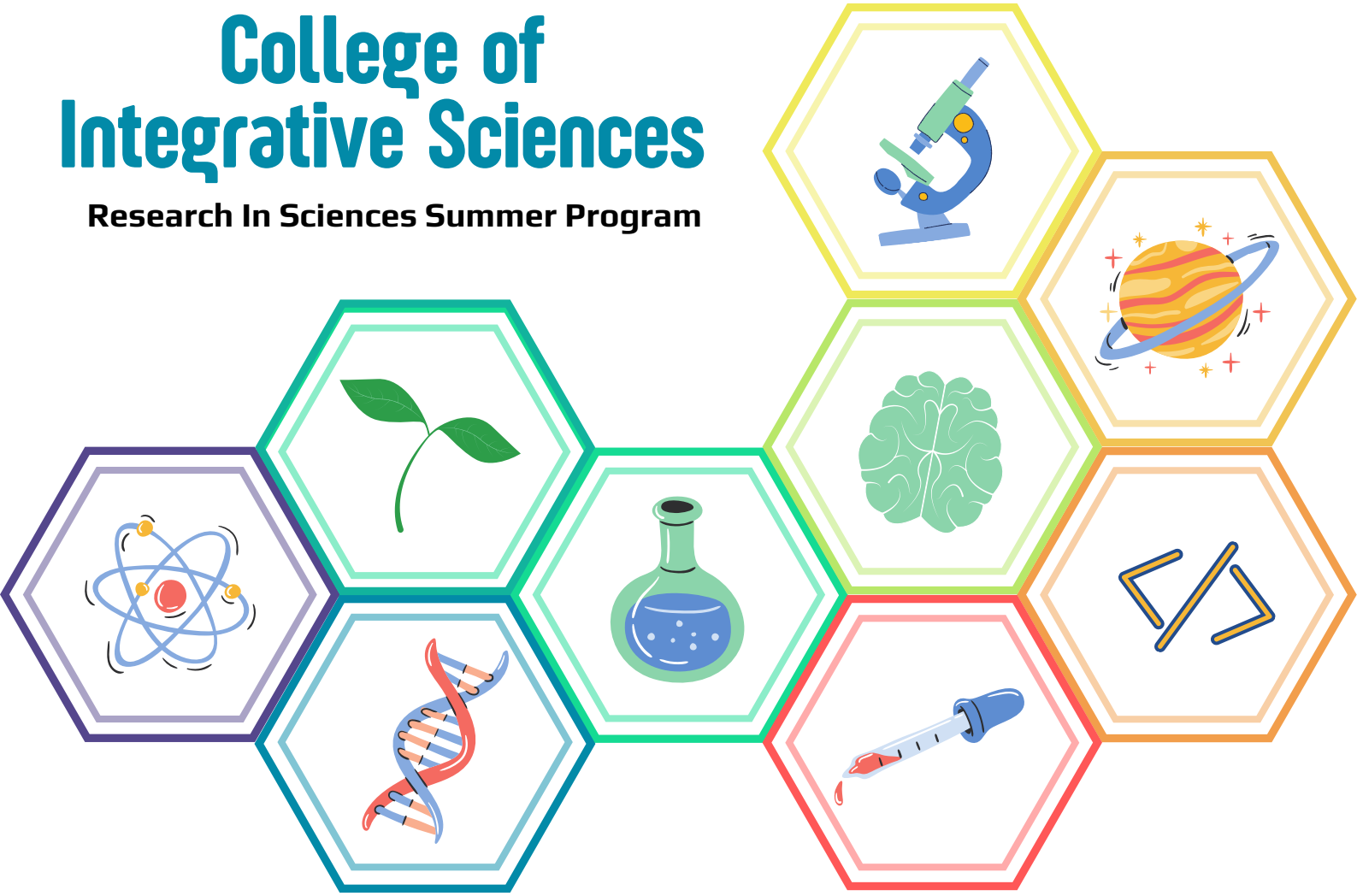
SUMMER 2022

College of Integrative Sciences

Research In Sciences Summer Program



POSTER SESSION

Thursday, July 28, 2022

1:30PM

Wesleyan University

Wesleyan University

The Research in Sciences Summer Program and Poster Session are funded by:

The College of Integrative Sciences

The College of the Environment

The Departments of Astronomy, Biology, Chemistry, Earth and Environmental Sciences, Mathematics and Computer Science, Molecular Biology and Biochemistry, Physics, Psychology, and the Neuroscience and Behavior Program

The Gordon Career Center

The Quantitative Analysis Center

Wesleyan Mathematics and Science Scholars Program

Wesleyan McNair Program

Grants from:

The Keck Northeast Astronomy Consortium

The National Institute of Health

The National Science Foundation

Rosetta Commons Research Experience for Undergraduates Internship Program

Wesleyan Grants in Support of Scholarship Internship Program

Alumni donors:

Joshua Boger

Shonni Silverberg

The Siegal family

The Sonnenblick family

Wesleyan University

SUMMER RESEARCH POSTER SESSION

1.1 Carlo Arnoldi (2024), Roy Kilgard (Astronomy)

Supernovae as Substitutes for Short Gamma-Ray Bursts

Short Gamma-Ray Bursts (sGRBs) are thought to be caused by the mergers of neutron star-neutron star and neutron star-black hole binaries. Study of these mergers can help determine the precise mass divide between neutron stars and black holes, which is currently unknown. We aim to constrain the potential mass ranges of these objects by studying their optical afterglows which persist from several days to weeks. At Van Vleck Observatory, we have automated our 24” telescope to conduct queue-based observations, and have observed recent supernovae in B and V filters over the course of several nights. We have used supernovae to test queue-based observing with the 24”, as a proxy for sGRBs, which are of comparable brightness, but less frequent. While supernovae are interesting in their own right, these observations are a crucial step towards future testing with transient sGRBs that will interrupt the established queue of observations.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

1.2 Owen Gonzales (2024), Meredith Hughes (Astronomy)

Measuring Host Star Mass in Debris Disks Using 12CO Line Emission

Owen Gonzales, Carlos Ordoñez, Saad Waheed

Recent improvements in radio interferometry have allowed for the development of novel techniques for probing debris disks - disks of gas and dust orbiting a star after planet formation. In most cases, stellar mass is estimated through calculations based on stellar evolution models, not direct dynamical measurements. The accuracy of these estimates remain unverified because there is no benchmark to compare their performance against. High resolution interferometric observations using the Atacama Large Millimeter/submillimeter Array (ALMA), and precise parallax distances given by *Gaia* allow us to dynamically measure precise stellar masses. In this project, we use the ^{12}CO (2-1) and (3-2) emission lines to analyze the Keplerian rotation of the gas around 10-100My old, main sequence, A type stars for which accepted mass estimates exist. The technique involves probing the redshift and blueshift of the emission lines, caused by the rotation of the gas around the disk. We translate these frequency offsets into velocities, which we use to extrapolate the mass of the host star. Our sample consists of three disks with relatively high flux: HD32297, HD141569, and HD131488. Models of these disks are generated using parametric ray tracing code and compared to data using affine-invariant Markov Chain Monte Carlo techniques to explore the parameter space of these models. This allows us to accurately characterize the uncertainties on the dynamical mass of the central star.If the best fit models produce stellar mass results that agree with accepted values, it is a good indication that the masses predicted by photometric models are accurate. This would provide evidence in favor of our current understanding of the stellar evolution of the stars probed in our sample.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

1.3 Kyle McGregor (2024), Seth Redfield (Astronomy)

Commensurability Offsets as a Tool for Comparative Characterization of Resonant Exoplanet Chains

This project seeks to holistically probe all multi-planet exoplanet systems for resonant chains through analyzing their offsets from pure integer ratio commensurabilities in an effort to dynamically contextualize systems in proximity to pure resonant chains. Orbital resonance is a nearly ubiquitous phenomenon observed on solar-system scales and has been identified in many exoplanet systems to date. A plurality of systems with low offsets from pure commensurabilities for their period ratios has been observed in the known population of multiplanet exoplanet systems. This project focuses on identifying resonant relationships in exoplanet systems through characterizing them comparatively through their offsets from pure commensurability chains. In particular, we focus on the dynamics GJ 9827 system, situated near the 1:3:5 mean motion resonance (MMR), in order to dynamically contextualize the system among other systems likewise in proximity to low first, second, and third-order resonances. To do this, we have created a relative index for each multiplanet system's offset from a pure commensurate relationship between orbital periods relative each planet's inner pair. With these, we can run n-body simulations to probe libration in each system's 3-body resonant angle to indicate large-scale trends between the dynamics of the 50-most resonant systems identified here.

.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

1.4 Sara Starecheski, Seth Redfield (Astronomy)

Modeling the Evolution of the Local ISM

The interstellar medium (ISM) is the gas and dust that lies between star systems. Observational and theoretical work have shown that the solar system lies near the center of a structure in the ISM known as the Local Bubble. This bubble is theorized to have formed from supernova blast waves, the first of which occurred ~14 MYrs ago in either the UCL or LCC star cluster, that heated and vacated the region inside the cavity. It has also been proposed that the Local Bubble may resemble an irregularly shaped Stromgren sphere, a cloud of ionized hydrogen surrounding a star, since the hydrogen in the Local Bubble is fully ionized and the Stromgren sphere of the star ε CMa is roughly the size of the Local Bubble. This project sought to create three dimensional models of the Local Bubble, the Stromgren spheres of significant stars in its vicinity, the UCL and LCC star clusters, and smaller more local clouds of ISM known as the Cluster of Local Interstellar Clouds (CLIC). Tracing this model back in time up to 20 Myrs in the past allows us to learn more about the origins and evolution of the Local ISM and further constrain our current theories. When visualizing all of these components, we discovered that tracing the orbits of the CLIC back in time puts their location in the vicinity of the LCC and UCL star clusters at the time of the most recent supernova explosion, offering a possible origin theory for these clouds. We also discovered that for much of the Local Bubble's lifetime, it was contained entirely within the Stromgren sphere of ε CMa, suggesting that if the Local Bubble is not an irregularly shaped Stromgren sphere, ε CMa still played an important role in its evolution. Future research can add additional components and constraints to this model to answer further questions about how these structures have dynamically interacted with each other over time.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.1 Katherine Fhu (2025), Joseph Coolon (Biology)

Contribution of Chitinase genes to host plant toxin resistance in Drosophila sechellia

Drosophila sechellia is a dietary specialist species of fruit fly, native to the Seychelles Islands where it feeds almost exclusively on the fruit of *Morinda citrifolia*, also known as noni fruit. Ripe noni fruit contains volatile toxins, primarily octanoic acid (OA) and hexanoic acid (HA), as a method of defense against herbivorous insects that is lethal to *D. sechellia*'s generalist sister species and insects more broadly. The genetic and molecular mechanisms of *D. sechellia*'s resistance to OA and HA are still poorly understood despite decades of research. In insects, chitin forms both the protective cuticle as well as the lining of the midgut, potentially acting as a first line of defense against toxins like OA and HA. Previous studies have shown that several genes related to chitin regulation change expression when *D. sechellia* is exposed to OA and HA. Of these genes, *Chitinase 7* (*Cht7*) and *Chitinase 9* (*Cht9*) encode for enzymes involved in the synthesis of chitin polymers. *Cht7* is involved in cuticle development, ecdysis, and wound healing, whereas *Cht9* contributes to the formation of the extracellular matrix in barrier tissues making both good candidates for contributions to OA and HA resistance. To test these genes for a role in OA resistance, *Cht7* and *Cht9* were knocked down with RNAi in *D. melanogaster* to decrease the expression of each individually and survival assays were conducted to observe changes in the flies' ability to survive exposure to OA. Our analysis revealed that knockdown of *Cht7* significantly improved OA resistance while knockdown of *Cht9* had no significant effect on OA resistance. These data suggested that chitin-containing physical barriers may play an important role in *D. sechellia* OA resistance and further studies of *Cht7* are necessary to better understand how it functions in OA resistance.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.2 Vivian Gu (2023) and Jocelyn Wang (2024), Fred Cohan (Biology)

Bacillus Genomes

In our work we aim to go beyond species classifications for bacteria to identify diversification of bacteria according to ecological differences, or ecotypes. We are focusing our research on 900 strains of various species of Bacillus isolated from samples collected in Death Valley, and here we are presenting our ecological analysis of data from *Bacillus atrophaeus, B. spizizenii*, and *B. inaquosorum*. The samples were collected at various elevations and from varying soil types, either free soil or rhizosphere. After sequencing was done, we annotated the genomes, found a core genome for each species, and made phylogenetic trees from the data. We then used an ecotype simulation program to find putative ecotypes, which we then tested for ecological distinctness based on the environmental data that we had collected previously. We discovered that each species showed ecological diversification by either elevation or rhizosphere or both.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.3 Vivian Gu (2023) and Jocelyn Wang (2024), Fred Cohan (Biology)

West Nile

In our research we aim to extend classification of viruses from species level down to the ecotype level, trying to find populations that are ecologically distinct. Our research concentrates on the West Nile Virus, which has many host bird and mosquito species. We wondered if ecotypes of West Nile Virus diversified based on specialization on their hosts, and also if they diversified based on geographical location. We obtained complete genome sequences of West Nile Virus from NCBI, from the host bird species Blue Jays and American Crows, as well as host mosquito genera Culex and Culiseta, as well as Psorophora, Ocheratatus, and Aedes species. We aligned these sequences, and constructed a phylogenetic tree with the data. We then determined putative ecotypes by running this tree through an ecotype simulation program, and matched the results to ecoregion data we found. We found that the ecotypes were significantly different across host species in both birds and mosquitoes. With our research we are continuing our work in “reverse ecology” in finding ecological diversity within virus species.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.4 Kiran Kowalski (2023) and Amy Smith (2024), Michael Singer (Biology)

Indirect Ecological Effects Of Phloem-Feeding Insects On Caterpillars: Tests Of Two Mechanisms

Previous research has found that the presence of phloem feeding insects activates the SA (salicylic acid) chemical defense pathway in plants like White Oak (*Quercus alba)*. This causes antagonistic crosstalk, a phenomenon that inhibits the JA (jasmonic acid) chemical defense pathway that functions against caterpillars. What remains understudied is whether it actually benefits the plant to have only one defense pathway active at a given time. We collected our data at several sites in central Connecticut using ant exclusion and inclusion, and phloem feeder removal and replacement as our experimental conditions. We revisited each site 2 subsequent times, each a week apart, to measure the changes in caterpillar and phloem feeder populations on our experimental branches. We also considered factors like caterpillar size and diet breadth, as these have been shown to affect an individual's vulnerability to predation, and therefore might reveal trends not visible when analyzing the data as a whole. We hypothesize that the white oak benefits from having only one defense pathway active at a time if there is an interactive effect between our two treatments which results in a tree receiving the same or greater protection from herbivory without having to produce expensive chemical defense compounds. Our goal is to examine the relationship between the presence of sap-feeding insects and changes in ant predation on caterpillars.

