SUMMER 2025

Cyclometalated Platinum Compounds Whose Oxidative Addition Mechanisms Depend on the Halide Substituent

Zainab Aleem & Benett Hathaway

Advisor: Craig Anderson

Organic ligands were made by condensation reactions between an aldehyde and a primary amine that formed an C=N imine. The nitrogen on the imine aided in chelate-assisted oxidative addition of C-X or C-H depending on the ligand used. The ligands were then reacted with the tetramethyl platinum dimer $Pt_2Me_4(\mu\text{-}SMe_2)_2$. The resulting complexes were characterized by multinuclear and multidimensional NMR spectrometry. The activation parameters of the compounds were found using NMR kinetic experiments. X-ray diffraction data was compared to DFT computational results.

Differences in Soil Microbial Activity in Farmed vs. Wild Forested Biome

Ani Alpert, Katelyn Campoverde, Shirley Dong, Tariq Ghafoori, Riley Greenberg & Myreen Toledo
Advisor: Gabriel Perron

Soil microbial communities play a crucial role in plant growth, nutrient cycling, and decomposition making them a key indicator of soil quality and health. Soil disturbing agricultural practices such as tilling and fertilizer use potentially reduces microbial diversity and ecosystem resilience. Therefore, understanding how cultivation practices influence soil microbiomes is essential for developing sustainable farm land management strategies. Here, we investigated potential differences in soil microbiomes between cultivated agricultural sites and uncultivated, forest edge sites. More specifically we examined whether wild forested areas characterized by vegetation have more diverse soil microbiomes compared to actively farmed sites.

Biogeochemical and Water Quality Assessment of the Saw Kill: Characterizing Bard's Drinking Water Source

Mia Asquini, Fuhua Feng Wu & Zainab Hashimi
Advisor: Emily White

The Saw Kill is a tributary of the Hudson River that runs through the campus of Bard College in Annandale-on-Hudson, Dutchess County, New York. The Saw Kill serves as the source of drinking water for campus as well as the receiving water for treated wastewater effluent from campus and the Village of Red Hook. Knowledge of baseline stream biogeochemistry and water quality is needed to help communities make informed decision about water treatment. In July 2025, surface stream water, sampled from four locations along the Saw Kill, and wastewater collected from the discharge pipes were analyzed to characterize Bard's drinking water source. Temperature, conductivity, and pH were measured in the field. Laboratory analyses included fecal indicator bacteria (*E. coli*), turbidity, alkalinity, and chemical composition (i.e., major ions, nutrients, carbon, and trace metals). As expected, wastewater effluent composition was distinguishable from that of the Saw Kill (i.e., higher conductivity, ions, nutrients, and dissolved organic carbon). A rain event (0.7 inches 1-day before sampling) resulted in lower conductivity and chloride (dilution) and elevated levels of *E. coli* (exceeding recreational beach water quality criteria) and turbidity (runoff) at all sites. Long-term monitoring is needed to fully evaluate spatiotemporal variability and further work is needed to explore the relationship between streamflow and stream chemistry. This work demonstrates that chemical tracers can be used to evaluate the influence of wastewater on Saw Kill water quality. This type of information, along with knowledge of baseline conditions can be used to help protect Bard's drinking water source.

Light Scattering Studies for Gravitational-wave Detectors

Kincade Avery, Fonsea Bagchi, Ibtesham Hossain, Lyric Mateo & Eric Zhao
Advisor: Antonios Kontos

The Laser Interferometer Gravitational-Wave Observatory (LIGO) uses a technique known as laser interferometry to detect gravitational-waves (GW) produced by astrophysical events such as black hole mergers and binary neutron star systems. These GW detectors require optical coatings that produce very little noise from both optical and mechanical losses, as well as baffles designed to absorb and redirect stray light away from the ends of the beamtube. Our research focused on a) characterizing defects in a sample of AlGaAs and b) measuring the Bidirectional Reflectance Distribution Function (BRDF) of different baffle material candidates for future generation GW detectors.

