence Relative Humidity of Inorganic and Organic Aerosols Determined by Quartz Crystal Microbalance

Alvin Burrows

Chemistry

- The goal of this study was to measure the hygroscopic properties of secondary organic aerosols (SOA) by determining the deliquescence relative humidity (DRH) and efflorescence relative humidity (ERH) via quartz crystal microbalance. This hygroscopic data was collected for common atmospheric salts such as ammonium sulphate ((NH₄)₂SO₄), ammonium nitrate (NH₄NO₃), potassium chloride (KCl), magnesium sulphate (MgSO₄) and several others so that a proper record of these points could be kept for comparison when these compounds would later be mixed with precursors to SOAs, such as glyoxal, methylglyoxal, citric acid, succinic acid and glyoxylic acid. This study focuses on glyoxal and methylglyoxal due to their abundance in the atmosphere. Model studies suggest that up to a third of global SOA production can be attributed to α -dicarbonyl compounds if the uptake of these compounds by clouds is irreversible¹. The role that organics and SOA's play as cloud condensation nuclei (CCN) is still unclear due to lack of research, which makes measuring their hygroscopic properties even more important². It has been suggested that organic matter can influence CCN by depressing surface tension, contributing solute and influencing droplet activation kinetics by forming a barrier to water uptake³. By documenting how organics affect deliquescence and efflorescence properties chemists can better characterise these compounds as well as make their role in the atmosphere less ambiguous.

Self-assembled monolayers (SAMs) of partially fluorinated arylthiols for potential application as organic vapor sensors

Faith Kersey-Bronec

Chemistry, FoCuS, Undergraduate Research

- This research seeks to develop a process to form ordered organic thin films, self-assembled monolayers (SAMs), on gold using fluorinated arylthiols (FATs). These FATs will then be defluorinated using an environmentally friendly rhodium-catalyzed reaction. SAMs of fluorinated arylthiols will be analyzed using scanning tunneling microscopy (STM) (1). The parameters for the defluorination reactions will be determined initially using GC-MS (2). The defluorination reaction with rhodium catalyst will then be applied to the fluorinated arylthiol SAMs and the resulting surfaces will be analyzed using STM and IR. The use of SAM surfaces to monitor rhodium catalyzed defluorination reactions is an alternative approach that could provide molecular-scale information about the reaction. GC-MS of the defluorination reactions with 4-fluorothiophenol and STM images of the SAM surfaces will be presented. The results of these experiments would have useful applications in the sensing of organic vapors (3). 1. Q. Jin, J. A. R., C. Z. Li, Y. Darici, N. J. Tao, Self-assembly of aromatic thiols on Au(III). *Surface Sciences* 1999, 425, 101-111. 2. Baumgartner, R.; Stieger, G. K.; McNeill, K., Complete Hydrodehalogenation of Polyfluorinated and Other Polyhalogenated Benzenes under Mild Catalytic Conditions. *Environmental Science & Technology* 2013, 47, 6545-6553. 3. Im, J.; Chandekar, A.; Whitten, J. E., Anomalous Vapor Sensor Response of a Fluorinated Alkylthiol-Protected Gold Nanoparticle Film. *Langmuir* 2009, 25, 4288-4292.

Kinetic Studies of the Photolysis of Dicarboxyls

Maeve Ryan

Chemistry

- Glyoxal and methylglyoxal are two common dicarboxyls found in the earth's atmosphere, originating from the oxidation of both biogenic and anthropogenic sources such as isoprene and 2-butanone. They partition into aqueous aerosols, where they can react with other molecules in the aqueous phase and undergo photolytic reactions. These reactions are thought to play a role in the formation of secondary organic aerosols (SOAs), which contribute to the overall amount of aerosols in earth's atmosphere. These aerosols affect air quality, cloud formation, and global temperature, as they reflect or absorb light, depending on their composition. This research focuses on kinetic studies of the degradation of glyoxal and methylglyoxal in solution with hydrogen peroxide when exposed to light, as well as the identification of products formed during such reactions. Preliminary data from GC/FID showed evidence of a zero order reaction ($k = 3 \times 10^{-7} \text{ M s}^{-1}$) for glyoxal, and a first order reaction ($k = 2 \times 10^{-4} \text{ s}^{-1}$) for methylglyoxal. Based on GC/MS results, methylglyoxal (5 mM starting product) produced acetic acid at a rate $5.5 \times 10^{-8} \text{ M s}^{-1}$. Future research to identify more products of the photolysis of these compounds, including potential oligomers, would provide more insight into the formation and composition of SOAs.