SUMMER RESEARCH POSTER SESSION

2.5 Vivian Lu (2023); Joseph Coolon (Biology)

The role of chitin-binding genes in octanoic acid resistance in Drosophila sechellia

Drosophila sechellia is a dietary specialist fruit fly endemic to the Seychelles islands, where it feeds primarily on *Morinda citrifolia*, commonly known as noni fruit. Ripe noni fruit contains plant defense fatty acids, notably octanoic acid (OA) and hexanoic acid (HA), which are lethal to insects including all closely related species of *Drosophila*. The genetic mechanisms that enable *D. sechellia* to resist these toxic volatiles remain unclear. Preliminary genetic screens have identified several chitin-binding genes differentially expressed in *D. sechellia* upon exposure to OA and HA. Here, we employ the GeneSwitch GAL4 system and use RNA interference to knock down the expression of selected chitin-binding genes–*Peritrophin-15a* and *Gasp*–in *D. melanogaster* to test their possible role in OA resistance. These genes are both involved in the synthesis of the chitinous extracellular matrix. *Peritrophin-15a* encodes structural components of the peritrophic membrane, a semi-permeable barrier that lines the midgut. *Gasp* is known to be involved in the embryonic development of the tracheal system but remains continuously expressed through adulthood. Following RNAi knockdown of these genes, we conducted survival assays to determine if they contribute to OA resistance. We found that decreasing expression of *Peritrophin-15a* does not alter resistance to OA, suggesting that the peritrophic matrix may not be a key player in OA resistance. Knockdown of *Gasp*, however, significantly improved resistance to OA, pointing to *Gasp* as a promising candidate for future investigation.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.6 Saira Mehra (2024), Jan Naegele (Biology)

Fetal GABAergic interneurons transplanted into the adult mouse hippocampus induce widespread changes in the neuronal connectivity of the host brain

Neurogenesis occurs throughout life in the dentate gyrus of the adult mammalian brain and serves an important role in learning and memory consolidation. The principal cell type that is regenerated in this manner is the granule cell of the dentate gyrus. The granule cells are neurons that form the mossy fiber pathway and receive widespread synaptic inputs from many other brain regions as well as hippocampal GABAergic interneurons. In Temporal Lobe Epilepsy (TLE) seizures trigger cell death of hippocampal GABAergic neurons, resulting in loss of inhibition onto granule cells. The interneurons also regulate adult neurogenesis and the birth and migration of adult-born granule cells. Abnormalities in adult neurogenesis that ensue after the loss of GABAergic interneurons include increased inputs from excitatory neurons, abnormal migration, and hyperexcitation of granule cells. These contribute the TLE and recurrent seizures. Previously, we showed that transplanting MGE GABA neurons transplantation reduces the frequency of seizures in this TLE model. We also showed that the transplants integrate and form synaptic connections within adult-born neurons in the dentate gyrus of the recipient (host) brains. Here we asked whether the transplanted GABAergic interneurons restored normal patterns of connections to adult-born granule cells.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.7 Louisa Monahan (2024), Taylor Teich (2023), Ken Wu (2023); Sonia Sultan (Biology)

The persistence of transgenerational plasticity (parental sun versus shade) in the annual plant *Polygonum persicaria*

The Sultan lab studies phenotypic plasticity (producing different phenotypes from a single genotype under different environmental conditions) within and across generations using the annual plant *Polygonum persicaria.* Previous work in this system has shown that parental shade versus sun differently influences offspring development. What remains unknown is how long these parental effects persist during development and if genotypes vary in their persistence. In the summer of 2022, we conducted a fully factorial greenhouse experiment using six inbred genotypes of *P. persicaria* that were previously grown in either shady/moist or sunny/moist conditions ("parent environment"). To test expression of parental effects over time in different offspring environments, replicate seedlings were grown under shady/moist, sunny/moist or sunny/dry conditions. Developmental phenotypes such as height and leaf count were measured at frequent intervals throughout the experiment. A significant and persistent parental effect was found for both offspring height and leaf count (through d. 33-35). The results provide evidence for the persistence of parental effects on functionally important traits late into offspring development. These findings give insight to how both previous and current environments can influence plant development, and how this integration may differ across genotypes - a key element providing the potential for these traits to evolve.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.8 Mikoto Nakamura (2024); Jennifer Mitchel (Biology)

Collective cell migration is a key process involved in various physiological processes such as wound healing and angiogenesis, and also a major motivator of pathological processes from inflammation to cancer metastases. However, the mechanisms and physical properties of collective cell dynamics are not yet well understood. Here, we study the mixing and collision of two migratory epithelial sheets. Previous work suggests that healthy epithelial sheets undergo limited mixing after closing a wound. We establish a wound-healing assay to allow the study of collective epithelial migration and collision, towards investigating the underlying mechanisms of mixing at the epithelial collision boundary. We study this behavior by seeding cells into a micropatterned stencil, allowing them to grow to confluence, and removing the boundary, thus creating a wound area into which cells can migrate. We then obtain time-lapse videos of MDCK epithelial cells as they migrate and track their movements. In agreement with previous studies, our initial data shows limited mixing at the boundary and the formation of a multicellular actin cable at the wound edge. We are currently investigating two hypotheses: first, that the disruption of cell-cell junctions through treatment with TGF-β would promote both migration and mixing, and second, that the disruption of actin at the specific time point when two epithelial cell sheets collide will enable the fluidization and a mixing of the cells. Understanding the mechanisms behind collective cellular behaviors may enable future engineering initiatives that will prevent cancer metastases.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.9 Elias Owen (2025); Laverne Mélon (Biology)

Evaluating an animal model to promote discovery of therapeutics for co-morbid Posttraumatic Stress and Alcohol Use Disorders

Only 7% of the 15 million Americans diagnosed with an Alcohol Use Disorder (AUD) receive treatment. Current therapeutics for AUD have low efficacy, especially for patients with co-morbid psychiatric disorders. AUD is highly comorbid with post-traumatic stress disorder (PTSD), and this worsens the outcomes of both disorders. There are currently no FDA approved therapeutics for AUD/PTSD and current AUD therapeutics may not be effective in this population. This represents a major gap in treatment options for these individuals. Our lab investigates the physiology of GABAergic neurosteroids, which have been shown to be disrupted in patients with a history of disordered drinking and in individuals with PTSD. In order to determine whether our therapeutic approach is viable, our short term goal is to evaluate the utility of a preclinical model for co-morbid AUD/PTSD. We trained aggressive male and female outbred mice to repeatedly attack experimental mice (inbred C57bl6/J). Following 10 days of this chronic stress experience, experimental mice were given daily access to an unsweetened alcohol solution (20%, v/v), each day for two weeks. Females showed a significant increase in alcohol drinking following chronic stress, while males show a marginal increase in intake. We next tested the efficacy of acamprosate (the current frontline drug for treating AUD) on dampening stress-induced increases in drinking. Stress induced increases in drinking for females was resistant to treatment by acamprosate, while the marginal increase in drinking noted for stressed males, was dampened. After a two week abstinence period, animals were tested in the open field maze (activity/locomotion). DeepLabCut, a toolbox for markerless pose estimation, was used to analyze behavioral recordings. Current analyses of mouse tracking show potential increases in thigmotaxis and reduction in activity following chronic stress and alcohol drinking. Future work will determine whether targeted modulation of GABAergic neurosteroid activity can successfully reduce stress-induced drinking and stress-associated changes in activity for both males and females.

.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.10 Daniel Stein (2024); Gloster Aaron (Biology)

Exploring the role of DARPP32+ Adult Born Neurons in Directed vs. Undirected Song

The song production circuit in adult male zebra finches has been extensively researched. However, certain aspects of the circuit remain mysterious. One such aspect is the presence of a certain subpopulation of adult-born neurons in the region HVC (proper name). These neurons, unlike roughly 50% of new neurons in HVC, do not project to the robust nucleus of the arcopallium (RA). In fact, if they do project outside of HVC, the location of this projection has not been determined. We identified these neurons by staining for the phosphoprotein DARPP-32, which suggests the presence of dopamine receptors. We used IHC procedures to stain these neurons for the protein ZENK, a marker of neuronal activity, as well as BrdU, which birthdates neurons. These procedures allowed us to link and ask questions about neuronal activity in different behavioral paradigms, namely directed, or mating song and undirected, or practicing song. With these tools, we explored the developmental timeline along which DARPP-32 adult born neurons begin responding to song production, and the difference in activity between RA-projecting neurons and DARPP-32 neurons in directed vs. undirected song.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.11 Joshua Woo (2023); Ruth Johnson (Biology)

Distinct cytoskeleton composition in different cell types dictate the cells' specific functions and tissue development. The precise mechanisms underlying the formation of cell-specific cytoskeletal elements, however, are not well understood. To unravel these developmental mechanisms, our lab investigates the relationship between cell type-specific expression of cytoskeletal genes and the formation of distinct cytoskeletal structures in the *Drosophila* eye. Here, specifically, I aim to elucidate the functions of Quail, an actin-binding protein that colocalizes with the unique cytoskeletal structure found in the eye's primary (1o) pigment cells, called apical radical actin filaments (ARAFs).

ARAFs resemble stress fibers but are organized across the entire apical surface of the cell rather than at the basal portion where stress fibers are normally located. Previous work demonstrated that ARAFs in 1o pigment cells colocalize with Quail, an actin-binding protein that is hypothesized to nucleate, sever, bundle and attach actin filaments to the cell membrane. Here, through dissections and immunostaining of control and mutant eye tissues containing *RNAi* constructs, we found that *Uas-quail RNAi 27623* effectively reduces Quail expression in the primary pigment cells. The reduction of Quail expression correlates to shorter lengths of ARAFs and reduced area of the 1o pigment cells. The angles that ARAFs form along the primary pigment cell and lattice cell border, however, were unaffected. Altogether, these findings suggest that Quail do not nucleate ARAFs but, instead, may involve in actin bundling and/or extension.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.1 Justin Bracero (2024); Michael A. Calter (Chemistry)

Performing the Synthesis of OBM, Analog of Parent Compound Rocaglamide

Rocaglamide is a compound extracted from the plant genus Aglaia, and is a compound known to demonstrate strong anti-cancer behavior (1). Due to this behavior, rocaglamide is commonly used in cancer treatment to target cancer cells without causing harm to non-cancerous body cells. However, it is not an effective compound to use against every single type of cancer. Therefore, it would be beneficial to create an analog of rocaglamide that retains the anti-cancer properties and targets specific types of cancer more effectively than rocaglamide could. This project attempts to achieve this goal by producing an analog of rocaglamide called OBM. OBM can be synthesized through a series of commonly used organic chemistry techniques, such as extraction, purification, and chromatography. A 400 Hz NMR machine is used to analyze the contents of our products, which helps to determine purity and conversion (4). The data collected from the production of OBM will contribute to future syntheses of rocaglamide analogs by creating a template on how to produce different analogs effectively and efficiently.

.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.2 Sophie Chang (2023);; Michael A. Calter (Chemistry)

Synthesis of Rocaglamide Analogs

Rocaglamide is effective in inhibiting the growth of cancer in only certain cancer cell lines. Therefore, it is useful to determine if our rocaglamide analogs are effective in inhibiting cell growth or inducing cell death in other cancer cell lines that rocaglamide has proved ineffective against. We are developing efficient syntheses of various Rocaglamide analogs, which are then sent over to Professor O'Neil's lab and tested against cancer cells. The synthesis detailed here is specifically for the rocaglamide analog OBM, which is carried out using various chemistry laboratory techniques. These techniques include setting up reactions, using silica gel column chromatography to purify products, and utilizing a 400 Hz NMR instrument to analyze the purity of the products.

.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.3 Alex Gorman (2025); Erika Taylor (Chemistry)

Computational Analysis of Heptosyltransferase I Inhibitors

Gram-negative bacteria are a unique group of bacteria that pose a special health risk due to their doubled layer membrane, with some examples being *E.coli*, *K. pneumoniae,* and *H.pylori*. The outer layer of Gram-negative bacteria is covered in Lipopolysaccharides (LPS) that protect the bacteria from many common antibiotics, making them harder to treat. This increased resistance, however, can be bypassed via inhibition of the protein Heptosyltransferase I (HepI). HepI is responsible for catalyzing the addition of heptose moieties to the inner core of LPS and serves as a promising drug target—HepI knockouts show increased antibiotic vulnerability due to their truncated LPS. Previous Taylor Lab studies used AutoDock Vina to filter the National Cancer Institute's Natural Products Set IV to identify potential inhibitors through molecular docking. The previous study identified 19 ligands that show a particularly strong binding affinity to HepI to test as potential inhibitors and 10 with especially low binding affinities to use as controls. The ligands were evaluated using coupled assays to calculate the dissociation constant (Ki) between HepI and each ligand. The experimental results, however, did not match the computed predictions, with there being little correlation between the two. In order to identify better inhibitors, all of the docking simulations are being rerun in Schrodinger Glide, a more advanced program, to confirm whether the error was in AutoDock Vina or the experimental procedure, as well as further narrow down the search for HepI inhibitors.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.4 Aidan Jones (2023); Alison O'Neil (Chemistry)

Investigating the Inflammatory Response of ALS patient iPSC Derived Astrocytes

Amyotrophic Lateral Sclerosis (ALS) is a progressive neurodegenerative disease characterized by the death of motor neurons (MN) in the brain and spinal cord. Neuroinflammation, a hallmark of neurodegenerative diseases, has an unsolved role in ALS pathogenesis and MN degeneration.1 Astrocytes, the most abundant cell type in the brain, are responsible for modulating the body's inflammatory response to stress or damage in the brain.2 However, mutations associated with ALS, such as C9orf72 and A4V SOD1, may affect the way astrocytes regulate neuroinflammation, potentially leading to MN death.

My initial project was to determine if inflamed ALS astrocytes express an altered library of inflammatory genes compared to wild-type (WT) and isogenic astrocytes. This would be accomplished by treating astrocytes with inflammatory cytokines and comparing gene expression of known inflammatory indicators CXCL1 and CCL2. However, results from cytokine-treated astrocytes growing in Fetal Bovine Serum (FBS) media showed they were not inflamed in comparison to untreated cells. Thus, my summer research shifted to determining the effects of 5% FBS astrocyte media on the morphology and activation of astrocytes. My findings suggest that 5% FBS media does alter astrocyte morphology and gene expression, and removal of FBS from astrocyte media restored the effectiveness of our inflammatory assay. These findings could have broad implications for the field given that 10% FBS media is commonly used to culture astrocytes. Results from research investigating astrocyte morphology and gene expression may need to be reevaluated if FBS was used in the astrocyte media.

Works Cited

1. 1) Liu J, Wang F. Role of Neuroinflammation in Amyotrophic Lateral Sclerosis: Cellular Mechanisms and Therapeutic Implications. Front Immunol. 2017 Aug 21;8:1005. doi: 10.3389/fimmu.2017.01005. PMID: 28871262; PMCID: PMC5567007.
2. 2) Van Deursen S. 2022 'The Effect of the ALS Associated C9ORF72 Hexanucleotide Repeat Expansion Mutation on Astrocyte Activation.' Wesleyan University, Middletown, CT

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.5 Gunn Jungpaibul (2024); Colin Smith (Chemistry)

Web-based GUI for FitNMR

Nuclear magnetic resonance (NMR) is a valuable tool for determining the structures of molecules and probing their dynamics, however, fitting overlapped signals in crowded spectra can cause issues for many large biomacromolecules. FitNMR is an open-source R package for analyzing multidimensional NMR data that performs well for such signals. The algorithm automates incorporation of additional peaks with a rigorous statistical test and reduces errors by sharing parameters within/between spectra. FitNMR uses analytically-derived models of NMR lineshapes that take into account truncation and apodization to return the true peak parameters. Implementation of FitNMR is currently script-based and requires the command-line interface to operate. This project aims to create a graphical user interface (GUI) for FitNMR to streamline the workflow for users. Usability testing was built into the development stream to create a tool that is intuitive and integrates smoothly into the existing workflow. To accomplish this we used R, RShiny, Plotly, JavaScript, HTML, and CSS to implement features such as the ability to change fitting groups by adding, deleting, combining, or splitting peaks.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.6 Anne Kiely (2024); Brian Northrop (Chemistry)

Organic semiconductors can be used to make strong, light, inexpensive electronic devices. Highly functionalized, π-conjugated complexes derived from phenazine, an N-heteroacene, can have high through-bond conductivity and resist degradation. This makes them promising as electronic components. At this time, there have been few attempts to create these types of complexes, and most known routes to phenazine synthesis are low-yield. This project shows progress toward synthesizing several diamines, which will ultimately be condensed with dihydroxyquinones to create π-conjugated phenazine-derived complexes. Reaction conditions and purification procedures were tuned to maximize yield, particularly for reaction steps that create side products. Ultimately, the target complexes are likely to form if the condensation reactions are reversible, which would allow the reactants and products to undergo dynamic covalent exchange until the most thermodynamically stable (and desired) product is reached. Determining the energies of intermediates and transition states of the phenazine condensation could indicate possible ways to influence the exchange rate, so the mechanism was investigated computationally with Gaussian 19. So far, we have determined the most favorable pathway for the mechanism's first two steps, and we discovered that the water loss steps are likely concerted with intramolecular proton transfers. Our initial investigations provide a basis for tuning the reversibility of phenazine condensations by altering reaction conditions and functionalizing the precursors. Overall, by developing efficient syntheses for phenazine-derived complexes and analyzing their electronic properties, we hope to produce new organic semiconducting materials and shed more light on the properties of π-conjugated organic systems.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.7 Maggie Lee (2023); Michelle Personick (Chemistry)