Inhibition of DHFR Enzyme by Ruthenium Metal Complex

Ela Besimi, Luke Collins & Alleisha Romain
Advisors: Swapan Jain & Craig Anderson

The folate pathway has long been studied as a target for anti-cancer research. This is due to the role of dihydrofolate reductase (DHFR) enzyme as an essential catalyst for the biosynthesis of purines, which is crucial for DNA production. Transition metal complexes may have the potential to inhibit the activity of DHFR, thereby slowing tumor growth. The unique chemical properties of ruthenium compounds provide promising alternatives to traditional platinum-based drugs because of their potential for selectivity and reduced side effects. The ruthenium complex under study is Ru80 which consists of two ruthenium centers coordinated to phenformin, a known antidiabetic drug. We examine the efficacy of this compound through enzymatic activity assays and ITC. These methods offer insights into how varying the drug concentration alters DHFR activity under crowded and pure conditions. Crowded conditions are used to simulate physiological conditions through the addition of ATP, PEG, GSH, Yeast RNA, and BSA. Activity assays showed that higher concentrations of Ru80 are needed to inhibit the activity of DHFR under crowded conditions than without crowding. The ITC revealed that the binding affinity of NADPH to DHFR is decreased with the addition of Ru80. In the future, we hope to further explore effects of Ru80 on NADPH binding through ITC and effects of Ru79 on DHFR through enzymatic activity assay.

Perceptual Depth Modulates Gaze Cueing: Evidence from the Ponzo Illusion

Prisha Bishen

Advisor: Tom Hutcheon

The human visual system has primarily advanced in natural three-dimensional environments (Lang et. al, 2012) yet virtually all gaze cueing studies involve two dimensional stimuli. Inspired by the Ponzo illusion, we aimed to investigate whether perceptual depth modulates gaze cueing and whether this would depend on the social nature of the cue. Eye-gaze has been shown to direct spatial attention in qualitatively different ways than non-social cues such as directional arrows (Chacon-Candia et al., 2023a; Chacon-Candia et al., 2023b; Marotta et al., 2012; Marotta et al., 2013; Marotta et al., 2018). In the current experiment we found a typical gaze cueing effect in which participants were faster to respond to targets that the cue directed attention towards compared to targets that the cue directed attention away from. In addition, we found that participants were faster to respond to arrow trials where the target appeared to be far from them (near point of convergence) compared to when the target was near (far from convergence). We did not find this difference when the cues were faces. This could potentially suggest that we are more gaze sensitive to arrows in the context of depth perception than faces.

Year #1: Burpee Trial Garden

Violet DiBiasio, Max Frackman, Lucia Lennox & Mikhal Terentiev
Advisor: Amy Parrella

The Burpee Trial Garden is a new initiative at Bard that is designed to test and grow new and experimental flowers, vegetables and herb seeds. It provides educational opportunities for hands-on gardening and scientific evaluation for field-proven top performers to home gardeners and the horticultural industry. The Burpee Trial Garden was grown, maintained and evaluated by students during June to October 2025. The Burpee Trial Garden is an organic outdoor laboratory with 20 garden beds, each 17' x 3', containing 50 different plant varieties. Students made observations everyday and evaluated each plant for a variety of characteristics. Four "New Product Candidates" were evaluated for this project. Preliminary conclusions and recommendations for additional research were determined. All data will be shared with the Burpee Foundation.