Effectiveness of ozone in wastewater sanitation in systems with high biological loads

Jennifer Paul

Biochemistry, Chemistry, FoCuS, Undergraduate Research

- The purpose of this experiment is to determine the effectiveness of ozone sterilization of water with high biological loads, such as zoo exhibits. Escherichia coli (E. coli) bacteria was diluted in PBS to multiple concentrations and then exposed to ozone for varying lengths of time. The resulting bacterial growth was graphed to create standard curves. These curves were then utilized to determine the optimal exposure time for zoo exhibit water samples. While ozone has been used in industry in wastewater treatment, this study is exploring the necessary exposure time for water with high biological loads. Ozonated systems are ideal for aquariums or systems containing sensitive animals, yet life support systems must be able to expose the water to sufficient amounts of ozone over an appropriate length of time in order for the process to be valuable. Comparing my research data with data from the Minnesota Zoo could support the large-scale application of this process.

Adderall, methamphetamine and dopamine transporters

Alexandra Madsen

Biochemistry, Chemistry, FoCuS

- Adderall (amphetamine salts) is a widely-used drug among adults and children and in recent years, it has become very popular among students, who use Adderall as a form of "smart drug" for studying for exams. While Adderall is used to treat patients with Attention Deficit Hyperactivity Disorder (ADHD) and narcolepsy, some take it illicitly. Adderall has multiple functions in the body including acting as a selective agonist that increases the activation of dopamine receptors and N-methyl-D-aspartate receptors and acting as a dopamine transporter inhibitor. The focus of this research is on Adderall acting as an inhibitor to the dopamine transporter specifically in Drosophila. Adderall acts as an inhibitor to the dopamine reuptake

transporter forcing dopamine to stay in the synaptic terminal for a longer period. The interaction of D-amphetamine (a component of Adderall) and methamphetamine with the dopamine transporter in *Drosophila melanogaster* will be explored. Both D-amphetamine and methamphetamine are structurally similar and both can inhibit the reuptake of dopamine. To understand the importance of the structural differences, Autodock Vina will be used to characterize the necessary intermolecular forces needed for binding the two ligands with the dopamine transporter.

Rose Bengal, a Metal-free Visible Light Photocatalysis

Gao Yang

Chemistry

- Visible-light photoredox has emerged as an important tool in recent years and is a target in generating cycloaddition. Over the year, metal complexes have been the focus in visible light catalysis. However, a greener chemical approach would be more desirable. Rose Bengal, an organic dye, is suitable as a replacement of metal complexes because it is environmentally friendly, inexpensive, abundant, easy to handle, and reusable. In the context of this paper, the effect of Rose Bengal as a catalysis on the development of cycloadditions, such as [2+2] and [2+3] cycloadditions, were explored and discussed. Rose Bengal combined with light resulted in high yield of over 80% in products. This work demonstrates the benefits of Rose Bengal in visible light catalysis, and as a potential replacement in metal complexes in reactions such as pericyclic, diels-alders, and other types of cycloaddition.

Fingerprint Analysis and Gender

Paige Maki

Chemistry

- Fingerprint analysis has been used widely in the forensics field as an identification method. This paper looks at different techniques, such as matrix-assisted laser desorption ionization (MALDI), Liquid Chromatography-mass spectrometry (LC-MS) and desorption electrospray ionization (DESI), used in the analysis of fingerprints, as well as determination of gender from fingerprints. After many years of progress, it has been discovered that different amino acids can be extracted from latent fingerprints. The gender of the person can be detected by looking at the biochemical material of the fingerprint. This is important for forensic scientists and fingerprint analysts, for it helps to narrow the suspect pool and help to deduce whom the perpetrator is. It also serves as a tool that can be used in testing for further substances found in the latent print, while also exposing any present or recent drug used by the perpetrator.