Nucleotide Modifications Change Dynamic Interactions of the Ribosome CAR Surface

The ribosome CAR interaction surface behaves as an extension to the A-site decoding center revealed through Molecular Dynamics (MD) simulations. This interactive surface is hypothesized to regulate protein translation through the hydrogen bonding interactions between the CAR interface and the +1 mRNA codon, next to enter the A-site. From previous research, the codon sequence specificity of the CAR-mRNA interaction has a strong preference for GCN codons. This could suggest that there is a sequence-dependent layer of translational regulation dependent on the CAR surface. The strength of the hydrogen bonding interactions with the +1 codon is hypothesized to be dependent on the presence of 10 residue modifications in the ribosome decoding center. The hydrogen bonding interaction is weak in the presence of all 10 residue modifications and strong in the absence of modifications. We would like to investigate the strength of this interaction with a single residue modification. We observed that in the presence of a single residue modification, CAR had interactions as weak as in the presence of all residue modifications. In the absence of modifications, there is a strong preference for GCN codons and a low preference for CGN codons. We hypothesize that the presence of all residue modifications, the CAR and +1 codon interaction remains sequence specific. In the presence of all modifications, although weaker, CAR continues to have the strongest interaction with GCN over other +1 codons

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.8 Leonard Majaducon (2025); T. David Westmoreland (Chemistry)

Prototropic Exchange Mechanisms in $[Cr(cyclen)(H_2O)_2]^{3+}$

Magnetic Resonance Imaging (MRI) is a common technique in medical diagnostics. Images result from measured changes in the proton longitudinal T_1 and transverse T_2 relaxation times of bulk water under an applied magnetic field. MRI Contrast Agents (CAs) are paramagnetic metal complexes which enhance contrast by inducing large changes in $T_{1,2}$. The measured $T_{1,2}$ can be related to the concentration of the CA to obtain the relaxivity $R_{1,2}$. A good MRI CA has high $R_{1,2}$ values, requiring efficient water molecule or proton (prototropic) exchange with the bulk water. Investigating the separate contributions of water molecule and prototropic exchange, however, is a challenge as these exchanges can occur simultaneously. Understanding the chemical mechanism of exchange is vital in designing and optimizing new CAs. Many chromium(III) complexes are substitutionally inert and have slow water exchange rates, making them suitable models for probing prototropic exchange. By correlating pH-dependent $R_{1,2}$ measurements and potentiometric titration data, and subsequent speciation modeling, the exchange mechanisms for each protonation state of $[Cr(cyclen)(H_2O)_2]^{3+}$ are proposed. The speciation model indicates four possible species: $[Cr(cyclen)(H_2O)_2]^{3+}$ (pKa=4.02), $[Cr(cyclen)(H_2O)(OH)]^{2+}$ (pKa=7.50), $[Cr(cyclen)(OH)_2]^{+}$ (pKa=11.86), and $[Cr(cyclen)(OH)_2]^{+}$ with a deprotonated amine in the cyclen (pH>11.86). $[Cr(cyclen)(H_2O)_2]^{3+}$ and $[Cr(cyclen)(OH)_2]^{+}$ relax by pH-independent interchange mechanism, $[Cr(cyclen)(H_2O)(OH)]^{2+}$ undergoes an acid-catalyzed mechanism. Above pH 10, base-catalyzed N-H prototropic exchange dominates in $[Cr(cyclen)(OH)_2]^{+}$.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.9 Maya Milrod (2024); Brian Northrop (Chemistry)

Experimental and Computational Investigation Into Reversible Cycloadditions

Dynamic covalent reactions have long been investigated as potential systems for covalent adaptable networks (CANs) to be used as cross-links within polymers. Cycloadditions such as Diels-Alder [4+2] systems are great candidates for this type of application. Previous investigations into cycloadditions between furans and maleimides have been the hallmark of reversible cycloadditions. Investigating other potentially reversible reactions can yield a new class of CAN cross-links to be applied to a multitude of areas of chemistry, particularly the macromolecule field. There has been much prior investigation into Diels-Alder reactions involving maleimide as a dienophile, however very little prior investigation into Diels-Alder cycloadditions with phenazine acting as the diene. Computational analysis predicts that alkoxy substituted phenazine and maleimide adducts are possibly favored thermodynamically and reversible kinetically. Similarly, reacting long studied furan derivatives with tropone derivatives seem to also yield possible dynamic covalent products according to computations. This study computationally investigates potential reversible reactions using density functional theory calculations to search for reversible cycloadditions, the desired reversibility range being ΔGs of formation in the range of –0.5 kcal to –4.5 kcal and ΔG of transition states falling, ideally, between 20 and 25 kcal. Pertinent reactants, as screened by computations, were synthesized or are in the process of being synthesized for further experimentation. New reversible cycloadditions can be harnessed in a multitude of ways, especially in the macromolecule and polymer fields. This study provides in depth information on new reversible cycloadditions in addition to pathways to synthesis and experimentation.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.10 Alexis Papavasiliou (2024); Michael A. Calter (Chemistry)

Investigating the Effects of Rocaglamide Analogues on the Specificity of A3

Rocaglamide, a natural product found in the plant genus *Aglaia,* has shown anti-cancer properties. Based on crystal structures (1), rocaglamide is known to bind to eukaryotic initiation factor 4A1 (A1), which is part of the DEAD box helicase (DDX) family. DDX proteins are RNA binding proteins. When rocaglamide binds to A1 it changes which RNA sequences the protein will bind to strongly. A1's modified target sequences are only in the 5' untranslated region (UTR) of the mRNA for pro-prolific proteins, preventing these proteins from being translated (1). By slightly modifying rocaglamide to make analogues of rocaglamide (OBM and TE2), data from Calter Lab suggests that these derivatives are binding to a different DDX, A3. A3 is known to bind to a sequence called SECIS(2). The RNA sequence SECIS is found in the 3' UTR of mRNA for selenocysteine incorporating proteins, like glutathione peroxidase 1 (GPX1) and glutathione peroxidase 4 (GPX4). GPX1 and GPX4 are peroxidases that digest harmful peroxides produced inside glycolysis-dependent cancer cells. When A3 is bound to the SECIS sequence the mRNA can not be translated into GPX1 and GPX4 resulting in the cancer cells lysing from the build up of harmful peroxides. In this study we are testing whether OBM and TE2 affect RNA binding of A3 to SECIS. RNA Electrophoresis Mobility Shift Assay (REMSA) and Native PAGE gels allow for visualization of the A3-SECIS interactions and how they are affected by the presence of a rocaglamide analogue. Better understanding how analogues of rocaglamide affect the function of proteins can help develop drugs to target different cancer cell lines from rocaglamide.

References

(1)Iwasaki S, Floor SN, Ingolia NT. Rocaglates convert DEAD-box protein eIF4A into a sequence-selective translational repressor. Nature. 2016 Jun 23;534(7608):558-61. doi: 10.1038/nature17978. Epub2016 Jun 15. PMID: 27309803; PMCID: PMC4946961. (2)Budiman ME, Bubenik JL, Miniard AC, Middleton LM, Gerber CA, Cash A, Driscoll DM. Eukaryotic initiation factor 4a3 is a selenium-regulated RNA-binding protein that selectively inhibits selenocysteine incorporation. Mol Cell. 2009 Aug 28;35(4):479-89. doi: 10.1016/j.molcel.2009.06.026. PMID: 19716792; PMCID: PMC2752292.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.11 Owen Rogers (2024); Colin Smith (Chemistry)

SOD1 Molecular Dynamics simulations and alchemical free energy calculations of N53D

The enzyme superoxide dismutase-1 (SOD1) is responsible for roughly 20% of cases of familial amyotrophic lateral sclerosis (fALS). The fully mature enzyme is dimeric, composed of 153 residues on each monomer and is Zn- and Cu-bound. SOD1-fALS occurs when mutated SOD1 is either misfolded or aggregates which results in cell death in motor neurons. A vast array of single amino acid side chain mutations have been found to be responsible for the enzyme becoming pathogenic and leading to motor neuron death, which is one of the hallmarks of ALS. One such mutation, N to D, is mimicked by deamidation of an asparagine residue to an aspartic acid side chain. Deamidation is a relatively under-studied process in the context of fALS and it involves the non-enzymatic loss of an amide group in glutamine or asparagine residues. Specifically, Residue 53 has been identified as a possible site of deamidation but has not been extensively investigated in the relevant literature (O'Neil et al). Using in-silico methods to simulate the alchemical morphing of mature homodimers of SOD1 into heterodimers is a computational way to determine the ΔG of heterodimerization (ΔG_{het}) in ways that cannot be done in vitro or in vivo. Using GROMACS and the GROMACS add-on pmx, 100 ps morphing simulations from N to D can be performed using alchemical intermediates to assess the physical characteristics of WT and MUT states of the protein to assess the favorability of different mutations. Preliminary results from three separate 100 ps morphing simulations show a negative ΔG_{het}, indicating that this mutation may stabilize heterodimer formation.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.12 Angela Rojas-Merchan (2024); Benjamin Elling (Chemistry)

Synthesis of Benzoldioxids for Ring-Opening Metathesis Polymerization of Water-Soluble, Degradable Polymers

Ring-Opening Metathesis Polymerization (ROMP) is a fast reaction that frequently uses Ruthenium-based catalysts to produce polymers from cyclic olefins. Ring strain relief is the reaction's driving force, so it performs best when monomer ring strain energy is high. Under living ROMP conditions, polymer chains grow at relatively the same rate with no termination or transfer. As a result, living ROMP typically yields narrow molecular weight distributions. One of its limitations, however, is the common use of norbornene, a high strain cyclic olefin. Norbornene works well with ROMP due to its structure, but reliance on norbornene-derived polymers limit the range of propertues. For example, it is time consuming to make these polymers water soluble. From an environmental standpoint, their inability to degrade is also a cause for concern due to the plastic waste crisis that continues to have adverse effects on humans and earth’s ecosystems.

Here we synthesize *anti*- and *syn*-benzoldioxids as alternative monomerw to norbornene. Due to their high strain energy, these monomers are promising candidates for living ROMP, and the polymers they form have the potential to be water soluble and readily depolymerized. Our experimental design focuses on the synthesis of syn-benzoldioxid from the starting material 1,4-cyclohexadiene. The proposed process involved bromination, oxidation, intramolecular epoxidation, the formation of thiiranes from epoxides, and lastly an elimination reaction. The first three synthesis steps yielded their expected products as shown via NMR, but unforeseen complications occurred when trying to perform intramolecular epoxidation with KOH. We discovered that the product degrades when the reaction is allowed to run for an extended period of time, and it may have also been actively degrading during column chromatography. Future directions include successfully completing the final three synthesis steps to obtain *syn*-benzoldioxid monomers for polymerization with Grubbs Third Generation Catalyst, modification, and depolymerization.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.13 Alex Seys (2023); Stewart Novick (Chemistry)

The Microwave Spectrum of Trifluoromethyl Triflate

In nucleophilic substitution reactions, triflates can be used to add specific substituents to a target molecule. Trifluoromethyl triflate ($CF_3SO_3CF_3$) is an example of a triflate, adding a trifluoromethyl group onto the target molecule. Little prior work exists on the structure of $CF_3SO_3CF_3$, or on triflates in general. Microwave spectroscopy is among the most accurate techniques for determining the structure of small molecules like triflates. Using a Balle-Flygare-type Fourier-transform microwave spectrometer, the microwave spectrum of $CF_3SO_3CF_3$was obtained. A total of 157 transitions were observed, ranging from 7.8 GHz to 13.5 GHz. Rotational constants and distortion constants were obtained. Prior work suggested similar molecules exhibit internal rotation. Based on the computed barriers to rotation, as well as the experimental spectrum, no internal rotation was seen. The constants obtained here are the most accurate yet determined for $CF_3SO_3CF_3$, and can provide a more thorough understanding of how its structure affects its reactivity.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.14 Emmet Sherman (2023); Brian Northrop (Chemistry)

In nucleophilic substitution reactions, triflates can be used to add specific substituents to a target molecule. Trifluoromethyl triflate ($CF_3SO_3CF_3$) is an example of a triflate, adding a trifluoromethyl group onto the target molecule. Little prior work exists on the structure of $CF_3SO_3CF_3$, or on triflates in general. Microwave spectroscopy is among the most accurate techniques for determining the structure of small molecules like triflates. Using a Balle-Flygare-type Fourier-transform microwave spectrometer, the microwave spectrum of $CF_3SO_3CF_3$was obtained. A total of 157 transitions were observed, ranging from 7.8 GHz to 13.5 GHz. Rotational constants and distortion constants were obtained. Prior work suggested similar molecules exhibit internal rotation. Based on the computed barriers to rotation, as well as the experimental spectrum, no internal rotation was seen. The constants obtained here are the most accurate yet determined for $CF_3SO_3CF_3$, and can provide a more thorough understanding of how its structure affects its reactivity.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.15 Avi Sriram (2025); Erika Taylor (Chemistry)

Transfer RNAs (tRNAs) are essential adapter molecules in the process of protein synthesis. They mediate the translation of genetic code into amino acid sequences that are read in the ribosome to create proteins. tRNAs must undergo many post-transcriptional modifications not only to maintain the molecule's structural stability, but also ensure cellular viability and translational competency. With these post-transcriptional tRNA modifications being vital to the survival of bacteria, they are promising as targets for antimicrobial drugs. Recently, the Taylor lab discovered a set of unstudied bacterial enzymes found in pathogenic organisms that include *Mycobacterium tuberculosis,* among others. Our lab has hypothesized that these enzymes may be involved in tRNA modification pathways and hence could potentially be potent antibiotic targets against the aforementioned bacteria. A UV-Vis spectroscopic analysis of the purified proteins of interest from *Mycobacterium smegmatis* and *Mycobacterium tuberculosis* expressed in *E. coli* (msmeg and mtb, respectively) showed a leftward shift from 280 nm to 260 nm, which indicates the presence of nucleic acid and supports the hypothesis that the enzyme may modify tRNA. Nucleic acids have been extracted from msmeg for sequencing, however due to potential RNase contamination and resulting low yields, nucleic acid could not be extracted from the mtb protein. As we apply more precautions to our protocols, we hope to isolate nucleic acids from msmeg and mtb proteins to determine their function and substrate.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.16 Stephen Vaughn (2023); Alison O'Neil (Chemistry)

Amyotrophic Lateral Sclerosis (ALS), also known as Lou Gehrig's Disease, is a progressive neurodegenerative disease characterized by the rapid degradation and death of upper and lower motor neurons (Rowland et al). Roughly 90% of ALS cases are non-genetic in nature, referred to as sporadic ALS (sALS). Previous work has associated a variety of environmental factors with development of sALS (Su et al. 2016), but most notable to our research is the chemical compound cis-chlordane (CC), an insecticide used in US agricultural practices and home fumigation until the late 1980s (EPA). Our lab has previously worked to establish a causal relationship between CC and an ALS phenotype in both zebrafish and in-vitro stem-cell derived motor neuron models. Furthermore, in response to CC treatment, RNA-sequencing data indicated upregulated unfolded protein response and changes in calcium binding proteins. Additional experiments showed an increased in reactive oxygen species. My research builds upon this groundwork and explores three potential mechanisms by which CC acts upon motor neurons and HEK cells: changing levels of ubiquitination, modifying autophagy, and altering cytoplasmic calcium removal.