Alignment of TRP Channels & HeLa Cell Viability After Exposure to Thyme Oil

Georgia Forrest

Advisor: Kate Huffer

Over the course of the 8-week BSRI program, I explored two distinct projects; the Alignment of TRP Channels and HeLa Cell Viability After Exposure to Thyme Oil. These research projects were completely separate, yet both further investigated themes of molecular biology and biomedical science. Transient Receptor Potential channels act as sensors for various environmental and cellular signals and are responsible for a multitude of sensory responses such as stress, vision, heat, cold, taste, and pain. Understanding their structure and similarities through visual aids and computational techniques, such as PyMol, Jalview, Python, and Fr-TM-Align, is key in identifying sensory diversity. Of the 199, 809 structural comparisons conducted, 188, 070 had significant similarities. Alongside the TRP channel research, my interest in holistic and homeopathic treatments inspired me to study the impact of thyme oil and its various components on HeLa cervical cancer cells. Thyme oil has anticancer benefits, making it a great experimental treatment. Linalool, β-pinene, p-cymene, terpineol, terpinen-4-ol, camphen, thymol, and turmeric were all tested on HeLa cell cultures, grown in DMEM media with and without fetal bovine serum (FBS). Ultimately, the results from the MTT assays demonstrated that the combination of components in thyme oil was most effective without FBS and with FBS, individual components such as linalool and β-Pinene were more effective and had higher absorbance. Future work could involve classifications for targeted drug design involving TRP channels and for the thyme oil project, it could eventually be experimented on animals, leading to effective treatment for human cancer patients.

Task-Relevance of Features Modulates Object Substitution Masking

Maya Gjonbalaj & Kateryna Panikhina
Advisor: Thomas Hutcheon

OSM (object substitution masking) refers to a phenomenon in which the identification of a central target is impaired when it is surrounded by sparse dots (the mask) that remain visible after the target disappears. However, improvement of target visibility (recovery) has been observed when the mask remains visible for extended periods. This experiment extends work by Savino and Kahan (2023), in which object images (soda cans and toilet paper rolls) displayed at different orientations (forward facing or horizontal) were used as the target and mask. Participants were asked to report the object identity of the target. Savino and Kahan (2023) reported that target-mask similarity at the object level had the strongest effect on OSM and recovery, indicating the importance of task-relevant features. To further test this finding, participants in the present study were asked to instead identify the orientation of the target. In accordance with Savino and Kahan's (2023) rationalization, target-mask similarity at the orientation level had the strongest effect on OSM, with congruent target-mask orientation pairings resulting in greater masking than incongruent pairings. Participants seemingly attended to task-relevant, featural information while inhibiting irrelevant object-level information. However, results did not support the effect of target-mask similarity on recovery over extended delay times.

Effect of Anthropogenic Pollution on *intI1* Gene Relative Abundance in the Sawkill Watershed

Ray Greenberg, Myreen Toledo, Tariq Ghafoori, Ani Alpert, Shirley Dong & Kaitlyn Campoverde
Advisor: Gabriel Perron

The release of genetic information into waterways is not currently a priority for wastewater treatment, but the presence of antibiotic resistance genes in the water supply allows for the spread of these genes between bacteria via horizontal gene transfer. The Sawkill river is an effective model for these dynamics because it is used both as a source of drinking water and for the release of treated wastewater. We sampled 4 sites along the river upstream, downstream, and right at the effluent pipe of the Bard College Wastewater Treatment Plant over the course of approximately a decade. We performed qPCR on extracted DNA from the samples for *16S* (general bacterial abundance) and *IntI1* (antibiotic resistance and general marker for human impact/pollution). We found that the site right at the wastewater treatment plant effluent pipe had higher relative abundance of *IntI1* than the other sites. It also increased more drastically in *IntI1* relative abundance during events of temporary increase, possibly caused by rainfall or rapid seasonal increases in campus population. Overall our results indicate that it may be beneficial for wastewater treatment plants to preemptively invest in technology to remove genetic material from their effluent water in order to help combat the antibiotic resistance crisis.