Ligand Effects on Iron Sandwich Complexes Studied by Cyclic Voltammetry

Alex Miller

Chemistry

- Over the past six decades, great progress has been made in the understanding of metal sandwich complexes, specifically in iron sandwich complexes. Metal sandwich complexes have been found to be very useful in polymerization catalysis and promoting C-H bond cleavage. We report the synthesis of a variety of iron sandwich complexes with varying substitutions on the aromatic rings connected to the iron metal center. Our synthesis consists of taking ferrocene (Cp-2Fe) and another aromatic ring for replacement, which replaces a

cyclopentadienyl ring on the ferrocene. These key metal complexes were used for study by cyclic voltammetry (CV) in order to determine the difference in the electrochemical properties of the iron complexes. The goal of our research is to prepare a series of the iron sandwich complexes for use in integrated lab (Chemistry 305). We have successfully established that a previously reported method that can be completed in the lab periods allotted.

Ambient Sampling and Qualification of PM10 Aerosols at St. John's University

Nicholas Harbeck

Chemistry

- Primary and Secondary aerosols include a wide range of particles present in the atmosphere. Studying atmospheric composition is an important step in identifying public health hazards and maintaining acceptable air quality levels.¹ Particles under 10 microns in diameter are of particular interest due to the lack of research performed on these molecules, especially compared to PM2.5 particles.² The purpose of sampling the air at St. John's University is to analyze the concentration and composition of PM10 Aerosols at various locations around the campus. This analysis allows for data comparison to national trends, as reported by the EPA. Additionally, this analysis fills an existing gap in tropospheric models of aerosol composition and concentration.³ GC/MS separation and identification techniques can determine the composition of PM10 samples and can elucidate atmospheric tracers that may exist in various locations around St. John's University.⁴ The college is unique in its geographic location due to the large amount of wilderness that surrounds the college. Sampling primarily occurs near Interstate 94 and the Sugar Shack to discover sources of pollution that may exist. 1. Adamson, I. Y. R., Prieditis, H., and Vincent, R. "Toxicology and Applied Pharmacology." 1999. Pulmonary toxicity of an atmospheric particulate sample is due to the soluble fraction. *Toxicol. Appl. Pharmacol.* 157, 43–50. 2. Riffault, Véronique, Arndt, Jovanna, Marris, Hélène, Mbengue, Saliou, Setyan, Ari, Alleman, Laurent Y., Deboudt, Karine, Flament, Pascal, Augustin, Patrick, Delbarre, Hervé & Wenger, John. "Critical Reviews in Environmental Science and Technology." 2015. Fine and Ultrafine Particles in the Vicinity of Industrial Activities: A Review. *Critical Reviews in Environmental Science and Technology*, 45:21, 2305-2356. 3. Heald, Colette L., Daniel J. Jacob, Rokjin J. Park, Lynn M. Russell, Barry J. Huebert, John H. Seinfeld, Hong Liao, and Rodney J. Weber. 2005. A large organic aerosol source in the free troposphere missing from current models. *Geophysical Research Letters* 32: L18809. 4. Marchese, A. J., Vaughn, L., Zimmerle, D., Martinez, D., Williams, L., Robinson, A. L., Mitchell, A. L., Subramanian, R., Tkacik, D. S., Roscioli, J. R., and Herndon, S.C. "Environmental Science & Technology." 2015. Methane Emissions from United States Natural Gas Gathering and Processing. *Environ. Sci. Technol.* 49, 10718–10727.

Quantifying Interactions of Myoglobin and Pegulated Iron nano particles

Alexander Vanyo

Chemistry

- The interactions of polyethylene glycol-coated (PEG) iron oxide magnetic nanoparticles (MNP) and myoglobin (mb) from equine skeletal muscle were explored using various spectroscopic techniques. UV-Vis spectrophotometry indicated strong binding between myoglobin and the iron oxide MNPs. Fluorescence quenching experiments were used to determine the binding constants (K_a), enthalpy changes (ΔH^θ), entropy changes (ΔS^θ), and free energy changes (ΔG^θ). The binding constants (K_a) were determined as $8.32 \pm 0.26 \times 10^6 \text{ M}^{-1}$, $7.42 \pm 0.67 \times 10^6 \text{ M}^{-1}$, $4.83 \pm 0.18 \times 10^6 \text{ M}^{-1}$ at 298, 303, and 308K, respectively. The enthalpy changes (ΔH^θ), entropy changes (ΔS^θ), and free energy changes (ΔG^θ) were determined to be -17.19 kJ/mol, 74.76 J/mol*K, and -39.47 kJ/mol, respectively. Circular Dichroism (CD) showed decreased α -helix content of myoglobin in the presence of the iron oxide MNPs. The effect of the iron oxide MNPs on the stability of myoglobin was studied using urea and GdnHCl.