Rowland LP, Shneider NA. Amyotrophic lateral sclerosis. N Engl J Med. 2001;344(22):1688-1700.
Su F, Goutman SA, Chernyak S, et al. Association of Environmental Toxins With Amyotrophic Lateral Sclerosis. JAMA Neurol. 2016;73(7):803–811. doi:10.1001/jamaneurol.2016.0594
Chlordane. Environmental Protection Agency.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

3.17 Mohona Yesmin (2023); Alison O'Neil (Chemistry)

Cancer is a world-wide common disease whose limited treatment options include chemo-therapies, radiation therapies, and surgery. All these treatments involve potential healthcare issues. Rocaglamide is a small molecule extracted from Chinese rice flower *Aglaia odorata* and has been used in ancient Chinese medicine for hundreds of years. In past studies done by King, Ming-Lu and colleagues in 1982 it had shown promising results to suppress tumor growth by selectively killing aneuploid tumor cells by repressing translation of specific mRNAs which can stop cancer cell growth. Therefore, its derivatives, TE-2 and OBM, are a potential cancer treatment. In this research, six different cancer cell lines were treated with different rocaglamide derivatives which showed they have tumor suppressing behavior in each cell line. Rocaglamide analogs can inhibit cell growth without toxicity to all the cell lines which mean it might potentially be used as an anti-cancer drug in the future. Later, to investigate the mechanism, lysates were collected using these derivatives to perform Western blots targeting Glutathione peroxidase 1 (GPX1) and Glutathione peroxidase 4 (GPX4) protein which showed GPX1 is consistently expressed less than GPX4. This has led to inconsistency in GPX1 analysis.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.1 Noah Braunstein (2023), R. Fox Hayes (2023); Martha S. Gilmore (Earth and Environmental Sciences)

The Impact of Bacteria on Martian Brine Precipitate Mineralogy

Mars has salt-water mixes (brines) that have gone through cycles of freezing, thawing, and mixing. This creates a solution with an abnormally low freezing point known as a eutectic temperature. Brines are able to remain aqueous at extreme temperatures, so they provide a potential habitable source of water for lifeforms, specifically bacteria. This experiment explores the morphologic and spectroscopic signatures of minerals evaporated from ion-rich brine analogues under Earth and early Mars atmospheric conditions and the ability of bacteria to affect that mineralogy. Precipitates formed from natural environmental brines yield mixed spectra that depend on grain size, shape, texture, hydration, coating, crystallinity, and habits of the composite minerals. Early Mars precipitate structures are difficult to compare to existing spectral libraries, which include mono-mineralogic crystallized spectra collected under Earth conditions in laboratories. Library samples are formed under ideal conditions and purified by stringent laboratory procedure. Thus, their spectra do not reflect the imperfect and complex Mars water chemistry that alters in-situ brine spectroscopy of specific mineral signatures. Evidence suggests our experiment addresses these spectroscopic discrepancies by characterizing composite precipitate mineralogy and VNIR spectroscopy in analogue atmosphere environments for Earth and Mars. In addition, literature has recorded evidence of bacterially-mediated mineral topology. As such, we will use bacteria to determine their unique biogeochemical imprint on these minerals. Replicates of *Bacillus subtilis* 1A1 and 1A2 were grown at 37 degrees celsius in a shaking incubator and plated for colony growth. Then, nine 50 mL brines were prepared to test the independent and combined effects of *B. subtilis* and growth mediums on precipitate mineralogy and spectroscopy. This was done in a non-sterile environment, due to a deficit in sterilization materials. The brines did not precipitate and could not be analyzed mineralogically; this was likely due to low circumference glassware, which inhibited evaporative processes. These brines were then plated. Growth of *B. subtilis* and contaminants were only seen in brines containing organics using visual turbidity observations and LB agar plates. Biofilms were seen at multiple altitudes in the organic-containing solutions by day four. Additionally, a mat of indeterminate bacteria were seen growing and depleting the precipitating salts at the central base of the glassware in all *B. subtilis* + mediums + brine experimental groups. A metric for B. *subtilis* medium selectivity against bacteria and between strains was determined using colony forming unit (CFU) counts on contaminant plates. This metric, known as the fractional medium selectivity score (FMSS), approximately reflects the preference of a medium for a certain bacteria against airborne microbes and other strains in experimental groups. Preliminary FMSS values and colony counts suggest that selective B. *subtilis* growth is maximized using 1A1 and B4 medium. More research is needed to prove causation. Our results suggest active *B. subtilis* metabolism of brine salts. This must be further investigated under sterile conditions with in-situ analysis of brines at various time stoppages to confirm B. *Subtilis* induced changes.

This will improve the understanding of the composition in Mars brine solutions by establishing a technique to account for spectroscopic differences produced by atmospheres and bacteria; in addition, the spectra of complex Mars mineralogy for various environmental analogues will act as an approximate spectral library for composite brine precipitates. The spectroscopic signature of biologically-mediated alterations in the minerals formed will set another standard, one for detection of microbes on other planets.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.2 Bridget Cornell (2023), Grace Goodman (2024); Phillip Resor (Earth and Environmental Sciences)

The majority of the mapping that led to the bedrock geological map of Connecticut by John Rodgers was done before plate tectonics, first discovered in the 1950's and 1960's, were widely accepted by the geologic community. Consequently, previously interpreted structures and lithologies must be reinterpreted. Outer Island is the southernmost of the Thimble Islands, located in the 15-minute Branford quadrangle, east of New Haven. The Branford quadrangle exposes rocks and structures important to understanding the tectonic evolution of southern New England from the Neoproterozoic through the Mesozoic and from lower crustal to near-surface environments. This work is part of a larger effort to create a detailed 1:24,000 scale bedrock geologic map of the Branford quadrangle. Additionally, the detailed mapping of Outer Island will lend important insight into the deformation of bedrock under anatectic conditions. This deformation led to complex ductile shear bands, pegmatite dikes, and partially assimilated host rock screens. In order to complete this mapping, researchers utilized a pole-mounted iPad to obtain videos of the bedrock. Researchers then ran the videos through Python in order to extract still images, geotagged each frame, and ultimately constructed 3D outcrop models in Agisoft Metashape. The models were then used for in-field mapping, achieved through careful field observation of dominant rock matrices, xenoliths, and mineralogy, as well as measurements of foliations, veins, pegmatites, and joints. Finally, the mapped data was compiled and digitized in ArcGIS Pro in order to obtain a detailed image of the island outcrop that can potentially be employed in future mapping and research, as well as the preservation of geologic history. The dominant rock type on the island is a granitic gneiss with K-feldspar augen and ubiquitous pegmatite dikes and ductile shear bands, dikes of aplite and pegmatite, and xenoliths of biotite granitic gneiss.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.3 Kelly Fenton-Samuels (2023); Suzanne O'Connell (Earth and Environmental Sciences)

Antarctic climate changes and their underlying mechanisms during the Early Pleistocene

Earth's orbit around the Sun varies in three predictable ways: obliquity (the angle of Earth's tilt on its axis), eccentricity (the shape of Earth's orbit), and precession (the direction of Earth's axis of rotation, also known as its wobble). These three orbital movements control the amount of insolation (solar radiation) received by Earth, triggering fluctuations in global ice volume and cyclic changes in Earth's climate. The benthic δ18O marine isotope record is utilized as a proxy for global ice volume, recording the rhythms of the ice ages over millions of years. During the Early Pleistocene (2.58–0.8 Ma), a strong 20,000-year precession signal is absent in the globally integrated δ18O record despite precession serving as the most influential orbital component on summer insolation intensity. One possible resolution is the Antiphase Hypothesis in which the effect of precession on summer insolation intensity is out of phase between hemispheres. Precession-paced changes in ice volume in each hemisphere would thus cancel out in globally integrated proxies such as δ18O. This project constructed records of ice-rafted debris (IRD) from Dove Basin dating back to the Early Pleistocene. These IRD abundances were then visually correlated to 20,000-year cycles of summer insolation to examine precession pacing in Southern Hemisphere iceberg calving. Furthermore, IRD weight percentages were correlated to both the δ18O record as well as data collected through the International Ocean Discovery Program (IODP) to illuminate iceberg flux and related Antarctic climate changes. Understanding the waxing and waning of ice sheets as well as their underlying causes is crucial in elucidating the mechanisms of past climate change and sea level rise, providing integral data for future climate prediction.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.4 Jasmin Fridman (2025); Suzanne O'Connell (Earth and Environmental Sciences)

Non-Destructive XRF Measurements in High-Latitude Marine Sediment to Understand Climate Change

X-ray fluorescence (XRF) core scanning of marine sediments has been used extensively to study changes in past environmental and climatic processes over a period of time. The evaluation of XRF-derived element ratios primarily in paleoclimatic and paleoceanographic studies includes differences in the relative abundances of elements. Here XRF core scanning data is presented from expedition 395C site U1554E, in the North Atlantic Ocean in the mid-Pleistocene period, and is compared against two other sites in the Southern Ocean, 693 and 1537. These sites are located at high latitudes, which are extremely sensitive to changes in environmental conditions. In addition, deep water, which is cold and salty, contributing to a high density, drives deep ocean circulation and forms in the Atlantic polar regions. Deep ocean currents are important because they can winnow bottom sediments, which means that fine sedimentary particles are brushed away, while heavier and more solid particles are left behind. Past changes in deep ocean currents are measured with particle size analyzers, particularly sortable silt mean (SS). An excellent proxy for SS is the ratio of Zr/Rb in XRF data, and helps to answer the question of whether or not stronger bottom currents occur at the same time. Furthermore, this highlights the need for further study of element ratios found through XRF data and if changes in their concentrations are correlated with climatic processes. This includes Ba/Al ratios and assessing productivity, which is production of organic matter, and its connection to interglacials and glacials.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.5 Yaiza Kinney (2024); Suzanne O'Connell (Earth and Environmental Sciences)

The International Ocean Discovery Program (IODP) Site U1534 is an ocean sediment core site located south of the Falkland Islands. Due to its strategic location, the site has a high sedimentation rate that can be used to reconstruct past climates. One of the most recent and important gradual changes in Earth's recent climate record was the Pliocene-Pleistocene Transition. Between 3 and 0.77 million years ago, the Earth's global climate cooled by approximately 2-3℃, marking the beginning of our current glacial period. Paleoclimate experts theorize that this global cooling was caused by Earth's orbital patterns known as the Milankovitch cycles. The Milankovitch cycles are made up of three distinct movements: (1) eccentricity, or the shape of Earth's orbit; (2) obliquity, or the angle of Earth's axis; and (3) precession, or the direction of Earth's axis. Although previous climate models indicate a strong correlation between eccentricity and obliquity with climate, these studies show conflicting results on the link between precession and Plio-Pleistocene cooling. Our research will continue to investigate this question by using shipboard data and the weight percentages of ice rafted detritus (IRD) to identify paleoclimate indicators of the early Pleistocene from IODP Site U1534. After analyzing the natural gamma radiation (NGR) and the gamma ray attenuation (GRA) within our samples, the data suggests a higher sedimentation rate below 106 meters below seafloor (mbsf) with an inflection point once it reaches around 111 mbsf. Understanding the subtle effect of Earth's orbit on climate and glacial cycles is crucial to understanding not only the past but the future of the Antarctic ice sheet.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.6 Braden Myers (2023); Timothy Ku (Earth and Environmental Sciences)

Blue carbon capture is at the forefront of research into how our marine ecosystems capture and store carbon as well as nitrogen from various sources. The capture and deposition of these carbon materials have been demonstrated in the multiple seagrasses that populate some coastal regions of our oceans. However, studies into the differences between naturally untouched seagrass beds compared to newer restored areas has not been vastly studied. Biscayne Bay which is located south of the Miami metro area was chosen for this experiment as many areas had been wiped out in previous years from dredging and filling. Many newer restoration projects have taken place recently throughout the bay to repopulate lost seagrass beds. We developed a technique into looking at natural and restored seagrass beds with respect to their carbon and nitrogen concentrations on the northern edges of Biscayne Bay. Using coring techniques between sixty to ninety centimeters in depth, an accumulation rate for these organic materials in different systems was able to be processed. Organic carbon by percent weight, calcium carbonate by percent weight, and organic carbon to nitrogen weights (C/N) were all calculated at various intervals within each core. Looking at differences between carbon and nitrogen ratios as well as carbon isotopic compositions, we have been able to see the contrasts of blue carbon capture between natural and restored areas over an extended time period. The C/N ratio was used to trace the source of organic burial from mangroves, seagrasses, and plankton. With the oceans being a carbon sink, seagrasses are invaluable to the storage of large amounts of organic carbon taken directly from the water column. Using the data collected from this experiment we hope to influence seagrass restoration projects for the future as a way of increasing our mitigation of anthropogenic carbon emissions.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.7 Chloe Odabashian (2023); Marth Gilmore (Earth and Environmental Sciences)

Spectral signatures of minerals averaged over the wavelength bands used by the DAVINCI and VERITAS mission's instruments

Due to Venus's CO_2-rich atmosphere and sulfuric acid clouds, its surface is difficult to observe in visible wavelengths. However, the European Space Agency's Venus Express mission visualized the surface through an atmospheric window around 1μm in the near-infrared (NIR) portion of the electromagnetic spectrum. The 1μm region is sensitive to the amount of Fe^{2+} in minerals, thus, this window enables us to study surface properties and possibly reveal the composition of some of the oldest terrains on Venus. Through this phenomenon is how the Deep Atmosphere Venus Investigation of Noble gasses, Chemistry, and Imaging (DAVINCI) probe and Venus Emissivity, Radio science, InSAR, Topography, and Spectroscopy (VERITAS) missions will study Venus. Images of the surface will be obtained using three different instruments onboard these two missions. On DAVINCI, the Venus Imaging System for Observational Reconnaissance (VISOR) instrument will image the surface in three NIR bands during flybys, and the Venus Descent Imager (VenDI) in two NIR channels (broad and narrow band) during the probe's descent. The Venus Emissivity Mapper (VEM) on board the VERITAS satellite is a spectrometer that will map the surface through atmospheric windows in six NIR channels. The spectra of minerals in the NIR are known from laboratory spectroscopy. At these wavelengths, iron-rich (mafic) minerals convey a lower reflectivity and a higher emissivity than other, silica-rich (felsic) minerals. Iron content is important because the presence of felsic minerals may suggest past plate recycling processes whose formation requires water-rich environments. The purpose of this research is to build a database of mineral spectra to match the spectra satellites will provide- mineral spectra averaged over bands around 1μm. To build this database, we run the spectra from the United States Geological Survey (USGS), Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), and Reflectance Experiment Laboratory (RELAB) mineral databases, as well as locally collected spectra, through an R code that averages the spectra at wavelengths that match the missions' instruments. The resulting spectral plots are akin to what the satellites will return, so when we go to Venus, we can identify surface composition. For laboratory data, we find distinct differences between the felsic and mafic rocks. At the VenDI channels, mafic rocks never plot over 35% reflectance on either the wide or narrow band, and felsic rocks have a higher reflectance in both bands. On the VEM and VISOR instruments, felsic rocks also have a higher reflectance than mafic rocks. By studying the minerals' spectral signatures now, we can be prepared to understand what we see on the surface of Venus.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.8 Jeet Patel (2024); Suzanne O'Connell (Earth and Environmental Sciences)

Pleistocene paleoclimate (research involving the Earth's climate from 2.58 million to 11,700 years ago) in Antarctica is studied through ice and marine sediment cores. These cores capture the environment of the time they were deposited. Ice rafted detritus (IRD) is deposited during both glacial and interglacial periods. The samples being researched were drilled from the Weddell Sea. In a collaborative effort between Wesleyan, Stony Brook, and Columbia University, researchers try to answer how unstable was the Antarctic ice sheet in this time period.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.9 Advait Prasad (2024); Helen Poulos (Earth and Environmental Sciences)

This research investigates the factors influencing bee abundances in Northeast Barrens Systems. Bees populations are declining globally due to habitat fragmentation and pesticide use, causing treatment to be needed to preserve at risk pollinators. The research included the use of statistical tools as well as data analysis to measure bee abundances over the years as barren habitats were managed by treatments such as fire, mowing etc. The findings of this project indicated that bee abundances in Northeast Barrens is related to vegetation canopy cover, however are not affected by the treatment pursued in the past 3 years.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