Stream Snapshots: Analyzing the Biogeochemistry and Water Quality of Six Hudson River Tributaries

Zainab Hashimi, Mia Asquini & Fuhua Feng Wu
Advisor: Emily White

Tributaries connect communities along the Hudson River. Within rural watersheds, human activities can negatively impact water quality, primarily through the input of nutrients from wastewater effluent and agricultural runoff. Knowledge of baseline stream biogeochemistry and water quality is needed to better inform watershed management decisions (e.g., drinking water source protection, harmful algal bloom prevention). Detailed characterization of streamwater chemistry from single sampling events was conducted to provide a "snapshot" of water quality in six Hudson River tributaries. Surface grab samples were collected from streams in Dutchess (Saw Kill, Stony Creek, Rhinebeck Kill, Landsman Kill), Columbia (Roeliff Jansen Kill), and Ulster (Rondout Creek, Black Creek) counties in July 2025. Additional samples were collected at and downstream of wastewater discharge pipes. Temperature, conductivity, and pH were measured in the field. Laboratory analyses included fecal indicator bacteria (*E. coli*), turbidity, alkalinity, and chemical composition (i.e., major ions, nutrients, carbon, and trace metals). Observed differences in sample composition reflect differences in watershed characteristics (e.g., area, land use/cover). Inputs of wastewater effluent, containing total dissolved nitrogen and phosphorus concentrations ranging from 10-25 mg/L N and 1-3 mg/L P, contributed to elevated downstream nutrient levels. Long-term monitoring data is needed to fully evaluate the spatiotemporal variability of water quality in these streams. Further work is needed to explore the

relationship between streamflow and stream chemistry. Such information will provide a better understanding of the characteristic patterns against which changes due to anthropogenic impacts and climate change related effects can be identified.

Moth Biodiversity on Bard Campus

Marcos Hernandez & Rita Peress

Advisor: Bruce Robertson

Insects populations have been seeing a rapid global decline within the past decades. Moths present a special case in this decline, as one of their main stressors is the encroachment of light pollution. This evolutionary trap fragments their populations, dissuades them from reproducing, and can increase predation. Bard campus contains many locations that are unaffected by the light pollution, this can lead to greater biodiversity of these insects. Estimating the number of species which live in this region can allow for a decent representation of what lives here without the influence of artificial lights. Using multiple different trapping methods, including UV sheet traps, bucket traps, and netting individuals across campus, we collected specimens to catalog. In the short period that we surveyed, we were able to find nearly 500 species of moths within this region. Over a longer timespan, more species would have been able to be collected, as different species occupy different times of the year. Surveying in more locations, encompassing more microhabitats would have also yielded more. Of what was collected, it represents a decent chunk of moths that are estimated to live within this region.

Exploring Drug Interactions with DNA-RNA Hybrids and CRISPR Systems Using Ruthenium Compounds

Sahil Husaini

Advisor: Swapan Jain

The CRISPR–Cas9 system is a precise gene-editing tool that relies on the interaction between the Cas9 enzyme, a guide RNA (sgRNA), and a DNA target to introduce site-specific breaks. This project explored how ruthenium-based compounds affect Cas9-mediated DNA cleavage and DNA stability. Linearized pUC19 plasmid DNA was used as the substrate in reactions containing Cas9, sgRNA, and different concentrations (0–250 μM) of Ru79, RuCymene, and Metformin. The samples were analyzed through agarose gel electrophoresis to observe DNA integrity and fragmentation. The results showed that Ru79 has a concentration-dependent effect: lower concentrations increased Cas9 cleavage activity, while higher concentrations appeared to inhibit it, possibly due to strong DNA binding or interference with the Cas9 complex. In comparison, RuCymene and Metformin caused only minor changes, acting as chemical controls.

In addition, melting studies were performed using synthetic DNA–RNA hybrid duplexes, both mimic and non-mimic, to evaluate their thermal stability with and without Ru79. The melting curve analysis showed that Ru79 lowered the melting temperature of the hybrids, indicating a destabilizing interaction that could influence the efficiency of Cas9 activity. Together, these findings suggest that Ru79 can both enhance and inhibit CRISPR–Cas9 function depending on its concentration and provide insights into how metal-based compounds can influence gene-editing reactions at the molecular level.

