Undergraduate Research Symposium

Saturday, April 19th, 2025
Science Building (SCI)
Hosted by Central Washington University

Oral Presentations

Talk 1 (11:20 am). Presenter: Téa Beaulieu, *Central Washington University*

Title: Dissecting the Protein-Protein Interactions Between QKI, EMX2, and CNOT6L.

The neocortex in mammalian brains is divided into distinct functional areas. The mechanisms through which these areas form remain obscure. One identified component of this mechanism is the graded production of the protein Emx2 within the developing embryonic neocortex. Emx2 physically interacts with the proteins Cnot6L and three versions of quaking (QKI) all of which are found within the developing mouse brain and are involved in regulating the fate of mRNA. Because of the identified interactions with Emx2 and the roles Cnot6L and the quaking proteins play in the fate of mRNA, they possess the potential to be involved in the mechanisms behind neocortical area formation. I am working to identify the parts of the quaking proteins that facilitate these interactions. This objective is achieved by isolating DNA encoding regions for the quaking proteins and evaluating whether these regions interact with Emx2 and Cnot6L. At present, the regions form amino acids 250 to the end of each of the three QKI have been shown not to mediate the interactions with Emx2 and Cnot6L. Eight new regions of the quaking proteins have been constructed and are in the process of being evaluated for protein-protein interactions using Yeast Two-Hybrid and GST-pulldown assays.

Talk 2 (11:40 am). Presenter: Peyton Schuldheiss, *Western Washington University*

Title: Partially insoluble reagents as heterogeneous supports for nanoparticles generated in situ during Pd-catalyzed Suzuki coupling.

It is well established that molecular Pd pre-catalysts can generate nanoparticles in situ during catalytic reactions. Nanoparticles generated in situ, which in some cases are catalytically relevant, have been isolated from solutions and observed to deposit on reaction vessels and stirbars. Here we report that Pd nanoparticles generated *in situ* during a Suzuki coupling can deposit on insoluble reagents such as bases and provide evidence that the reagent-supported nanoparticles are relevant in catalysis. Similarly, we investigated if Pd nanoparticles can utilize insoluble organic compounds as supports. The optimization of instrumental methods for detecting Pd nanoparticles on reagents-turned-supports using scanning electron microscopy and electron dispersive spectroscopy will also be presented.

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Poster Presentations (Session 1) 10-11:15 am, SCI Foyer

#P1, Presenter: Jack Armour, *Western Washington University*

Covalent adaptable networks (CANs) are a form of thermoset-like polymers that readily undergo a dynamic network rearrangement upon the introduction of a thermal stimulus. Using isothiourea-based crosslinks, an SN-1-like exchange of key bonds allows for thermoplastic-like polymer reprocessability in what would otherwise be a permanent thermoset. We hypothesize that discretely functionalized monomers may be utilized to improve network homogeneity and thus properties by the removal of polydispersity as a complicating factor of material properties. Starting with a multifunctional thiourea, a carbodiimide monomer can be formed without the need for polymerization step, allowing access to new networks by crosslinking with commercially available multifunctional thiols. We hypothesize that an isothiourea-based network material would undergo a dynamic, dissociative bond-exchange rearrangement.

#P2, Presenter: Billingsley, Reagan, *Western Washington University*

Silk-Coated Fluorescent Polymer Nanoparticles for Bioimaging.

The silk fibroin protein found in silkworm cocoons is an emerging biomaterial, notable for its mechanical robustness, biocompatibility and biodegradability, among other favorable properties. This makes the protein a valuable tool for biomedical applications, including as a scaffold for bioimaging agents. Many methods have been investigated to synthesize fluorescent silk derivatives for the purpose of bioimaging, including pairing silk with quantum dots as well as fluorescent proteins such as GFP. However, there remains a challenge to find an efficient, low cost, and most importantly biocompatible and photostable method that could be applied *in vivo*. In this study, we fabricate and characterize silk-coated conjugated polymer nanoparticles (Pdots) of poly(phenylene vinylene) and poly(fluorene) derivatives. We use UV absorbance and fluorescence spectra to characterize light output, as well as dynamic light scattering to analyze particle size distribution. Preliminary data analysis reveals that the silk-coated Pdots maintain bright, stable fluorescence and a narrow size distribution, providing a potential biomedical agent for *in vivo* imaging.