4.10 Brittany Rosenberg (2023); Timothy Ku (Earth and Environmental Sciences)

Our goal of staying within 1.5 degrees of preindustrial global temperatures is unachievable without carbon sequestration and storage. As of March 2022, the estimated atmospheric CO2 concentration was 100 ppm greater than the IPCC target. This gas traps heat in our atmosphere and contributes to climate change. Scientists and economists alike are looking to coastal ecosystems in attempts to expand incentivized routes of sequestration. Referred to as blue carbon environments, wetlands like mangrove forests are capable of storing carbon at a higher density than their terrestrial counterparts. Despite increasing attention to blue carbon environments (BCEs), there are still some carbon accounting factors that are unknown. One of which is how rates of CO2e removal in restored ecosystems compare to natural ones. In BCEs there are several organisms that can sequester carbon. The extent to which each organism contributes carbon is also unknown. In attempts to understand where the carbon comes from and the rate of sequestration, we analyzed sediment cores and plant samples. Using an Element Analyzer, we wrapped homogenized powder from each depth interval and analyzed the carbon and nitrogen content. We used coulometry to find the inorganic carbon and subtracted this value from the carbon content to find organic carbon. Surprisingly, there is little difference between organic matter content in restored and natural ecosystems. Based on the C/N ratio, the primary source of carbon comes from seagrasses. We will prepare the intervals for isotopic analysis to further pinpoint the plant species and determine percent mixing. These findings can direct restoration efforts with respect to increased carbon sequestration. This, along with an understanding of the sequestration rates of restored BCEs, should affect policymakers in carbon accounting.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

5.1 Isabella Ahearn (2023); Laverne Mélon (Neuroscience and Behavior)

Alcohol use disorder (AUD) affects 14.5 million people every day, making it the third leading-preventable cause of death in the United States. Understanding the neurobiological underpinnings of this disorder is crucial to developing therapeutics for AUD. Repeated exposure to drugs, like alcohol, leads to sensitization of the mesocorticolimbic dopamine circuit which originates in the ventral tegmental area (VTA). This project compares the behavioral and neurobiological effects of sensitization to alcohol in male and female mice. Our goal was to determine whether males and females show similar changes in activity of this dopamine pathway and its sensitivity to natural reward, following ethanol sensitization. Mice received acute or repeated (14) injections (i.p) of alcohol across two weeks (20% ethanol, in saline) and were tested immediately following injections on the first and final days in an open field maze. Locomotor activity for mice that were repeatedly administered alcohol was significantly greater than those receiving alcohol for the first time on day 14 (i.e. mice had a sensitized response to the drug). To probe activity of the reward pathway, mice were given an opportunity to interact with a sexually-immature juvenile for 5 minutes during early or protracted withdrawal. Female mice demonstrated a reduction in preference for social interaction during protracted withdrawal. Brains were harvested in a separate cohort following repeated or acute administration of alcohol to identify which population of neurons in the dopaminergic circuit is changing their response to ethanol or natural rewards overtime. As the lab has identified sex differences in the expression of subtypes of GABAergic inhibition in the VTA (with males showing little to no expression of the major GABA-A subtype that mediates tonic inhibition), we probed for an understudied subtype of GABAA receptor containing an epsilon subunit and for Tyrosine Hydroxylase (rate limiting enzyme responsible for dopamine synthesis) in the ventral tegmental area. We positively identified this subtype of GABA-A receptor on dopaminergic and non-dopaminergic cells in the VTA and are currently measuring alcohol's impact on this subtype of GABA-A receptor. Future work will determine whether sex differences in the reactivity to natural rewards that we see following sensitization to alcohol involves direct or indirect inhibition of dopamine neurons in the reward circuit via epsilon-containing GABA-A receptors.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

5.2 Aaron Berson (2023); Gloster Aaron (Neuroscience and Behavior)

Examination of the Na,K-ATPase Pump as a Target of Cis-Chlordane in sALS Development

Making up nearly 90% of the annual 20,000 ALS cases in the US alone per year, sporadic amyotrophic lateral sclerosis (sALS) is a neurodegenerative disease characterized by the death of motor neurons. As opposed to those with familial ALS, sALS patients do not express a known heritable genetic mutation. Instead, past literature has considered environmental factors as possible causes for one's development of the disease. Exposure to *cis*-chlordane, an organochlorine pesticide commonly used in American farming practices during the mid-20th century, has been found to be positively correlated with sALS development.[1] Observing that *cis*-chlordane led to signs of poor neuronal health, a 2021 study determined that treating embryonic stem cell (ESC)-derived motor neurons with *cis*-chlordane led to lower maximum firing rates and larger action potential drops.[2] However, a specific mechanism for how *cis*-chlordane damages motor neurons remains unknown. *Cis*-chlordane cohorts exhibited reduced upslope and downslope rates of action potentials and increased resting membrane potentials, suggesting that sodium and potassium ion transport was being impaired. We hypothesized that *cis*-chlordane specifically targets and damages the Na,K-ATPase pumps of motor neurons, thereby diminishing the driving forces of sodium and potassium ions. This summer, the primary work of my research sought out to assess this proposed mechanism through whole-cell patch clamping of motor neurons in an *in vitro* model of sALS derived from human embryonic stem cells (hESCs). Motor neurons were exposed to ouabain, a well-known plant-derived toxic glycoside, to inhibit their Na,K-ATPase pumps. Ouabain has been demonstrated to change and even block action potential characteristics by binding near the K^+-binding sites of Na,K-ATPase pumps with high affinity.[3] By comparing the results of this study to previous electrophysiological observations of motor neurons treated with *cis*-chlordane, the Na,K-ATPase pump is shown to be a plausible target of *cis*-chlordane and examines how the pesticide might ultimately lead to the dysfunction and death of motor neurons seen in ALS patients.

References:

1. Su FC, Goutman SA, Chernyak S, Mukherjee B, Callaghan BC, Batterman S, Feldman EL (2016) Association of Environmental Toxins With Amyotrophic Lateral Sclerosis. JAMA Neurol 73:803-811.
2. Moon, E. F. (2021). Electrophysiological Changes of Motor Neurons in a hESC Model of Sporadic and Familiar Amyotrophic Lateral Sclerosis [Masters Thesis, Wesleyan University].
3. Ogawa, H., Shinoda, T., Cornelius, F., & Toyoshima, C. (2009). Crystal Structure of the Sodium-Potassium Pump (Na+,K+-ATPase) with Bound Potassium and Ouabain. PNAS, 106(33), 13742–13747. https://doi.org/10.1073/pnas.0907054106

Wesleyan University

SUMMER RESEARCH POSTER SESSION

5.3 Maggie Lee (2023); Michelle Personick (Chemistry)

Nucleotide Modifications Change Dynamic Interactions of the Ribosome CAR Surface

The ribosome CAR interaction surface behaves as an extension to the A-site decoding center revealed through Molecular Dynamics (MD) simulations. This interactive surface is hypothesized to regulate protein translation through the hydrogen bonding interactions between the CAR interface and the +1 mRNA codon, next to enter the A-site. From previous research, the codon sequence specificity of the CAR-mRNA interaction has a strong preference for GCN codons. This could suggest that there is a sequence-dependent layer of translational regulation dependent on the CAR surface. The strength of the hydrogen bonding interactions with the +1 codon is hypothesized to be dependent on the presence of 10 residue modifications in the ribosome decoding center. The hydrogen bonding interaction is weak in the presence of all 10 residue modifications and strong in the absence of modifications. We would like to investigate the strength of this interaction with a single residue modification. We observed that in the presence of a single residue modification, CAR had interactions as weak as in the presence of all residue modifications. In the absence of modifications, there is a strong preference for GCN codons and a low preference for CGN codons. We hypothesize that the presence of all residue modifications, the CAR and +1 codon interaction remains sequence specific. In the presence of all modifications, although weaker, CAR continues to have the strongest interaction with GCN over other +1 codons

Wesleyan University

SUMMER RESEARCH POSTER SESSION

5.4 Qunzhe Lin (2023); Theodore Beck Sternlieb (Mathematics and Computer Science), Kelly Thayer (Chemistry)

Deep Reinforcement Learning for Specific Drug Design

p53 is an important protein in the human body which functions to suppress cancerous tumors. However, when p53 itself becomes mutated, it fails to perform its function, allowing unchecked cell growth. The small molecule PK11000 (REFERENCE) has been shown to reactivate native activity of the p53 Y220C hotspot mutation, both in vitro and in vivo. However, because it covalently binds to Cysteine residues indiscriminately, it causes many side effects. Now with the help of Molecular Dynamics and Machine Learning, we aim to design new drugs similar to PK11000 without the side effects. The project will look into the machine learning model for searching alternatives of PK11000, which includes how specific Deep Machine Learning model with graph generation works, how the model is fine-tuned for this project, as well as how potentially we can refining the existing model in the future.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

5.5 Sean Stetson (2025); Kelly Thayer (College of Integrative Sciences)

Allosteric regulation, a form of protein interaction in which a molecule bonded to a protein is able to control a distant site, presents great promise in molecular medicine. However, the fine details of how allosteric signals are sent through a protein remain a mystery. Our recent molecular dynamics studies considered the hotspot Y220C point mutation as an allosteric perturbation to the p53 protein, which is in turn allosterically restored by the binding of the PK11000 compound.

Long range electrostatic networks provided promising insight into the mechanism of transmission of allosteric signaling within the globular DNA binding domain. These findings raise the question as to what further information could be gained from inclusion of the disordered N- and C-terminal regions known to be involved in regulation of p53 activity through post translational modifications. This current work introduces constructs involving the full length modeled protein, the Y220C mutant, and the PK11000 drug bound to p53Y220C. We report preliminary results from all-atom AMBER molecular dynamics simulations on these constructs in light of allosteric action at a distance and implications for de novo design of new restorative allosteric therapeutics.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.1 Neil Bohan (2023); Joseph Coolon (Biology)

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.2 Ethan Brill-Cass (2023); Logan Dancey (Government)

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.3 Revi Brown (2023); Jennifer Mitchel (Biology)

Analyzing the Distribution of Cell Shape and Speed in Co-Cultures of Solid-Like Epithelial Cells and Fluid-Like Mesenchymal Cells

Epithelial cells are typically solid-like (SL), but in the case of injury, development, or cancer these cells can undergo a pseudo-phase transition becoming more fluid-like (FL). During this phase transition, cell shape becomes more elongated with increased variability. Interestingly, in both SL and FL cells, cell shape is defined by the granular packing distribution: the k-Gamma probability distribution. We hypothesis that both the shape distribution and migration behavior of SL cells will be influenced by co-culture with FL cells. Here we co-culture healthy and cancerous cells from breast tissue to test the effect of FL cells on SL cell shape and migration. We co-cultured healthy SL MCF10A (MCF) epithelial cells with cancerous FL MDA-MB-231 (MDA) mesenchymal cells at the following ratios: 100:0, 90:10, 75:25, 50:50, 25:72, 0:100. MDA cells expressed a cytoplasmic fluorescent signal, allowing them to be distinguished from the MCF cells. For each mixture ratio, both cell shapes and cell movements were analyzed. To measure cell shape, cells were stained for E-Cadherin to mark epithelial boundaries (specific to MCF cells) and DAPI to mark nuclei. We obtained confocal images of these stained cells and analyzed them to determine cell shape with a custom pipeline developed in ImageJ and CellProfiler. In agreement with previous work and theoretical predictions, cell shapes of MCF cells in all of the mixtures followed a k-gamma distribution, however the cell shape distribution varied across conditions. In particular, with increasing proportions of MDA cells, the parameter k decreased, and variability of MCF cell shapes increased, suggesting that these cells may be undergoing a SL to FL phase transition. In parallel studies with the same cell mixtures, we obtained live-cell time-lapse movies over 24hr and using an optical flow algorithm in Matlab we tracked the trajectories of MCF cells. As proportion of MDA cells increased, so did the mean velocity of the MCF cells. These results provide proof of concept that co-culture with FL cells skews SL towards a phase transition. In order to further investigate the influence of co-culture of FL and SL cells, we will repeat the above experiments by mixing SL and FL cells derived from both healthy and cancerous tissues derived from pancreas and prostate.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.4 Angelina Chang (2024); Karl Boulware (Economics)

The impacts of COVID 19 have disproportionately affected people of colour, especially African Americans. My project gives a broader view on the time use of the people most disrupted during the height of the pandemic. By using 2020 microdata files from the American Time Use Survey (ATUS) conducted by the U.S Bureau of Labor Statistics, we can have a clear view of how African Americans spent their day before and after COVID 19 disruptions happened. By combining the microdata files: ATUS Respondent, ATUS summary and ATUS-CPS and analysing through STATA we found that Work and work-related activities decreased whilst Leisure & Sports increased relative to the base case month of February before the pandemic started. Hopefully, others interested in understanding the use of African Americans' time can use my data and findings for further research.

Quantitative Analysis Center

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.5 Cara Chen (2023); Mary Alice Haddad (Government)

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.6 Jiaxuan Chen (2023); Richard Grossman (Economics)

The stock market volatility can be measured by the implied volatility of options. To analyze the British stock market volatility before and after the NYSE stock market crash in 1929, we looked into the options price data across different sectors in the British stock market and calculated the implied volatility based on the stock bid price using Black Scholes Merton Option Pricing Formula. We found that there was a significant increase in implied volatility after the Great Depression in 1929 overall. Among oil, rubber, and newspaper sectors, we also found a significant increase in implied volatility. Future work will focus on collecting more data after 1929 to consolidate the conclusions found. Besides, it will also be interesting to calculate the implied volatility for US stocks traded in London to see if there is a meaningful implied volatility difference between US stocks and British stocks traded in London.

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.7 Nicole Deng (2024); Andrea Negrete (Psychology)

Insufficient effort responding (IER) from unmotivated participants can threaten the quality of the research. The purpose of the current research is to prepare the survey dataset for future analysis. The main focuses are to investigate: 1) methods of determining IER. 2) the relationship between IER and demographic information. 3) external validity of the study. Repones time distribution and attention check question (ACQ) are combined to detect participants with poor quality data. Results from statistical tests indicate a higher frequency for youths identified as particular races and first-generation immigrants to provide IER. We do not see any problem with the generalizability of our future analysis on youth socialization and identity, based on the distribution maps.

Acknowledgements: I would like to thank Professor Andrea Negrete from the Psychology department, Professor Gooyabadi, Professor Nazzaro, Professor Kabacoff from the Qualitative Analysis Center for their kind help.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.8 Rome Duong (2023); Pavel Oleinikov (QAC)

Follow the Diagonals: Finding String Matches through Matrix Operations

Pairwise comparisons produce a diagonal line of matches and are originally used in homology. This method is extended to text similarity detections in programming languages as well as large collections of texts. The tokenization of texts allows dynamic programming such as Global Alignment to detect similar texts while running on either the CPUs or the GPU. An alternate approach is combining the visual analysis method with the tokenization of texts. This image-processing pipeline also utilizes Convolutional Neural Networks for the detection of texts in large batches with the consumption of GPU resources. After running the Global Alignment model and image-processing pipeline model on both GPU and CPU, the image-processing pipeline model ran faster while returning all of the string matches.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.9 Calvin Gao (2023); Melanie Khamis (Economics)

The US has been a popular destination for Mexican migrants. In the US, Mexican consulates issue identity cards known as *matricula consular* to Mexican Citizens. Possessing an identity card provides migrants with benefits such as having an eligible proof of identity to apply for bank accounts and driver licenses. We analyze these confidential data to understand Mexican Migration patterns and how GDP may correlate with the decision to migrate or to return to Mexico, in particular at the time of the US Great Recession.

Maps are generated using the STATA software to explore patterns through the visualization of the origins (Mexican states) and destinations (US states and counties). A confidential dataset was used in this research project, hence, a poster will not be available online.

Quantitative Analysis Center

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.10 John Guillamon (BAMA); Tsampikos Kottos (Physics)

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.11 Nathan Hausspiegel (2024); Greg Voth (Physics)

In a fluid mechanics lab, it is often the case that a particle's movement through fluid must be studied in minute detail. Our lab records videos of 3D-printed particles moving in a high-volume tank of water with four high-speed cameras, and we aim to examine their motion by determining the position and rotation of these particles from the videos. Our method for reconstructing particle orientation from video footage involves rendering images of a 3D model of the particle from the perspectives of the four cameras, and using a search algorithm to rotate and translate the model until it matches the video footage. Our current implementation of this method uses MATLAB for searching and image rendering; however, image rendering in MATLAB is slow and lacks detail, and does not take the lens distortion of the real-world cameras into account. We propose a method to use an open-source 3D video game engine (Unreal Engine 5) to implement the image rendering and search algorithm, which has the resources to render much more realistic images of 3D models and can also take into account lens distortion. Further research is needed to improve the speed and real-world accuracy of this method, and to determine whether or not it is suitable for long-term use in analyzing lab data.