Shedding Light on Alkene Aziridination: Visible Light Photocatalysis with N-aminopyridinium Ylides

Gwendolyn E. Jamison
Advisor: Emily McLaughlin

C-N bonds are everywhere in natural and unnatural molecules. This project aims to utilize visible light photocatalysis, which simulates photosynthesis-like conditions, in order to create substituted aziridine products. Research has shown that visible light photocatalysis is an effective method for production of these aziridines on a small scale. This summer, and continuing on into the fall, we are working specifically on the scalability and purification of these products.

Characterizing the Proximity Effect in One Photon Absorption Direct Laser Writing and Calibrating the Two-Photon Microscope

Jaiden Johnson, Avery Crafton, Kasiem Washington, & Harper Serringer
Advisor: Chris LaFratta

This research explores using direct laser writing (DLW) for high-resolution microscale fabrication, with a focus on understanding the proximity effect in one-photon absorption (OPA) systems using a 532 nm laser. The proximity effect is known to cause linewidth broadening which results in a loss of resolution and distortion of intended microstructures. In this study, we present a method to measure the strength of the proximity effect by splitting the beam into two and simultaneously writing two sets of lines that are separated in space and time. The results provide a quantitative measure of this effect's strength in one photon absorption and suggest that molecular diffusion likely plays a major role in the proximity effect. Further research and data collection is needed to understand the proximity effect over a larger space and time scales. We also describe efforts related to the testing of a two-photon microscope.

What's Left Unsaid: How Command Rejection Communication Shapes Assumptions About Robot Norm Understanding

Shiraz Kirmani, Kateryna Klimanova & Juan Diego Mora Rubio
Advisor: Theresa Law

Robots may be given commands that they are incapable of completing. Robots may also be given commands that break norms (e.g., to steal or litter). Sometimes, they may be given a command that they both *cannot* and *should not* accept. This project explores the question of how command rejection communication affects the assumptions people make about a robot's level of norm understanding. To do so, we ran two online studies in which participants read or observed four different situations in which a robot rejected a norm violating command that it was also incapable of carrying out. We varied the level of information that participants received about why the rejection took place: (1) a non-verbal rejection; (2) a minimal verbal rejection that supplied no explicit reasoning; (3) a verbal rejection that only identified a capability-based limitation preventing compliance with the command; and (4) a verbal rejection that identified both a capability-based limitation as well as a moral objection. We then asked participants how likely it was that the robot would have followed the command had the capability limitation described in the vignette been lifted; in other words, did participants assume that the robot had an understanding of norms and morals such that it *still* would reject the command even if it was functionally capable of completing it? We found that in both text- and video-based vignettes, participants saw the Capability-Only Explanation robot to be the most likely to otherwise follow a non-normative command. This suggests that a *lack* of information may be functionally meaningful when people form mental models of how robots understand and apply human norms.

Qudit Visualizations

Thanasis Kostikas & Yaroslav Valchyshen

Advisor: Paul Cadden-Zimansky

Quantum computing and quantum information have been at the forefront of the intersection between Physics and Computer Science research over the past few years. Unlike classical bits, quantum computers use qubits to perform computational tasks, which encode information with two possible outcomes, either 0 or 1. We can generalize the notion of a qubit, to include quantum states with *d* possible outcomes. These states are called qudits. This research project focuses on the geometrical visualization of qudits, and more specifically builds a bridge between the algebraic and geometrical representation of qudits.

Flats and Caps in Quad

Yumo Liu & Husna Manalai
Advisor: Lauren Rose

In the card game Quads, players look for collections of four cards satisfying a particular pattern, called Quads. The cards correspond to points in the affine space $\mathbb{F}_2^6$, and quads correspond to planes in this vector space. We explore how many quads there can be in a fixed number of cards, as well as methods for expanding particular quad-free sets to larger quad-free sets.