Mixed Self-Assembled Monolayers Formed Through The Coadsorption Of Decylthiocyanate And Octanethiol On Gold Surfaces

Rejene Giinther

Chemistry, FoCuS, Undergraduate Research

- The study of ordered molecular assemblies on inorganic surfaces has been a popular area of research recently because of the applications in biotechnology and sensors. Alkanethiols on the gold surface are the most common approach for making organic films (self-assembled monolayers, SAMs). To have more control over the structure and properties of the surface, more than one type of molecule can be adsorbed on the surface, making a multicomponent SAM. Typically, this is done through coadsorption, which means that the gold surface is subjected to the different molecules at the same time. Alkyl thiocyanates (R-SCN) interact with the gold surface differently than alkanethiols and provide another way of tuning surface properties. Here we use decyl thiocyanate and octanethiol and modify coadsorption deposition parameters such as temperature, exposure time, and concentration to better understand how thiocyanates attach to the surface in comparison to thiols. Scanning tunneling microscopy (STM) is used to characterize the surface at a molecular level to assess the spatial distribution of the molecules on the surface. As the solution concentration of the decyl thiocyanate increases, relative to the octanethiol, there is an increase in its presence on the surface. As the overall concentration decreases, the resulting surface shows more rearrangement of the octanethiol SAM. This research helps expand the methods of forming multicomponent SAMs to help fine-tune the properties of the surface.

Investigation and synthesis of novel aromatic azo inhibitors of Low Molecular Weight-Protein Tyrosine Phosphatase Isoform B

Raymond Twumasi

Biochemistry, Chemistry

- The goal of this investigation is to synthesize novel aromatic azo inhibitors based on a developed combinational library of aromatic azo inhibitors to LMW-PTP, a group of proteins that have not had much coverage in its scientific development. These inhibitors, determined via in silico screening, would then be tested on their levels of inhibition in vitro. The synthesis of the inhibitor of interest was achieved via Sandmeyer reactions, utilizing p-aminobenzoic acid. A major compound used to initiate the synthesis, 2-hydroxy-3-naphthoic acid, was linked with p-aminobenzoic acid, and the final product was purified via recrystallization. Characterization techniques included ¹H-NMR, ¹³C-NMR, COSY, and HMQC. Currently, the novel inhibitor has been successfully synthesized and in vitro testing is soon to follow. This newly synthesized product was an analogue to a previously synthesized competitive inhibitor, 156563, which had an inhibitor dissociation constant of 33.5 μM. By synthesizing an analogue to inhibitor 156563, our group hopes to explore and advance properties of the inhibitor such as binding affinity and interactions as well as an improved inhibitor dissociation constant. This project is necessary because the over expression of LMW-PTP Isoform B has been associated with the development of cancer and diabetes. Therefore, the importance of identifying potent inhibitors of LMW-PTP cannot be understated, as they may one day serve as effective treatments to these diseases. It is our hope to continue to synthesize more inhibitors to optimize inhibition activity.