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.12 Caleb Henning (2025); Balazas Zelity (Economics)

Economists have hypothesized that there is a relationship between seasonal affective disorder (SAD) and consumer feelings about the economy, often measured indirectly through stock market performance. However, not much research has been done on the relationship between SAD and the more direct measure of consumer confidence. The purpose of this research is to examine if there is a relationship between SAD and consumer confidence by indirectly measuring SAD through the seasonal variables of sunlight duration, solar elevation, and sun declination. The results revealed that there is a slight positive and statistically significant relationship between sunlight duration, solar elevation, and consumer confidence, particularly when looking at measures for consumer perceptions of the future of their jobs, personal investments, and local economy at large, even when controlling for larger economic predictors such as GDP growth rate, annual change in CPI, and unemployment rate. These findings suggest that the length of daylight and the elevation of the sun may affect consumer confidence and positive/negative feelings about the economy. Further research should be done into this topic to validate these results and confirm the presence or absence of SAD as a predictor variable through more direct measurements.

Quantitative Analysis Center

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.13 Pete Hwang (2025), Evelyn Zhou (2024), Sophia Pogliano (2023), Fox Hayes (2023), Kristen Scopino (Biology), Daniel Krizanc (Computer Science), Kelly M. Thayer (Chemistry), and Michael P. Weir (Biology)

Probing GNN Codon Enrichment and Ribosome Function

The ribosome CAR interaction surface is hypothesized to provide a layer of translation regulation through hydrogen-bonding to the +1 mRNA codon that is next to enter the ribosome A site during translocation. In a previous study with molecular dynamics simulations, we discovered a strong codon sequence specificity of this CAR-mRNA interaction. In this study, we used sequence bioinformatics to investigate the relationship between GNN codon enrichment of gene sequence open reading frames (ORF) and levels of gene expression in yeast cells under stressed conditions. A negative correlation was found between the two, suggesting the presence of translational regulation, possibly mediated by CAR.

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.14 Samantha Koo (2023); Charles Sanislow (Psychology)

Understanding the Relation Between Anxiety and Depression Symptoms

Generalized Anxiety Disorder (GAD) and Major Depressive Disorder (MDD) are both internalizing disorders found to be highly comorbid with each other. GAD and MDD have four symptoms that overlap in their diagnostic criteria, sleep disturbance, psychomotor agitation/retardation, fatigue, and loss of concentration. Various frameworks and models have been proposed to reevaluate approaches to psychopathology. The “P” factor, or the general factor of psychopathology, implies that there are shared psychopathological mechanisms that function across multiple mental disorders. This study looks at the relation between anxiety and depression symptoms to explore the underlying mechanisms. Data used in this study is from the National Comorbidity Survey Replication (NCS-R) Survey which was designed to examine the prevalence, risk factors, and consequences of psychiatric morbidity and comorbidity. The findings of this study suggest that the symptoms of GAD and MDD can be separated into three different factors, disruptions in motivation, in arousal and regulation, and in cognition. The goal of this work is to inform understanding of the relation between GAD and MDD, which, in turn, will provide clues for future research on the underlying mechanisms and why symptoms overlap.

Quantitative Analysis Center

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.15 Jiyong Lee (2023); Balazas Zelity (Economics)

The persistence of transgenerational plasticity (parental sun versus shade) in the annual plant *Polygonum persicaria*

Foreign Direct Investment (FDI) refers to an investment made by a resident of one country in another. The investor faces choices whether to repatriate their profit to the origin country or to reinvest it in the host country. The reinvestment rate is the ratio of the reinvestment to the total amount of the reinvestment and the repatriation. This project aims to identify the determinants of the FDI reinvestment rate and explain what makes a country more attractive for reinvestment. To do so, a regression model against the reinvestment rate with the fixed effects of the year, host country, and origin country was run, using the pairwise reinvestment and repatriation data of the OECD countries from 2005 to 2020. The results showed that the geographical distance, cultural distance, host country's GDP growth rate, and the change in origin country's real exchange rate were the statistically significant factors affecting the reinvestment rate.

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

2.16 Simin Liu (2025); Maryam Gooyabodi (QAC)

Color is a universal concept existing in every language. While each language has its own unique characteristics, there has been found a shared pattern existing across different language groups. Studying the similarities and differences in color naming between languages could give us a clear view of some underlying shared patterns in linguistics and even a better understanding of how people think. The interesting thing about color naming is that people coming from different language backgrounds all over the world could fall into the same clusters based on their characteristics of color naming. The primary purpose of this study is to explore if some demographic features, like climate, will have a crucial influence on big clusters. To examine the relationships between those, contingency tables and multinomial regressions are widely used to see whether anything unexpected happens. The results state that factors including climate types, people's occupation, latitude, and longitude are important in determining memberships in some clusters. However, every factor seems only to have a weak impact on cluster determination, which means that further study is needed to reveal the mysterious mechanism of color naming.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.17 Linda Lu (2024); Andrew Quintman (Religion)

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.18 Prakriti Mittal (2024); Andrea Patalano (Psychology)

The left digit effect is a numerical bias in which numbers with nearly identical magnitudes but different left digits are estimated to be significantly different from each other (eg., 699 and 701). It is also found in number line estimation tasks which are reliable predictors of math outcomes. Previous studies, using motivational incentives and accuracy feedback, have been unsuccessful in reducing the left digit effect. We tested the use of a benchmark intervention to reduce the left digit effect as it has been shown to reduce accuracy error generally. Participants (N = 165 adults) completed three blocks of 60 trials each of a 0-1000 number line task, where the second block had benchmarks for half of the participants. We found a statistically significant interaction, indicating a sustained reduction in the left digit effect during and following the second block with the benchmark intervention. There was also a significantly positive correlation between one's left digit effect in the first block of the number line estimation task and one's left digit effect one a more complex consumer judgment task.

Quantitative Analysis Center
WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.19 Latonya Smith (2024), Emma Tuhabonye (2023); Erika Franklin Fowler (Government)

Guns As Symbols in Political Ads

Recent increases in mass shootings have resulted in more political discussions about guns and subsequently gun laws. As a result, researchers have focused on analyzing political ads as a way to examine the discourse in reference to these issues. Our data set was the TV advertisements sponsored by federal candidates for the 2020 general election. This project uses it to focus on the detection of gun images and the mention of guns in political television advertisements. We used and compared deep learning techniques such as object detection and image classification to analyze the images and videos in these ads and used logistic regression to determine the factors that influence the decision to mention guns or use their images. We also used Fightin Words (Monroe et al 2008) to assess the distinct terms that are used by Democrats and Republicans in TV political ads that mention guns. Our findings revealed that party affiliation only matters for gun mentionings. We also saw that Democrats and Republicans talk about gun issues in different ways. From this we decided on our next steps to further our research.

Quantitative Analysis Center

WESLEYAN

Wesleyan University

SUMMER RESEARCH POSTER SESSION

6.20 Zara Zhou (2023); Lisa Dombrowski (East Asian Studies)

Wesleyan University

SUMMER RESEARCH POSTER SESSION

7.1 Wyatt Dahlstrom (2023); James Lipton (Computer Science)

Wesleyan University

SUMMER RESEARCH POSTER SESSION

7.2 Oliver Diamond (2023); Victoria Manfredi (Computer Science)

Non Collaborative Multi-Agent Reinforcement Learning for Computer Networks

Reinforcement learning (RL) is a subfield of artificial intelligence concerned with agents learning from interaction with an environment in order to maximize a reward function or achieve a goal. In traditional cooperative multi-agent reinforcement learning, agents work together, performing coordinated actions to cooperatively achieve a goal. We introduce a more computationally tractable problem, multicopy reinforcement learning. In multicopy RL, an agent wishes to complete a task as quickly as possible (minimize delay), while minimizing some measure of cost. The agent may make an arbitrary number of copies of itself during the process, each of which will try a different immediate action to attempt to reach the goal quickly. Assuming that there is significant noise in the delay along different paths to the goal, more copies will decrease delay but increase cost. The problem is to choose the optimal number and type of actions to minimize time to the goal and the cost of all chosen paths. The cost is combined across all agent copies, while the time to the goal is considered for only the fastest agent. Multicopy RL has particularly useful applications in the field of mobile computer networks, where there are distributions of delay for different paths when sending a packet from a source to a destination. In our work, we use a gridworld environment to test the multicopy algorithm and observe that the agent successfully identifies a policy which achieves an optimal trade off between cost and delay for environments with varying noise and cost parameters.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

7.3 Isabella Tassone (2024); Sebastian Zimmeck (Computer Science)

Enhancing Online Privacy: The Development of Practical Privacy Choice Mechanisms

According to The California Consumer Privacy Act (CCPA) and other laws, people have a legal right to opt out from the sharing/selling of their data. However, there remains a lack of practical mechanisms for people to exercise their legal right to privacy on the internet. Our research aims to change that; we set out to learn more about how people understand and make privacy decisions on the internet when presented with various mechanisms for doing so. We achieve this through a browser extension we developed with various designs – or schemes – for opting out. Each of these schemes presents users with a distinct manner in which they may protect their data from being shared or sold to advertisers. Some of these schemes will allow for more specific, personalizable privacy decisions, whereas others will force users to make more generalized choices. Through analyzing trends in different participants' use of the various schemes of the extension, we hope to gain insight on people's personalization preferences when dealing with their privacy online; that is, whether people would rather make individual, site-by-site decisions, or one generalized choice. Early results of our currently ongoing study suggest that people will voice that they prefer personalization, but when given both options will instead make a generalized privacy choice. Our goal is – by analyzing data gathered through monitored use of the browser extension – to develop more effective, usable devices that people may utilize to better protect their privacy on the internet.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.1 Arpie Bakhshian (2024); Amy MacQueen (Molecular Biology and Biochemistry)

Studying the Molecular Architecture of the Synaptonemal Complex by Investigating Ecm11 Mutant Interactions in *Saccharomyces cerevisiae*

The synaptonemal complex (SC) is a hallmark, protein- rich structure conserved across meiotic organisms. The Ecm11-Gmc2 complex has been identified as the central element of budding yeast SC, though we do not know its exact composition on the structural level. Previous research conducted by our lab has taken a structure-function approach to understand the structure of the Ecm11-Gmc2 complex, and it has been proposed that it forms a 2:2 complex within yeast SC. *In vivo,* analysis of budding yeast strains containing specific mutations within the predicted Ecm11-Gmc2 interaction region of the *ECM11* gene have been analyzed via fluorescent microscope imaging and have shown to disrupt SC assembly. Two of these mutants in particular have been of interest, since they have shown Ecm11-Gmc2 interactions within a mitotic setting, but fail to assemble SC. For this reason, this project aims to understand the Ecm11-Gmc2 interactions of these two mutants, *ecm11-F263A* and *ecm11-Δ105-180,* within a meiotic setting using proximity labeling with TurboID. Using this approach, Ecm11 mutant cis and trans interactions as well as Gmc2 interactions could be visualized via Streptavidin-HRP through Western Blot. The results of this experiment have yielded interesting results, and we have concluded that these specific mutations may inhibit the formation of SC central element and/or the formation of the 2:2 complex. Future perspectives include visualizing other mutants that are known to inhibit SC formation to understand what exactly the reason that these specific interactions are not visualized in these Ecm11 mutants

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.2 Julissa B Cruz (2025), Sophia Morgan (2025); Candice Etson (Molecular Biology and Biochemistry)

Investigating the Mechanism of DNA-Mediated Cleavage and Binding of the MvaI Restriction Endonuclease

Restriction endonucleases are enzymes that are able to cleave duplex DNA at or near a specific nucleotide sequence. MvaI is a Type IIP restriction endonuclease found in Kocuria varians. Most Type IIP restriction endonucleases are homodimers that cleave a palindromic DNA sequence, however, MvaI has been shown to bind and cleave the pseudo palindromic sequence CC/WGG (where W can be A or T) as a monomer. Previous studies of the related monomeric restriction endonuclease BcnI revealed that this enzyme cleaves both strands of its pseudo palindromic sequence during a single binding event by flipping on the DNA. This kind of reorientation may require the protein to enter a pseudo bound state, which can be disrupted by high salt concentration. Alternatively, the protein may maintain nonspecific contacts with the DNA backbone, rendering the transition insensitive to ionic strength. Preliminary work with BcnI suggests that it does not pass through a pseudo bound state. We are now investigating whether the same is true for MvaI. We use a total internal reflection fluorescence microscopy (TIRF) based single molecule assay to observe DNA cleavage and determine how salt impacts the reaction mechanism. We also use DNA substrates that are designed to report on either duplex cleavage or nicking of a specific strand of the pseudo palindromic sequence to determine whether there is a bias in initial binding orientation. Our overall goal is to establish a model for how monomeric Type IIP restriction endonucleases bind and cleave duplex DNA.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.3 Bold Boldbayer (2023); Ishita Mukerji (Molecular Biology and Biochemistry)

Probing the importance of the Phe x Glu motif of yeast mismatch repair protein, Msh2-Msh6, in recognizing Holliday Junction

Bold Boldbayar, Amy Du, Zane Lombardo, Ishita Mukerji

From prokaryotes to humans, MutS is a Mismatch Repair (MMR) protein that recognizes post-replicative single-nucleotide mismatches and 1-2 nucleotide insertions. MutSα, the Msh2-Msh6 heterodimer protein complex, is also an ATPase and interacts with DNA mismatches through the Msh6 subunit as shown by X-ray crystallography. The Msh6 subunit contains the evolutionarily conserved Phe-X-Glu motif, two residues that stack with and hydrogen bond to the mismatch, respectively, leading to bending of the DNA. Msh2-Msh6 also binds Holliday Junctions (HJ), a key meiotic recombination and homologous recombination repair intermediate. In this investigation, we specifically address the functional importance of the Phe x Glu motif in binding and recognition of HJ by the *S. cerevisiae* Msh2-Msh6 protein.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.4 Andrew Cao (2023); Rich Olson (Molecular Biology and Biochemistry)

Vibrio cholera, the bacteria responsible for causing the diarrheal disease cholera, forms biofilms allowing them to bind to host surfaces as well as protect themselves from external threats. Mucin, the primary protein within mucus, is hypothesized to enable *V. cholerae's* attachment and formation of biofilms onto biotic surfaces. In this model, it is proposed that the M1M2 domain of a tandem ßγ-domain of the V. *cholerae* protein RbmC is responsible for this mucin-biofilm adhesion. A previous CFG glycan array performed by our lab showed that the main binding targets for RbmCM1M2 are O-glycans. However, it is unclear at the moment how $RbmC_{M1M2}$ currently binds and interacts with O-glycans and other binding targets in mucins. project aims to help characterize M1M2 interactions with mucins by performing an alanine-scanning mutagenesis. 20 amino acid residues on M1M2E's outer surface have been identified to be conserved between M1, M2, and StcE, a known musicinase, suggesting that they form a conserved binding site for mucins. Each of these 20 residues individually to alanine to determine which residues are important in mediating M1M2 binding to mucin. We will first conduct site-directed mutagenesis to generate M1M2 mutants of interest. Next, we will express and purify M1M2 mutants from E. coli and confirm their stability and foldedness using several biophysical techniques (CD melts, dye-binding assays, etc.). We will then measure the mucin-binding activity of mutants using gel-shifts and isothermal titration calorimetry. In the end, we hope to map the mucin binding site on M1M2 in order to gain insight into the M1M2/mucin interaction. This information will expand our knowledge of the function of these adhesins, with the hope of understanding the pathogenesis of this important

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.5 Fa'alataitaua Fitisemanu (2024); Teresita Padilla-Benavides (Molecular Biology and Biochemistry)

Biochemical and structural insights into the novel copper-binding protein, CRIP2

Fa'alataitaua Fitisemanu[1], Ahmed Almohamed[1], Emma Johnston[1], Meili M. Stanten[1], Jaime Carrazco-Carrillo[1], Lorena Novoa-Aponte[2], Cat McCann[1], Alex Hinbest[1], Ranjuna Weerasekera[1], Martha L. Jiménez-González[2], Luis Ortiz-Frade[2], Rich Olson[1], Teresita Padilla-Benevides[1*]

[1]Molecular Biology and Biochemistry Department. Wesleyan University. Middletown, CT, 06459. USA
[2]National Insitiute of Health, Bethesda, MD, 20892. USA
[3] Centro de Investigación y Desarrollo Tecnológico en Electroquímica. Querétaro, 76703. México

Abstract

Copper (Cu) functions as a necessary micronutrient in mammalian cells and is a prerequisite to their proliferation and differentiation. Cu homeostasis is tightly regulated by a large network of copper-binding proteins, as a surplus of Cu is toxic to cells (1). The main regulator of the Cu network is The Metal Regulatory Transcription Factor 1 (MTF1), which interacts with a novel group of Cu-binding proteins. The Cysteine Rich Protein 2 (CRIP2) was observed as an interactor with MTF1 in immunoprecipitation assays coupled with mass spectrometry (2,3). Furthermore, the is evidence that CRIP2 interacts with the Cu-binding chaperone ATOX1 to receive Cu from the cytosol (4). Limited data is available on the biochemical properties of CRIP2, and no current structural data is known for the whole protein. To elucidate the structure of CRIP2, we are establishing the proper conditions for the development of a crystal structure. Additional biochemical characterization of CRIP2 includes limited proteolysis, Cu binding stoichiometry and affinity, and cyclic voltammetry analyses.