Optimization of a Transposon Mutagenesis Workflow and Construction of a Mutant Library in a Motile *Janthinobacterium* Strain

Giorgi Matitashvili
Advisor: Brooke Jude

Violacein-producing strains of *Janthinobacterium* are beneficial environmental bacteria commonly found in aquatic environments. They are known for their antimicrobial properties and exhibit diverse motility behaviours. In this study, we investigated a strain that forms a distinctive swimming motility pattern. To identify the genetic basis underlying this phenotype, we optimised a transposon mutagenesis protocol for our *Janthinobacterium* isolate. Using this approach, we generated a library of over 4,000 mutants, with more than 350 displaying a range of altered motility and pigmentation phenotypes. This work establishes an efficient and reproducible transposon mutagenesis pipeline for *Janthinobacterium* and lays the foundation for identifying genes responsible for our strain's unique behaviour.

Characterization of Acid-Sensing Ion Channel Response to Ibuprofen by Patch Clamp Electrophysiology

Rio Maule

Advisor: Kate Huffer

When tissues become inflamed or injured, the surrounding environment often becomes more acidic. The nervous system detects this acidity through acid-sensing ion channels (ASICs), which activate pain pathways in response to low pH. One subtype, ASIC1a, has been shown in rats to be directly inhibited by the common NSAID ibuprofen, suggesting a possible role in modulating pain beyond its anti-inflammatory effects (Lynagh et al., 2017). Whether ibuprofen affects the human version of ASIC1a in the same way remains unknown. This project investigates that question by expressing human ASIC1a in HEK293T (Human Embryonic Kidney) cells and using whole-cell patch-clamp electrophysiology to measure channel activity in an acidic environment (pH 6.0). Following baseline recordings, ibuprofen is applied to assess its potential to reduce ASIC1a-mediated currents. While data collection is ongoing, this experimental design provides a direct method for testing whether ibuprofen modulates human ASIC1a activity, which may help clarify how the drug contributes to pain relief at the molecular level.

Pd(II) and Pt(II) Compounds with N,S Thioureate and Thiosemicarbazone Ligands

Ben Murray, Sayed Zubair Sadat & Asa Platt

Advisor: Matthew Greenberg

In this work, we synthesized palladium and platinum complexes bearing N,S chelating ligands. These compounds are potential single source precursor materials for palladium and platinum sulfide materials as well as molecular sulfido clusters with interesting catalytic and electronic properties. Palladium homoleptic compounds bearing bis-chelate N,S-thioureate ligands were prepared by reacting N,N,N'-trisubstituted thioureas(N=butyl, N'=aryl) with bis(acetonitrile)dichloropalladium(II). Cationic heteroleptic thioureate complexes incorporating tetramethylethylenediamine (TMEDA) as a neutral N,N-chelate were prepared by reacting bis(acetonitrile)dichloropalladium(II), TMEDA, and trisubstituted thiourea proligands, and then isolated as tetraphenylborate salts. Disubstituted thioureas reacted in the presence of chelating phosphine ligands with bis(acetonitrile)dichloropalladium(II) to afford new heteroleptic complexes. New thiosemicarbazone ligands were prepared by reacting aldehydes with 4,4-dimethylthiosemicarbazide. These ligands then were reacted with Pt(SMe 2)Cl 2 resulting in new Pt(II) complexes.