#P3, Presenter: Camilee Boland, Pacific Lutheran University

#P4, Presenter: Olivia Caldwell, *Western Washington University*

Detection of Micro- and Nano-Plastic Contaminants Using Surface-Enhanced Raman Scattering. Spectroscopy.

Raman spectroscopy is a highly sensitive, non-destructive technique for molecular analysis, offering rapid identification of structures via vibrational "fingerprints" without the need for sample preparation. However, its sensitivity is limited by the low inelastic scattering efficiency (1 in 10^{15} photons). Surface-enhanced Raman scattering (SERS) overcomes this by using gold or silver surfaces to amplify the Raman signal, with enhancement factors ranging from 10^3 to 10^{15}. The detection of micro- and nano-plastics, particularly those smaller than 1 μm, poses a significant environmental challenge. In this study, we demonstrate the use of SERS to detect microplastics as small as 1 μm, such as polystyrene microspheres. We are developing a novel SERS-based plasmonic filter for detecting submicron plastic particles, which have been difficult to capture using existing methods. These filters are created by depositing silver or gold nanoparticles onto polycarbonate membranes with etched pores. Microplastic particles larger than the pore size are captured and analyzed using a scanning confocal Raman microscope. This research aims to show the effectiveness of SERS-based plasmonic filters in detecting submicron plastic contaminants in environmental samples.

#P5, Presenter: Kiera Campbell and Jennifer Moe, *Central Washington University*

The neocortex, the largest part of the mammalian cerebral cortex, is divided into areas each associated with a particular function. Although the mechanisms establishing where these boundaries are positioned has not been solved, it is known that the graded expression of the protein Emx2 is involved. The objective of the Kroll laboratory is to identify how Emx2 regulates the generation of these areas by studying the proteins with which it interacts. Currently, the Kroll laboratory has identified several proteins that interact with Emx2, including Cnot6l, QKI-5, QKI-6, and QKI-7, and determined that they also interact with each other. The project proposed here is to identify the region of the QKI proteins that mediates their protein-protein interactions with Emx2 and Cnot6L. This goal will be accomplished using yeast two-hybrid and GST-pulldown assays to test for interactions between Emx2, Cnot6L and the different regions of QKI.

#P6, Presenter: Noah Cox-Tigre, *Western Washington University*

Characterizing P94 mutants and the Transmembrane Domain in *Staphylococcus aureus* Sortase A .

This research sought to discriminate the effect of different amino acids at the P94 position in *Staphylococcus aureus* sortase A (saSrtA) on enzymatic activity as well as elucidating the interaction between P94 and Y187 in saSrtA, including how this interaction may impact specificity for the "X" position in the LPXTG target motif, where X=any amino acid. Mutant sortase proteins were purified and peptide substrates were synthesized using solid state synthesis. Enzymatic activity was assessed using fluorescence plate reader assays. We found that the different P94X mutants show a spectrum of activity but that they can generally be grouped into two sections: high initial activity and low initial activity. P94R changes groups, showing increased activity with LPETG versus LPSTG. This work is significant because better characterization of the structure of saSrtA and how domains affect activity can lead to the development of more active sortase variants that can be used for sortase mediated ligation, a technique for creating novel proteins.

#P7, Presenters: Katharyn Curry and Alan Gitonga, *Central Washington University*

Stereocontrolled synthesis of α-hydroxy-δ-lactam carboxamides by catalytic ring-opening aminolysis of bridged δ-lactam-γ-lactones.

The α-hydroxy-δ-valerolactam and piperidine-3-carboxamide scaffolds are replete in natural products and pharmaceuticals, including anticonvulsant and antithrombotic agents. A modular and stereocontrolled strategy that merges these elusive topologies into one motif could facilitate the discovery of more small molecules with medicinal value. Here, we demonstrate that bridged valerolactam-butyrolactones can be transformed to highly decorated 3-hydroxy-2-piperidinone carboxamides by catalytic and site-selective deconstructive aminolysis with amines. The products were obtained in a sterocontrolled manner following oxidative addition and concomitant trapping with the amine. The scaffold hopping proceeds with exclusive acyl C–O bond cleavage under palladium catalysis and represents the first catalytic method for activating the acyl C–O bonds of γ-lactones

#P8, Presenter: Ava DeKoekkoek, *Western Washington University*

Synthesis of Guanidine-based Supramolecular Networks and Polymers.