1. Maung, M. T., Carlson, A., Olea-Flores, M., Elkhadragy, L., Schachtschneider, K. M., Navarro-Tito, N., and Padilla-Benavides, T. (2021) The molecular and cellular basis of copper dysregulation and its relationship with human pathologies. *Faseb J* **35**, e21810
2. Chen, X., Hua, H., Balamurugan, K., Kong, X., Zhang, L., George, G. N., Georgiev, O., Schaffner, W., and Giedroc, D. P. (2008) Copper sensing function of Drosophila metal-responsive transcription factor-1 is mediated by a tetranuclear Cu(I) cluster. *Nucleic Acids Res* **36**, 3128-3138
3. Giedroc, D. P., Chen, X., and Apuy, J. L. (2001) Metal response element (MRE)-binding transcription factor-1 (MTF-1): structure, function, and regulation. *Antioxidants & redox signaling* **3**, 577-596
4. Chen L, Li N, Zhang M, Sun M, Bian J, Yang B, Li Z, Wang J, Li F, Shi X, Wang Y, Yuan F, Zou P, Shan C, Wang J. APEX2-based Proximity Labeling of Atox1 Identifies CRIP2 as a Nuclear Copper-binding Protein that Regulates Autophagy Activation. Angew Chem Int Ed Engl. 2021 Nov 22;60(48):25346-25355. doi: 10.1002/anie.202108961. Epub 2021 Oct 27. PMID: 34550632.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.6 Charlotte George (2024); Amy MacQueen (Molecular Biology and Biochemistry)

Zip1 SUMOylation and its Influence on Zip3 Colocalization

Meiosis is an essential cell division process in which diploid cells divide into haploid cells, or cells with only half the chromosomes of a typical undivided cell. Proper association and pairing of matching homologous chromosomes, or pairs of chromosomes representing the same type of genetic information, one from each parent, is necessary to ensure that daughter haploid cells produced by the meiotic process have the correct amount of chromosomes, and the synaptonemal complex (SC) assists in maintaining appropriate homolog pairing. In *Saccharomyces cerevisiae* (budding yeast), a protein known as Zip1 makes up the structural components of the SC. The recombinosome, a complex of proteins including E3 SUMO-ligase protein Zip3, are responsible for regulating SC formation and recombination events between homologs. When the SC doesn't form properly, Zip1 forms an irregular polycomplex structure, and we observe, using cytology and immunofluorescent tagging, that Zip3 colocalizes with this polycomplex. However, when mutating specific stretches of the Zip1 protein, we find that Zip3 no longer colocalizes with the polycomplex, which leads us to believe that there are residues in Zip1 that are necessary for Zip3 colocalization. We hypothesize that Zip1 residues that are SUMOylated (a post-translational modification) serve as a mechanism for Zip3 to associate with Zip1. Two highly SUMOylated Zip1 residues, K13 and K92, are within the stretches of Zip1 that we've observed are necessary for Zip3 colocalization. If we change these two residues from their original SUMOylatable amino acids (lysine) to unSUMOylatable amino acids (arginine), we can see if this results in a loss of Zip3 colocalization, implying these residues are not only necessary for colocalization but also that the colocalization mechanism is through Zip3 association with SUMO proteins.

References:
Cheng, S.-Y., Parziale, M., Morehouse, S. J., Feil, A., Davies, O. R., Muyt, A. de, Borde, V., & MacQueen, A. J. (2019, June 20). Crossover recombination and synapsis are linked by adjacent regions within the N terminus of the ZIP1 synaptonemal complex protein. PLOS Genetics. Retrieved July 21, 2022, from https://journals.plos.org/plosgenetics/article?id=10.1371%2Fjournal.pgen.1008201

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.7 Yun Huynh (2025); Candice Etson (Molecular Biology and Biochemistry)

The International Ocean Discovery Program (IODP) Site U1534 is an ocean sediment core site located south of the Falkland Islands. Due to its strategic location, the site has a high sedimentation rate that can be used to reconstruct past climates. One of the most recent and important gradual changes in Earth's recent climate record was the Pliocene-Pleistocene Transition. Between 3 and 0.77 million years ago, the Earth's global climate cooled by approximately 2-3℃, marking the beginning of our current glacial period. Paleoclimate experts theorize that this global cooling was caused by Earth's orbital patterns known as the Milankovitch cycles. The Milankovitch cycles are made up of three distinct movements: (1) eccentricity, or the shape of Earth's orbit; (2) obliquity, or the angle of Earth's axis; and (3) precession, or the direction of Earth's axis. Although previous climate models indicate a strong correlation between eccentricity and obliquity with climate, these studies show conflicting results on the link between precession and Plio-Pleistocene cooling. Our research will continue to investigate this question by using shipboard data and the weight percentages of ice rafted detritus (IRD) to identify paleoclimate indicators of the early Pleistocene from IODP Site U1534. After analyzing the natural gamma radiation (NGR) and the gamma ray attenuation (GRA) within our samples, the data suggests a higher sedimentation rate below 106 meters below seafloor (mbsf) with an inflection point once it reaches around 111 mbsf. Understanding the subtle effect of Earth's orbit on climate and glacial cycles is crucial to understanding not only the past but the future of the Antarctic ice sheet.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.8 Edrea Jiang (2025); Scott Holmes (Molecular Biology and Biochemistry)

Exploring the Relationship Between the H2A.Z and H1 Histones and the Condensin Complex

Chromosome condensation is a critical part of cell division, allowing for proper separation of a cell's genetic material. During mitosis, this compaction process is facilitated by a pentameric protein complex called the condensin complex. Histones are proteins that make up nucleosomes, the basic unit of DNA packaging, and play a role in many different processes including transcription, DNA repair, and, notably, condensation. There are several different histone types: the core histones (H2A, H2B, H3, and H4), a linker histone (H1), and variants such as H2A.Z. Previous findings have shown that the depletion of H2A.Z results in chromosome condensation defects and the additional knockout of the H1 histones can rescue these defects. In this project, we sought to understand the relationship between the H1 and H2A.Z histones and the condensin complex. To do so, we used PCR-based gene knockout to delete *HTZ1*, the gene that encodes H2A.Z and/or *HHO1*, the gene that encodes H1, from strains that are temperature sensitive due to specific mutations in various subunits of the condensin complex. By using serial dilution assays, the relative temperature sensitivity—reflective of condensin activity—of the knockout strains and the original strains with condensin complex mutations were compared and analyzed, revealing that both H2A.Z and H1 play a role in suppressing condensin activity in an allele-specific manner.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.9 Emma Johnston (2024); Teresita Padilla-Benavides (Molecular Biology and Biochemistry)

The Role of Baf180 and its Corresponding SWI/SNF Complex in Metal Regulation

SWI/SNF complexes play an important role in chromatin regulation and remodeling, allowing for their large impact on gene expression. The three main classes of SWI/SNF complexes, BAF, PBAF, and ncBAF, play different roles in this larger process[2]. In order to further understand these complexes, we investigated how three specific gene knockdowns correspond to aspects of the SWI/SNF complex and how these aspects affect metal regulation. Previous findings show that a KD of *Baf180* (PBAF) affects the maintenance of cellular homeostasis in myoblasts[4]. Based on this, we hypothesize that *Baf180* knockdown and its corresponding SWI/SNF complex are specifically implicated in metal regulation. There is a gap of knowledge in this area specifically in relation to how different metals interact with proteins working with the SWI/SNF complex. Our research focuses on how cell count, and therefore cell survival, changes across different knockdowns when exposed to metal solutions. To do this, we plated C2C12 myoblast cells at an optimal density for cell proliferation and supplemented the media with different metal concentrations. We then used a cellometer to determine the survival rates of the cells. We expect knockdown *Baf180* to have a decreased cell count when metals are added and predict *Baf250* (BAF) and *Brd9* (ncBAF) to have similar results to the WT/SCR controls. Understanding the role of SWI/SNF complexes in metal regulation helps to expand the knowledge surrounding the general roles of the SWI/SNF complexes, whose roles and functions are still being defined.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.10 David Jusino (2024), Yun Hyunh (2025); Candice Etson (Molecular Biology and Biochemistry)

Restriction Endonucleases (REases) are enzymes that can cleave specific DNA sequences. As a part of the restriction-modification system, these enzymes protect many bacterial and archeal species from viral infection. Furthermore, type IIP REases have been a staple in molecular biology research and biotechnology. Traditional type IIP REases are homodimers that cleave within a short, palindromic DNA sequence. Despite being classified as a Type IIP REase, BcnI, found in Brevibacillus centrosporus, is a monomer that cleaves the pseudo-palindromic sequence 5'-CC/SGG-3' (Where S can be C or G and / indicates the cleavage site). Though a single monomer BcnI cannot perform simultaneous cleaving of Duplex DNA, it can do so in a single binding event by re-orienting itself relative to the two antiparallel DNA strands. BcnI can reorient by either "hopping", which requires severing electrostatic interactions with the substrate's backbone to temporarily enter a pseudo-bound state, or "tumbling", which does not require such dissociation. To determine which model best describes reorientation by BcnI, we observe DNA cleavage at the single-molecule level, using TIRF-microscopy. Since rebinding to the substrate from the pseudo-bound state is inhibited by salt, we observe DNA cleavage in the presence of buffers with increasing ionic strength. If Bcn1 hops, increasing the ionic strength of the experimental buffer is expected to lower the subsequent yield of cleavage events. If the enzyme tumbles, we expect no such dependence on ionic strength. Our preliminary studies indicate that BcnI does not seem to enter a pseudo-bound state, maintaining electrostatic contact with the DNA during reorientation.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.11 Romani Osbourne (2025); Rich Olson (Molecular Biology and Biochemistry)

Mapping the Mucin-binding ability of the M2 domain of RbmC from Vibrio cholerae

Romani Osbourne, Ranjuna Weerasekera, Rich Olson

Vibrio cholerae, the pathogen that causes the infectious disease cholera, forms biofilms as part of its invasive and survival mechanisms. Mucin, the primary protein in mucus, is hypothesized to facilitate *V. cholerae*'s biofilm attachment to biotic surfaces. Mucus - which covers much of the human digestive tract - is thought to capture chunks of biofilm after *V. cholerae-infected* food or water is ingested. This robust mucus-biofilm attachment is advantageous for *V. cholerae* as it makes the pathogen less susceptible to peristalsis. Previous studies have shown that the tandem βγ-domain of the *V. cholerae* protein RbmC (called M1M2 domains) binds mucin and that this domain is very similar to StcE - a protein in hemorrhagic *E. coli*, which is a known mucinase. However, little is known about the exact binding mechanism and epitope on mucin that is recognized by the M1M2 domains. This study seeks to both qualitatively determine which amino acids on M1M2 are most crucial for binding mucin. Targeting a patch of amino acids that is 100% conserved between M1, M2, and StcE, we aim to carry out mutagenesis on 20 M2 candidate residues to create single alanine mutants. Currently, native gel shift assays were done on two mutants – D49A and N50A – as well as on wild type. Preliminary results suggest that residue N50 disrupts mucin-M2 binding to a greater extent than residue D49. Knowledge of the most crucial mucin binding M2 epitope could elucidate essential biostructures which could help to determine targets for therapeutic intervention (like drugs) to treat cholera and could potentially give us insights into the mechanisms of other biofilm-forming, disease-causing pathogens.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.12 Sara Ptaszynska (2024); Scott Holmes (Molecular Biology and Biochemistry)

The H1 linker histone interacts with DNA at the entry and exit sight of the nucleosome, its structure differs from the highly conserved four core histones composing the nucleosome octamer. Unlike in humans in *S. cerevisiae* the H1 histone is not essential for cell viability and very little is known about its function. We propose an assay sensitive to changes in the functioning of *HHO1*, using Crispr/Cas9 we introduce various mutations into the *HHO1* gene to explore the potential significance of the second globular domain and analyse potential post translational modification sites. We then analyse the Hmo1 and Hho1 similarities by conducting a serial dilution assay sensitive to silencing at the HMR locus and telomeres, displaying the rather opposite relationship between the two proteins. We then use the TurboID technique to identify the proteins interacting with the H1 linker histone, showing no difference in binding partners between the HHO1 and its derivative lacking the second globular domain.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.13 Michael Quinteros (2024); Teresita Padilla-Benavides (Molecular Biology and Biochemistry)

Metal homeostasis is a crucial cellular process needed for the proper and healthy development of cells. This highly controlled metal regulation is carried out by an intricate array of metalloproteins. Our lab studies the interaction between metalloproteins and metals such as copper (Cu) and zinc (Zn) and their contributions to the development of skeletal muscle in vitro. Results have demonstrated that disruption of metal homeostasis in muscle cells impairs myoblast proliferation and delays differentiation. Notably, one of the adverse health effects of the SARS-CoV-2 virus is muscle weakness and dysfunction, an issue that has yet to be elucidated at the molecular level. SARS-CoV-2 encodes a gene known as ORF3a, a proposed viroporin (ion channel) that inhibits the acidification of the lysosome and results in a unique egress pathway for SARS-CoV-2. Based on structural and sequence homology analysis, the ORF3a protein possesses several potential metal-binding residues located in key positions similarly to Cu+-ATPases and Zn2+ transporters. We hypothesize that when ORF3a is expressed in human host cells, it may transport metal ions, which may affect metal homeostasis in tissues and organs of infected individuals, including skeletal muscle. Ectopic expression of ORF3a in murine myoblasts impacted cell growth and reduced the expression of several metalloproteins. Confocal microscopy analyses showed that ORF3a is partially located in the Golgi apparatus, where it appears to induce the expression and colocalizes with the Cu+-exporter ATP7A. Our work has the potential to provide the mechanistic details of a novel pathway by which metal homeostasis, and in consequence, muscle function is disrupted upon infection with SARS-CoV-2 virus.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.14 Meili Stanten (2024); Teresita Padilla-Benavides (Molecular Biology and Biochemistry)

The Regulation of Myoblast Proliferation by CSRP2: a Novel Copper Binding Protein

The development of mammalian cells and tissues requires a critical micronutrient: copper (Cu).However, Cu toxicity occurs if concentration levels exceed cellular needs. If Cu homeostasis is not maintained, conditions like Wilson's and Menkes's diseases can occur. Myogenesis encompasses metabolic and morphological changes that are linked to Cu, like energy production and redox homeostasis. We propose that the role of Cu is not limited to mitochondrial biogenesis, but that it also promotes the activity of Cu-binding transcription factors to promote cell growth and differentiation. The novel Cu-binding transcription factor, CSRP2, is a potential contributor to myoblast growth. We propose that Cu regulates the activity of CSRP2, which may cooperate with other myogenic transcription factors to control cell cycle progression, and in consequence the proliferation of cultured primary myoblasts. Future site directed mutagenesis studies of the putative Cu-binding sites of CSRP2 will elucidate the contributions of the ion to transcriptional regulation. Competition assays will be used to measure equilibrium metal binding affinities of wild-type and mutant CSRP2. This work has the potential to characterize the mechanism by which Cu-dependent transcription factors regulate the development of skeletal muscle, which may be key in the treatment of phenotypes observed in Menkes and Wilson's disease patients.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