Measuring Neighborhood Change: An Applied Machine Learning Approach to Understanding Variation in Eviction and Displacement

Nataliia Novoseltseva

Advisor: Jordan Ayala

The housing crisis in the United States has deep structural roots and continues to expose enduring inequalities in access to affordable and stable housing. In 2025, renter cost burdens across the U.S. reached another record high (Harvard JCHC 2025). Across the country, stagnant wages, rising housing costs, and increasing rent burdens have left millions of renters at risk of displacement. In Kansas City, Missouri, these pressures are particularly severe: over 45% of households are renter-occupied, and about 44% of renters spend more than 30% of their income on rent (U.S. Census Bureau ACS 2023). Real estate investment and neighborhood shifts in socioeconomic composition, often captured through measures of gentrification, are well-documented drivers of rising housing instability. Gentrification is frequently accompanied by displacement, the forced movement of households or entire communities, particularly among low-resourced groups, further deepening existing social and economic inequalities.

This study examines the relationship between gentrification and displacement, measured through court-ordered eviction rates, by comparing associations between eviction rates and multiple operationalizations of gentrification. Using kernel-based regularized least squares (KRLS), a machine learning approach to nonlinear regression, the expectations-based measure of gentrification yields consistent results across alternative model specifications that vary in the inclusion

of housing, demographic, and neighborhood investment predictors, with KRLS estimates indicating nonlinear associations among renter cost burden, racial composition, and other neighborhood characteristics linked to eviction risk. This approach enables the identification of thresholds at which these factors are associated with elevated eviction risk.

Anthropogenic Landscapes and Their Impact on Bird Communities

Olamipo Ogunleye
Advisor: Ellie Diamant

Human activity constantly reshapes bird habitats, and while the effects of urbanization on avian biodiversity are well-documented, less is known about the impact exurban and rural landscapes have as well. Our study quantifies the impact of anthropogenic landscape changes on bird count and species richness in Dutchess County, New York. We conducted ecological surveys across 85 sites, recording data which was then visualized and analyzed using R. Our findings reveal that most of these communities are dominated by adaptable generalist species, such as the Gray Catbird. Furthermore, species richness was negatively correlated with human activity and positively correlated with habitat integrity.

Dual-Emitting Cyclometalated Platinum(II) Compounds with Isocyanide Ligands

Everest Oppenheimer & Ricardo Cortines Rama

Advisor: Craig Anderson

Cyclometalated platinum(II) compounds with both C^N chelating iminic ligands and isocyanides ligands were synthesized. Two sets of compounds from the reaction of two separate HC^N proligands (derived from thiophene or benzene) with [Pt2Me4(*μ*-SMe2)2] were obtained resulting in square planar compounds with an anionic C^N ligand, a methyl ligand, and a dimethylsulfide (dms) ligand completing the coordination sphere. Subsequently, the dms ligand was easily replaced with several isocyanide ligands (2-naphthyl, adamantyl, 2,6-dimethylphenyl, p-toluenesulfonylmethyl). The compounds were characterized by multi-nuclear NMR spectroscopy, IR spectroscopy, and single crystal X-ray diffraction (SCXRD). Their photophysical properties were explored using UV/vis, emission, and transient absorption (TA) spectroscopies. The emission spectra for the thiophene-derived compounds show well-defined dual emission peaks, while the benzene-derived compounds' peaks were less resolved. TDFT and TD-DFT calculations were performed to investigate the observed spectroscopic properties of the newly synthesized complexes.

Progress Towards Synthesis of Ruthenium Therapeutics

Alleisha Romain, Charles Grenadier & Melody Zhang

Advisors: Craig Anderson & Swapan Jain

Organometallic compounds have emerged as an alternative to coordination compounds in anticancer research due to the ability to interact selectively with biological macromolecules. Among these, ruthenium-based complexes have shown particular promise, as compared to the well-known platinum drugs, offering reduced toxicity. In this work, we pursued the synthesis and preliminary characterization of novel Ru–imine systems as a foundation for future studies examining their structure and enzyme inhibitory potential

Impacts of Yarrow (*Achilea millefolium*) Essential Oil on Bird Nests and Nesting Outcomes

Isadora Rowan

Advisor: Ellie Diamant

Birds often incorporate aromatic herbs and greenery into their nests, which has been found to benefit chick heath by reducing parasite load. In this study, yarrow (*Achillea millefolium*) oil was added to the nests of cavity nesting birds and grapeseed oil (non aromatic) was added to half the nests as a control. Chick health, survival, and fledging rate was recorded.