Hydrogen bonding between small molecules can give rise to supramolecular networks, polymers, and frameworks. Traditional polymers and frameworks use covalent interactions to form their macromolecular structure, leading to materials that have slow degradation, are not easily reprocessed, and persist in the environment. Hydrogen bonding allows for the creation of materials that are reprocessable, recyclable, and solvent degradable while still exhibiting the characteristics of their covalently bonded counterparts. To form these supramolecular materials, we have synthesized a library of bis(guanidine)s that are combined with multifunctional oxyacids in 1:1 functional group ratio. The thermal properties and viscoelasticity of the resulting materials are then probed using thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), and rheology, which demonstrate the polymer-like properties of these materials.

#P9, Presenter: Ifunanya Ede, *Central Washington University*

A Colorimetric Sensor Array for Differentiating Emerging Material Contaminants Based on Surface Chemistry.

Emerging materials contaminants such as nanomaterials and microplastics pose significant environmental risks due to their elusive nature and the limitations of current monitoring methods. Conventional techniques like UV-Vis absorbance spectroscopy and electron microscopy are effective, but costly, non-portable, and must be deployed in complementary ways to detect materials contaminants. These difficulties in detecting materials contaminants disproportionately impact populations in communities with increased vulnerability to contamination in water sources. To address these challenges, this study developed a simple, portable, and rapid colorimetric sensor tailored for detecting materials contaminants in drinking water. The sensor design features an array utilizing chemo-responsive dyes or commercially available pH indicators such as methyl orange, methyl red, methyl blue, mordant orange, acridine orange base, bromocresol green and methylene blue. The collective color-change response of the array serves as a distinctive “colorimetric fingerprint;” enabling the identification of specific materials contaminants. This research evaluated the sensor array’s capability to differentiate nanomaterials contaminants based on their surface charge. Specifically, the efficacy of the array in detecting and quantifying polyelectrolyte-coated gold nanorods has been systematically evaluated. Polyelectrolytes coated on the gold nanorods surface include polyallylamine hydrochloride (PAH), polyacrylic acid (PAA), polystyrene sulfonate(PSS), and poly diallyl dimethylammonium chloride (PDADMAC).

#P10, Presenter: Nicole Gomez-Barragan, *Pacific Lutheran University*

#P11, Presenter: Ariel Hall, *Western Washington University*

Using Nanocomposites as Nanotracers for Understanding Microplastic Impact.

Microplastics are nano-sized plastics that can be found in many environments – such as aquatic environments, sediment, etc. Overall, these materials can leach harmful chemicals, which can be an ecological concern. To understand their overall impact, materials such as nanocomposites–microplastics with materials like nanoparticles in them - to trace microplastic impact in simulated environments. However, installing nanoparticles into microplastics is challenging. An emulsion polymerization has been selected to incorporate those nanoparticles into polymer that typically represent the most common plastics found in the environment. The purpose of this project is to be able to create the nanocomposites and utilize different instrumentation such as fluorescence microscopy, fluorometry, scanning electron microscopy, and eventually ICP-MS to detect and track the materials in leading experiments with the material's properties.

#P12, Presenter: David Henry, *Western Washington University*

Studies Toward the Total Synthesis of Rupestines J and K.

Progress has been made on the total synthesis of rupestines J and K. These sesquiterpene alkaloids resemble the bioactive molecule cananodine. Rupestines are found in the flowers of the oft utilized ancient Uyghur medicinal plant: *Artemesia rupestris L.* which is known for anti-fungal/malarial/cancer properties. The Vyvyan group has successfully synthesized many of the molecules within this target group. This project explores the synthesis of 2 targets: rupestines J and K. A key reaction in the synthesis includes an intramolecular Mizoroki-heck cyclization to form a 7-membered ring fused to a pyridine core. Of the total 12 synthetic steps for rupestine K and 13 steps for rupestine J, 9 steps have been completed.

#P13, Presenter: McKenzie Kapralova, *Pacific Lutheran University*

Poster Presentations (Session 2) 1:30-2:45 pm, SCI Foyer

#P14, Presenter: Emily Kessler, *Western Washington University*

#P15, Presenter: Zoie Luttinen, *Western Washington University*

Synthesis and Oxidation of Fe(MeOPDI)$(CO)_2$ in Solution for the Production of CO from CO_2.