Regional Ambient Sampling of Organic Aerosols

Meredith Liu

Chemistry

- The purpose of this research was to conduct a literature study concerning regional ambient sampling of secondary aerosols. Ambient sampling of secondary organic aerosols (SOAs) within the United States indicate regional differences in particle size and contributing pollutants. SOAs exhibit size-dependent hygroscopicity or the capacity to interact with the moisture content of the atmosphere.¹ Urban, residential, and rural areas in the Midwest also exhibit varying particle size distribution based on the sources contributing to the SOAs in the area.² SOAs were also shown to be the single largest component of PM₁ aerosol in Riverside, California.³ Herein I present a literature review of ambient sampling techniques for varying particle sizes within different regions around the U.S.³ This research study is important to the understanding of atmospheric issues facing different areas of the United States based on the pollutants contributing to particle size and the sources from which the pollution originates. In the future, the scope of this overview could be expanded to a global model in order to understand the environmental implications facing our world in relation to organic aerosols. References 1. Laskina, O.; Morris, H. S.; Grandquist, J. R.; Qin, Z.; Stone, E. A.; Tivanski, A. V.; Grassian, V. H. Size Matters in the Water Uptake and Hygroscopic Growth of Atmospherically Relevant Multicomponent Aerosol Particles. *J. Phys. Chem.* 2015, 119, 4489-4497. 2. Jayarathne, T.; Rathnayake, C. M.; Stone, E. A. Local source impacts on primary and secondary aerosols in the Midwestern United States. *Atmospheric Environment.* 2016, 130, 74-83. 3. Docherty, K. S.; Stone, E. A.; Ulbrich, I. M.; DeCarlo, P.

F.; Snyder, D. C.; Schauer, J. J.; Peltier, R. E.; Weber, R. J.; Murphy, S. M.; Seinfeld, J. H.; Grover, B. D.; Eatough, D. J.; Jimenez, J. L. Apportionment of Primary and Secondary Organic Aerosols in Southern California during the 2005 Study of Organic Aerosols in Riverside (SOAR-1). *Environ. Sci. Technol.* 2008, 42, 7655-7662.

The effects of rifampin on treating co-infected patients with the Human Immunodeficiency Virus and Tuberculosis.

Thomas Nilles-Melchert

Biochemistry, Chemistry

- Tuberculosis is one of the leading causes of death worldwide and is the leading cause of death for individuals infected with HIV/AIDS.¹ While there are effective treatment regimens for both of these diseases, the coinfection poses problems to the treatment of these diseases. This is due to the inductive effects of rifampin, an antibiotic used to treat Tuberculosis, on xenobiotic metabolism. Rifampin increases metabolism by binding human pregnane X receptors and inducing transcription of phase I, II, and III enzymes of xenobiotic metabolism.² This induction increases the metabolism of non-nucleotide reverse transcriptase inhibitors, protease inhibitors, and integrase inhibitors classes of antiretroviral therapy (ART). To effectively treat the coinfection, one of these three classes of ART must be use as well as rifampin.³ Other treatment options are available and are known salvage treatments. Salvage treatments have higher mortality, lead to drug resistance in HIV and/or TB, and have more adverse side effects than the first line of treatment.⁴ Understanding the mechanism of metabolism of treatment options and their effects on metabolism, treatment regimens can be created to overcome the effects of rifampin. New antiretroviral drugs are currently being created to avoid the effects of rifampin altogether. ³

Sequential adsorption of decyl thiocyanate on an octanethiol bound gold surface

Daniel Zoltek

Chemistry, Undergraduate Research

- This research focuses on the use of decyl thiocyanate (DTCN) as a self-assembling component in conjunction with octanethiol on the gold surface. Self-assembling monolayers (SAMs) on gold surfaces are a straightforward and versatile method for modifying the physical properties of a surface. Alkyl thiocyanates (R-SCN) have been shown to form alkanethiolate monolayers on the gold surface through a surface-mediated process that breaks the S-CN bond. DTCN has been shown to form ordered monolayers through vapor deposition, however images of ordering through sequential adsorption have not been produced. In these studies, an octanethiol monolayer was exposed to decyl thiocyanate in solution; temperature and concentration were varied to better understand the dependence on these deposition parameters. Scanning tunneling microscopy (STM) imaging is capable of imaging functionalized surfaces with molecular-scale resolution. Here, STM is used to characterize the spatial distribution of the decyl thiocyanate adsorption on the pre-formed octanethiol surface. DTCN was found to adsorb within octanethiol domain boundaries and other defects. Continued exposure to DTCN results in further disordering of the octanethiol domain boundaries, however DTCN cluster size appeared to decrease in surface coverage in the samples exposed for a longer period of time. This research provides alternate methods for functionalizing gold surfaces with additional control of the physical properties.