We found no significant impacts of yarrow on fledging success across cavity nesting birds. Future work will determine relationships between oil, chick health, ectoparasite load, and microbiome.

Synthesis and Photophysical Properties of Cu^{2+} and Mn^{2+} Metal Halide Nanocrystals

Timofey Semenov & Camila Sandaal

Advisor: Matthew Greenberg

The synthesis of lead-free metal halide nanomaterials with tunable photophysical properties comparable to lead halide perovskite nanomaterials is desirable given the toxicity of Pb^{2+} . In this work, we investigated red and blue light emitting metal halide nanocrystals that use Cu^{2+} and Mn^{2+} as alternatives to Pb^{2+}. $CsMnCl_3$ and $CsMnBr_3$ nanomaterials were synthesized and their halide exchange chemistry with trimethylsilyl halides was studied. M_2CuCl_4 ($M = K^+$, Rb^+, Cs^+) nanocrystals were prepared to examine how alkali-metal composition impacts photophysical properties.

Visible Light-induced Cyclobutane Synthesis: Intermolecular [2 + 2] Cycloadditions with Vinylogous Ester Heterocycles

Alexandria Thomas, Maryam Mohibby & Maximus G. Shultz
Advisor: Emily McLaughlin

[2+2] cycloaddition reactions have been traditionally catalyzed by high-energy ultraviolet light which can be highly toxic and damaging. In recent photochemical advancement studies, visible light-mediated photocatalyst reactions have been proven to be a more optimal energy source for highly substituted [2+2] cycloaddition reactions. In our research, we're observing the regioselctivity and stereoselctivity of [2+2] cyclo addition reactions with alkenes and two different enones: Phenyl oxazinone and phenyl pyranone. Our goal is to develop the most efficient, and regioselective products with various cyclobutene derivatives, catalyst, and solvents in [2+2] cycloaddition synthesis.

Cataloging a Non-tuberculosis Mycobacteria Patient Sample Library

Kerri Tran & Habiba Musah

Advisor: Brooke Jude

Non-tuberculosis mycobacteria (NTMs), the less infectious relative of tuberculosis and leprosy causing microbes, are prolific, and also capable of causing problematic infections. These bacteria generally only infect immunocompromised individuals, and studies show higher infection rates in tropical zones. With global climate change projecting expansion of these zones, it is vital to understand these bacteria and treat infection better. One clue is that tuberculosis adjacent strains exhibit multiple colony morphologies and different resilience to antimicrobial drugs, shaping individual treatment plans.

We worked with a previously collected NTM library of clinical isolates, in order to phenotypically catalog the complex mixed microbial groups.Over 8 weeks, we determined that of the 12 strains present, all were viable, classified as mycobacteria, and had multiple still mixed morphologies. Ongoing research seeks to further separate and characterize the different morphologies in each strain, and eventually determine their antibiotic resistance profile for use in future therapeutic studies.

Birefringence for Quantum Kaleidoscope Manufacturing

Aidan Young & Jiyu Kwon
Advisor: Paul Cadden-Zimansky

Birefringence is an optical property of anisotropic materials in which the refractive index depends on the polarization of incident light. Our study aimed to design and quantify color patterns produced by birefringent materials placed between two linear polarizers using inexpensive, accessible materials. Beyond visual exploration, our goal was to understand the theoretical framework, derive quantitative relations, measure birefringence, and build a computational model capable of predicting color based on material thickness, birefringent index, and polarizer angle. Using Jones-matrix formalism and CIE color-space mapping, we analyzed how orientation and material parameters determine observed color patterns. The results confirmed a sinusoidal intensity dependence and yielded a measured birefringence of approximately $\Delta n \approx 0.0023$, consistent with published values.