Production of CO, a usable fuel and feedstock, from CO_2 can typically require large quantities of reactants and energy which may produce harmful byproducts, due to the high bond enthalpy of the C=O double bonds. This work describes the production of CO from CO_2 by using the catalytic characteristics of a ligand-based reduction. The structure of Fe(MeOPDI)$(CO)_2$ consists of an iron-center, pydridinediimine ligand (PDI) scaffold, and a ligand arm 2-methyl-6-methoxyaniline and is useful for its ability to bind CO to the metal center, when reduced. The precursor to the CO bound Fe(MeOPDI)$(CO)_2$, Fe(MeOPDI)Cl_2, is reduced to Fe(MeOPDI)$(CO)_2$ under CO chemically, which confirmed redox ability in the resonance stabilized PDI/Fe system in solution. The direduced, dicarbonyl compound is currently being studied for its ability to undergo oxidation, resulting in the subsequent release of CO when the electrons are removed from the system. Redox events were determined and the CO_2 to CO conversion is currently being studied electrochemically. The results of those studies will be reported. The reduction of CO_2 to CO electrochemically avoids use of harmful chemical reactants and allows the reaction to be scaled up industrially and readily reversible.

#P16, Presenter: Sam MacFarland, *Seattle Pacific University*

#P17, Presenter: Juana Merolla, *Saint Martin's University*

Isolation and Bioactive Potential of Antibiotics from Actinomycetes in Archaeological Soils.

Actinomycetes are widely distributed in all parts of the world. They are especially important to soil ecosystems, where they play a key role as decomposers of organic material and more. Their ability to produce bioactive compounds such as antifungals, immunosuppressants, and antibiotics makes them an important resource for medicine and biotechnology. The primary aim of this study is to isolate antibiotics from soil samples derived from ancient gravesites on the island of Majorca at a 2000-year-old Roman archeological site and to identify antifungal and antibacterial compounds. Actinomycetes were cultured on liquid selective media and extracted with dichloromethane to obtain crude mixtures of the bioactive products. Once extracted, the compounds were assayed for their ability to inhibit the growth of bacteria and mold. After purification, the compounds may be identified using chemical means. The results of this study will aid in understanding the variety of compounds produced by actinomycetes in ancient soils and the potential for new medicine and biotechnology.

#P18, Presenter: Cody Messika, *Central Washington University*

Formation of Organic Coronas on Engineered Nanoparticles.

With the emergence of new studies that highlight the effects of microplastics as well as their prevalence in the environment, it is important that new studies address the physical properties of nanopolymers. The fate, transport, and toxicity of microplastics and nanomaterials is closely related to the formation of biomolecular coronas on the materials surface. This study aims to determine the binding constants (K_a) for two corona-forming molecules, lignin and bovine serum albumin (BSA) binding to cetyltrimethylammonium bromide (CTAB) capped gold nanorods (AuNRs). In addition to measuring the original binding constant of lignin and BSA to the AuNR surface, the binding constant of each molecule was also measured once a biomolecular corona was already present on the nanorod's surface. This study specifically focused on BSA binding to lignin-coated AuNRs, and lignin binding to fetal bovine serum (FBS) coated AuNRs to determine if binding of common biological macromolecules to that of engineered nanomaterials is indeed probable. The data shows a presence of an existing biomolecular corona on AuNR decreased the binding affinity for a new corona. For example, BSA binding to CTAB-AuNR decreases from a K_a of 21.9 ± 1.10 fM^{-1} to 2.59 ± 0.90 fM^{-1} when lignin is the corona.

#P19, Presenter: Tog-yeum Junior Hermann Nagorngar, *Pacific Lutheran University*

Amino Acid Analysis: The Extraction and Derivatization of Amino Acids in Seawater.

We explore the Earth in order to discover and understand the ecosystems present on it. Representing 70% of the surface of the globe, the oceans are arguably the place we struggle the most to explore due to their size and depth (we know more about space than we do about our oceans). Dissolved organic compounds, produced by diverse marine organisms for a wide variety of reasons, are present in very low concentration in the oceans. This research was done in order to develop, design, and ameliorate existing techniques to detect and analyze dissolved organic compounds (amino acid in this case) present in seawater. Cation exchange chromatography, derivatization and gas chromatography mass spectrometry were used. The results were not as expected but the methodology is very promising. With some ameliorations, that methodology will be able to help us detect and analyze known and unknown particles at very low concentration in our vast oceans.

#P20, Presenter: Nazir Pamplin, *Western Washington University*

Investigating Alkenone Biosynthesis.

Alkenones are a unique family of lipids produced by certain species of microalgae. These compounds have been studied for decades as paleoclimatological indicators, and more recently demonstrated to show promise as a renewable and sustainable hydrocarbon feedstock for various green technologies. Despite all this work, alkenone biosynthesis remains poorly understood. Here we describe new approaches to understand alkenone production in algae.