The Dimerization of Gold Nanoparticles

Stephanie Jean

Chemistry, FoCuS, Undergraduate Research

- The goal of this project is to dimerize gold nanoparticles using dithiol linkers. These gold dimers act as the base for a platform to be used for studying plasmon-based reactions. A better understanding of the plasmon-based mechanisms will improve the efficiency, cost, and selectivity of these reactions. Once the nanoparticles were synthesised, initial attempts at dimerization involved the addition of a dithiol to the nanoparticle solution. Changes in the properties of the nanoparticles demonstrated that size and concentration play a major role in the control of the dimerization process. The particles aggregated quickly, so a quenching reaction was developed via disulphide oxidation reaction between the dithiol and a monothiol. The quenching reaction allows for better aggregation control, so that the reaction could be stopped at dimer aggregates as opposed to large particle clusters.

On trends in ozone in Sequoia National Park 2000–2015: upwind chemistry and local impacts

Claire Buysse

Chemistry

- Sequoia National Park (SNP) has the worst ozone air pollution of any national park in the United States. Ozone pollution levels in SNP are high enough to exert damaging impacts on humans, animals, and vegetation. The major source of ozone to SNP is chemical production within the nearby and ozone-polluted San Joaquin Valley (SJV), which is then transported out of the valley into the park. Emission controls to reduce ozone in the SJV have been in place for the last two decades and these controls should have had the effect of altering ozone levels within SNP. This work has two aims. First, we investigate the chemistry driving trends in ozone in SNP and link these changes to trends in ozone in the SJV. Second, we consider both the metrics and time frames that best capture ozone trends contributing to vegetative damage, as these are not well represented in assessments of human health-based ambient air quality standards over an entire ozone season.

DNA Repair Enzymes in Archaea

Alyson Welle

Biochemistry, Biology

- The goal of this research was to study the enzymes in Archaea that are believed to participate in DNA repair to see if they complement the DNA repair enzymes found in eukaryotes. This was done by inserting the archaea gene into a plasmid and then using that plasmid to insert the archaea gene into yeast cells which have specific DNA repair enzymes removed. The yeast was then exposed to a DNA damaging agent and allowed to grow. If the archaea gene is complementary to the removed yeast gene, the cell survival will be large. If the gene is not a complement to the removed one, cell survival will be low. The archaeal genes studied were, BAX-1, HEF-1, and FEN-1. The yeast used had either the RAD-1 or RAD-2 gene removed.

HIBERNATOR AND NON-HIBERNATOR RESPONSES TO ACUTE CHANGES IN WATER INTAKE

Sydni Andruskiewicz

Biochemistry, Biology, Integrative Health Sciences, NATS, Undergraduate Research

- Hibernating animals undergo dramatic changes in metabolic rates during torpor. One of most notable changes in these animals is the ability to maintain blood pressure and perfuse certain organs. Consequentially, blood perfusion to the kidneys is greatly decreased and the ability to concentrate urine halts. However, about once a week, torpor is interrupted and the animal becomes active to rewarm itself about once a week. This activity induces rapid regeneration of the extracellular osmotic gradient of the kidney, and allows urine to be concentrated. Nonetheless, regaining the extracellular osmotic gradient creates a potentially fatal consequence to the kidney cells. To combat the adverse effects of regaining an osmotic gradient, the animals significantly increase protective mechanisms within their kidneys, such as heat shock proteins (HSP) and organic osmolytes. It is well known that these rapid changes occur during cold-seasons, and little research has been done to compare these protective mechanisms within hibernating animals during the summer. To address this question, we worked in conjunction with a previous researcher to compare the data that has been done on a typical hibernator (*Ichthyomys tridecimlineatus*) to data of a non-hibernator (*Rattus norvegicus*). *Rattus norvegicus* was placed under various water intake regimes to facilitate changes in the vertical osmotic gradient of the kidney. We then measured renal expression of HSP70, papillary urea, sorbitol, and the glomerular filtration rate in response to changes in the vertical osmotic gradient. Experimental treatments led to expected changes in urine volume and concentration for the rats, and serum homeostasis was largely maintained. GFR significantly decreased in the dehydration groups compared to the 600mM sucrose groups. The expression of HSP70 was not significantly different in any of the rat groups, but there was increased sorbitol concentrations as papillary urea concentrations increased during combination treatment.