#P21, Presenter: Yasmine Panchmatia, *Westen Washington University*

N-functionalized polyureas by cationic ring-opening polymerization of iminooxazolidines.

Polyureas are a class of chemicals known for their high durability and flexibility and have a wide range of applications including uses in construction, manufacturing, drug delivery and tissue engineering. Traditional synthesis of these polymers is achieved by step-growth polymerization that links amines with carbonylating agents, limiting N-functionality and macromolecular architecture of the resulting polymer. Furthermore, the traditional method of polymerization lacks control of polymer mass, dispersity, and endgroups. We have developed a pathway towards synthesis of N-functionalized polyureas through cationic ring-opening polymerization (CROP) of iminooxazolidines which may resolve the previous limitations of traditional synthesis of polyureas. The iminooxazolidine monomer can be derived from commercially available amines or isocyanates and aldehydes. The synthetic pathway for the monomer allows for independent tunability for each N-substituent. Heating the iminooxazolidines in the presence of an electrophilic initiator, followed by spectroscopic analysis showed polymerization and conversion to the hypothesized repeat unit. Gel permeation chromatography indicated narrow dispersity and MALDI-TOF analysis shows repeat unit spacing that is consistent with the hypothesized CROP. The heightened tunability of polyurea structures derived from iminooxazolidines through the CROP pathway could allow for wider adaptability of polyureas for specific applications.

#P22, Presenter: Bo Petrich, *Western Washington University*

Towards Using a Centrifuge to Assess the Catalytic Role of Nanoparticles Formed During Pd-catalyzed C-H Arylation Reactions.

Molecular palladium catalysts are widely used in synthetic applications. However, during the catalyzed reactions the molecular palladium catalysts can form nanoparticles. These nanoparticles may be catalytically relevant and could be directly involved in the reactions as catalysts. We report our efforts toward developing a novel procedure for assessing whether the nanoparticles are catalytically relevant. The procedure uses centrifugal forces to isolate the forming nanoparticles and physically separate them from interacting with the substrate. A C-H arylation reaction between 1-methylindole and bis(4-tert-butylphenyl)iodonium 4-methylbenzene-1-sulfonate (an iodonium salt) producing 2-(4-(tert-butyl)phenyl)-1-methyl-1H-indole (N-methylindole-tertbutylphenyl) is used as a model reaction.

#P23, Presenter: Christopher Rupp, *Western Washington University*

Synthesis of Pyrene Functionalized Iron Pyridinediimine Complexes for the Production of CO from CO_2.

Carbon monoxide gas is a valuable feedstock chemical capable of being used as a clean burning fuel, industrial process gas, and synthetic precursor. CO production from CO_2 using redox active iron pyridinediimine (PDI) complexes has previously been demonstrated by us through the use of chemical reductants. The complexes to be discussed here contain pendant pyrene groups capable of pi-stacking to carbon electrodes such as glassy carbon and high surface area porous carbon nanomaterials. These complexes will be studied for production of CO from CO_2 electrochemically. IR, NMR, and SEM/EDX, and cyclic voltametric analysis of the complexes and relevant currently synthesized Carbon Black surface adsorbed counterparts will be discussed.

#P24, Presenters: Keegan Yu, Samuel Edwards, Keegan Gales, and Hannah Litus, *Central Washington University*

Deconstructive Functionalization of Bridged Lactam-Lactones for the Synthesis of Potential Diabetes Wound Healing Agents.

Diabetes mellitus (DM) is the health condition most responsible for the occurrence of chronic wounds. The United States of America spends over $25 billion each year for the treatment of DM-induced chronic wounds and about 6.5 million patients are affected. Currently, some medicines promote wound healing by regulating pathological signaling pathways. However, they are quite expensive and some are starting to develop drug-resistant issues. Therefore, it is vital to find new medications or techniques to hasten the healing of wounds. In this project, a solvent-controlled and copper-free addition of alkenyl Grignard reagents to bridged lactam-lactones has been implemented, leading to the unexpected synthesis of lactam-bearing homoallylic ketones. The critical factors responsible for the site-selective attack of the lactam-lactone by alkenyl Grignard reagents are being surveyed. The ability of these novel compounds to treat diabetic wounds will be evaluated through collaborations.

#P25, Presenters: Zoey Coleman, *Saint Martin's University*