8.15 Tai Lon Tan (2024); Ishita Mukerji (Molecular Biology and Biochemistry)

Elucidating Mismatch Binding by S.Cerevisiae Msh2-Msh6 via Photocrosslinking Probes

The Msh2-Msh6 heterodimer recognizes and corrects DNA mismatches that arise post replication and during recombination. Crystallographic structures show that the Msh6 subunit identifies DNA mismatches for repair. Interestingly, Msh2-Msh6 also binds DNA Holliday Junctions (HJ) with high affinity; however, the specifics of this binding interaction and the key residues involved are relatively unknown. To investigate these interactions, two approaches were employed. The first method, developed by Schultz et al. 2002, employs a non-natural benzophenone amino acid pBpA to photocrosslink the protein to the DNA. Site-directed mutagenesis introduced TAG amber stop codons in place of residues potentially involved in junction recognition to ultimately incorporate pBpA at those sites. The second approach photocrosslinked Msh2-Msh6 to HJs with 5-bromouridine substitutions. Exposure to UV light allowed for visual analysis of the protein-DNA interaction to gain further insight into dynamics of the Msh2-Msh6 junction interaction.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.1 Terry Brannigan (2024); Greg Voth (Physics)

The behavior of fluid turbulence can be described by areas of stretching and compression. I am studying the directions and magnitudes of stretching experienced by particles throughout a 3-dimensional, turbulent fluid flow. Previous research has shown that in mapping the alignment of passive directors in a 2-dimensional chaotic flow, “scar lines” emerge where the directors’ alignments invert over a very small distance (Hejazi, Bardia, Voth). My research is focused on extending this to 3D and observing the structure of alignment inversion surfaces (i.e. scar surfaces, scar lines) in high resolution. By using MATLAB to advect points in 3D through a periodic sine flow, I can get the deformation gradients of all points in space. From these I can calculate the Cauchy-Green strain tensors whose eigenvectors give me the directions of maximum stretching/compression, and whose eigenvalues give me the magnitudes of this stretching/compression. By using color maps to plot the angles and magnitudes, we can see that scar lines do indeed emerge in 3-dimensional chaotic flows.

Hejazi, Bardia, Voth. “Emergent Scar Lines in Chaotic Advection of Passive Directors.” *Physical Review Fluids*, vol. 2, no. 12, 2017, https://doi.org/10.1103/physrevfluids.2.124501.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.2 Adin Dowling (2025); Tsampikos Kottos (Physics)

The rapid development and proliferation of high power directed energy weapons technology has raised the urgency to explore new protection schemes of electromagnetically sensitive components from high irradiance (or fluence) incident radiation. In this respect, receiver protectors (RP) constitute an important class of protection devices as they provide protection to sensitive telecommunication assets. Their effectiveness is characterized by the so-called dynamic range i.e. the ratio of incident power or fluence for which the RP is destroyed (limiter damage threshold) to the value of incident power (or fluence) above which the output power or fluence is limited (limiting threshold).

Our objective is to develop a novel class of **non-resonant broad-band RPs** which: (1) are realizable at various operational wavelengths, from the visible to the C-band range; (2) have a wide transmission bandwidth for low-power incident radiation without compromising the high-transmittivity ($> 50\%$); (3) demonstrate an abrupt attenuation (>20dB) of the transmittance above their limiting threshold; (4) demonstrate a broad-band protection, for high-power incident radiation; (5) have a large dynamic range and tunable limiting threshold – adoptable to the underlying applications; (6) demonstrate a fast time-response for limiting action and fast recovery time.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.3 Freddie Gao (2024); Fred Ellis (Physics)

Analog Noise Circuit Design for LC Pumping

The noise signal is often a necessary component in experiments with electronics, and there are several approaches to generate electrical noise; for instance, noise can be digitally produced with the help of a pseudo-random number generator. However, analog noise is still more preferable in some circumstances. In our experiment, we have employed both a reverse biased Zener diode, and a base-emitter reverse biased transistor to gain electrical noise. The mechanism behind both of these choices is the static breakdown that happens when we reverse bias these components, which produces a completely natural and random noise. Although the transistor does produce the noise that we are looking for, the material itself undergoes irreversible damage as the breakdown happens, leading to the decrease of the amplitude of the noise, which is rather inconsistent in comparison to the Zener diode, as it is designed to be reverse biased and the noise amplitude stays reasonably stable. The circuit set up includes the Zener diode and a BF998 MOSFET follower in order to have a more precise measurement of the noise voltage level and some amplification of the noise signal.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.4 Emily Kabat (2024); Fred Ellis (Physics)

LC Noise Pumping with Varactor Diodes

This research examines whether varactor diodes are a viable method for modulating the capacitance in an LC circuit attached to a noise source. Thermodynamics requires that growing and shrinking the gap between the plates of the capacitor will pump the energy in the noise in and out of the circuit. However, mechanically modulating the capacitance cannot be done at megahertz frequencies. In this experiment, we attempt to accomplish this modulation of capacitance with reverse biased varactor diodes. Diodes have two conducting regions sandwiching a nonconducting region, which is physically expanded and contracted by an applied AC voltage. This effectively modulates the capacitance of the diodes, pumping the noise through the circuit. We found that in our circuit, the varactors do modulate the capacitance as hoped, and the quality of the diodes themselves should be sufficient to pump noise. Ultimately, we would like to be able to pump electric noise such that the LC resonator can cool a noise source in the same way that the Carnot cycle can extract heat from a hot bath.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.5 Serena Landers (2024); Tsampikos Kottos (Physics)

Wave Packet Dynamics in Proximity to a Stationary Inflection Point

Stationary inflection points (SIPs) are spectral singularities in the Bloch dispersion relations of periodic metamaterials. They emerge due to the formation of exceptional point degeneracies of the Bloch modes of the system. At the SIP, the group velocity and the second derivative of the dispersion relation with respect to the wavenumber k are equal to zero, signifying the formation of slow light which is robust against losses and structural imperfections. While previous studies have focused on monochromatic wave propagation in photonic structures with SIPs, here, we analyze pulse propagation. Using asymptotic series analysis and detailed numerical simulations, we quantify the spreading of such pulses. Our analysis allows us to design photonic circuits that maintain the shape of the wave packet via SIP dispersion engineering. Ultimately, the goal in these design schemes is to consider the interplay of the SIP slow light with the unavoidable nonlinear mechanisms and other experimental realities appearing in photonic arrangements.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.6 Kevin Liao (2025); Renee Sher (Physics)

Analyzing Perovskites through Confocal PL Mapping

Perovskites are compounds that appear to be ideal for the production of solar cells thanks to their high efficiency compared to other similar materials and their relatively cheap cost to manufacture. However, several issues such as their poor stability limit their commercial applications. In particular, mixed halide perovskites (an incredibly versatile subset of perovskites thanks to their tunable optoelectronic properties) are difficult to use because of a process that occurs upon photoexcitation known as halide segregation, during which the various kinds of halides present within the perovskite separate (ultimately causing the overall efficiency of the material to plummet). Modern researchers are currently unsure as to the specifics of this process, with a multitude of theories currently being proposed and developed. Here, in order to delve deeper into the mechanical properties of this process, we examine several perovskites using a confocal microscope and analyze the resulting image sets using MATLAB to investigate light emission intensity for each sample as it relates to time, wavelength, and space. Moving forward, we hope that this analysis provides our lab with more quantitative information regarding the behavior of luminescent regions within our sample perovskites and acts as an additional resource that can be utilized for the analysis of additional sample materials.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.7 Shutang Meng (2023); Lutz Hüwel (Physics)

Double breakdown of laser-induced plasma 4mm above liquid surface

Both time-resolved and 1D space-resolved spectra of a laser-induced plasma focused 4 mm above an air/water interface have been studied to explore the spatial evolution of the plasma and its corresponding electron density. The space-resolved profile provides clear evidence of two breakdown events (one on the liquid surface and one in the air near the focal point) separated, at all delay times, by a low emission region. Time-resolved electron densities of the two plasmas are extracted from fitted linewidths of three atomic emission lines (656.3 nm H Balmer-α, 589 nm Na D, and 594 nm N II lines). Overall, results are consistent with electron densities decaying from about $6 \cdot 10^{18}$ cm^{-3} at 50 ns by about two orders of magnitude at 10 μs. However, systematic differences between densities obtained from the three emission lines exist and are only partially understood. Further studies, including changing the gas above the liquid, are planned to try to elucidate these and other open questions.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.8 Billy Yue (2023); Renee Sher (Physics)

Silicon (Si) semiconductors has been used in a broad range of fields including photodetection devices and solar cells. Nevertheless, intrinsic Si solar cells can only absorb light with wavelengths shorter than near-infrared wavelengths. Adding deep level impurities into intrinsic Si will help facilitate electron excitation for low energy photons and increasing the efficiency of solar cells. Tellurium has been shown as a potential dopant for Si semiconductors. It has a low diffusion rate in Si substrate, allowing higher doping concentrations, and shows thermal stability up to 400 Celsius. Previous study found that, under decreasing temperature, Te-hyperdoped silicon showed increasing spectral responsivity. Hence, it is important to study how temperature variation influences carrier recombination and carrier lifetime. To prepare for temperature dependent measurements, we conducted experiment under room temperature to decide the dopant concentration and pump power for low temperature measurements. We studied the carrier decay dynamics for Te-hyperdoped Si with concentrations at 0.25%, 0.5%, 1%, 1.5%, 2%, and 2.5% under 400 nm laser with varying intensities at room temperature. We measured the change in material conductivity before and after laser excitation through THz spectroscopy. Carrier lifetime can then be deducted by fitting the data with a bi-exponential decay curve. Comparing the initial conductivity after excitation for different concentrations. We found that the initial increase in conductivities for dopant concentrations smaller than 1.5% are one magnitude larger than that for dopants with concentrations larger or equal to 1.5%. This can be explained by insulator to metal transition (IMT) effect which happens between 1% to 1.5% for Te-hyperdopped Si. In addition, we observed 1.5% and 0.25% samples with significantly smaller carrier lifetime. We then measured change in conductivity for 1% and 2% sample with pump power varying from 0.6 to 6mW. By fitting with the bi-exponential decay model, we find that, for 1% sample, carrier lifetime increases with pump power, showing a potential saturation effect. For 2% sample, a higher dopant concentration allows faster carrier recombination, and the saturation effect was not observed. Furthermore, we found a non-linear relationship between initial conductivity and pump power. This showed that conductivity has fluence dependency, which can be explained by change in carrier mobility as carrier density increases. Further work includes testing samples crystallinity to explain whether 1.5% and 0.25% sample behave differently due to crystal structure. Perform temperature dependent measurement for 1% and 2% sample under 1 mw to observe IMT and prevent saturation effect.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

9.9 Bin Yun (2023); Renee Sher (Physics)

Solar energy has become important as part of a renewable energy source. In order to study the suitable semiconductor materials being used for harvesting solar energy, one must know how solar cells behave and their efficiency. This is directly related to the lifetime of photoexcited electrons, which can be measured by time-resolved terahertz spectroscopy. In this project, we implement a new spectroscopy setup by using tunable laser diodes to imitate sunlight's peak wavelength and intensity better. However, without accurate measurements of electron mobility in our material, the uncertainty of the lifetime extracted from our experiment is very large. Here we implement Fourier analysis and show that the mobility could be directly analyzed from our experiment to enhance the accuracy of an extracted lifetime. Our results demonstrate that lifetime measurements can be conducted with this new setup and may be further optimized such as a better signal-to-noise ratio. Eventually, the improvement of the instrument will give an insight into the behaviors of charge carriers in the solar panel materials and the application of the materials in renewable energy technology.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.1 Julia Brody-Barre (2023); Jill Morawski (Psychology)

Engaging Experimental Subjects: Psychologists' Reports on their Research Participants, 1968-1970

In the late 1960s, responding to apprehensions about federal regulation of human subjects research, the American Psychological Association (APA) gathered empirical data on psychologists' encounters with ethical problems to serve as evidence for developing an ethics code. Several versions of an open-ended survey were sent to thousands of APA members**.** Each form requested the respondents' background information and posed an open-ended question asking respondents to describe incidents of ethical concern. The data set consists of the approximately 2000 known surviving responses, housed in the Library of Congress. The survey responses are the focus of our analysis. While the APA purportedly coded the surveys, no analysis was ever released. Yet the responses offer a unique glimpse into the complex social realities of laboratory life as respondents were not limited by the formal constraints of scientific writing, thus enabling reports of subjectivities and relations that are excluded from scientific publications. The plentiful descriptions of subjects belie the discipline's positivist ethos of objectivity, which assumably assured a laboratory cleansed of extraneous subjectivity and interactions. By examining the attributions made of subjects, we can better understand the assumptions underlying many of the psychologists' ethical reasoning. We can also chart respondents' use of self-knowledge to ascertain subjects' experiences, which often mirrored then middle-class understandings of autonomy, agency, and emotional homeostasis that were taking form within psychological science (and American society).

We have imported the surviving responses into data analysis software MaxQDA 2018 and performed a qualitative analysis using 17 coding categories. A second-and-third stage grounded theory sub-coding was performed on a sample of 755 instances of the "subject attributions" category from 427 surveys. A second stage sub-coding categorized appraisals as "prior to experimental conditions" (314 attributions in 119 documents) or "within-experiment" (578 attributions in 366 documents or 85.7%). 137 segments were coded as both. A third stage sub-coding was performed on the 578 "within-experiment" coded segments, analyzing whether appraisals were referencing subjects' "motivations/cognitions," (250 segments, in 118 documents), "emotional/psychological states," (273 segments, in 194 documents), or "other" (110 segments, in 88 documents). The findings contribute to a better understanding of researchers' reflexive processes concerning empirical research and the cultural context of scientific logic during the period. Closely examining these midcentury descriptions of psychologists' experiences can shed light on the reflexive and cultural dynamics of the modern laboratory.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.2 Maya Faber (2025), Ellie Flynn (2024), Ava Galdenzi (2024), Kayla Penza (2024), Christina Xu (2023); Anna Shusterman (Psychology)

Blind Spots and Sweet Spots: Implementing Guided Play Through the Wesleyan Preschool Math Games

After launching the Wesleyan Preschool Math Games (WPMG) project, the Shusterman lab aimed to improve the early numeracy skills of preschool children through the use of guided play, an approach that has been shown to yield many benefits for learning (Weisberg 2016). In 2021-2022, we launched the first year-long intervention to test the effectiveness of guided play with high and low guidance experimental conditions. As a result of partial fidelity and low adherence to guidance conditions by teachers, the intervention was less effective than hoped. In order to understand why guided play is difficult to implement outside of a laboratory setting, we were sent to local preschools to engage the students in guided play through math games. This study had two main goals: (1) Effectively implement guided play and determine the barriers and pathways to successful intervention: the **blind spots and sweet spots** (2) Find useful insight for the training of future undergraduate math ambassadors. The experience revealed that **child characteristics**, such as temperament, engagement, and math ability, affect guided play. Our findings can contribute to the 2022-2023 phase of the study, which will utilize undergraduate math ambassadors to address blind spots in previous conditions and training instructions, thus offering more flexibility in the conceptualization of guided play.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.3 Shakira Fortson (BAMA); Charles Sanislow (Psychology)

Cognitive Emotional Interactions and Mood Instability

Previous research indicates that mood instability is a common feature amongst many psychological diagnoses such as Bipolar disorder, ADHD, Depression, Borderline and Personality Disorder. The prevalence, specifically in BPD and ADHD, made curious as to if there is a disruption or imbalance in cognitive and emotional processes that correlate with mood. Emotion-cognition interactions in mood instability may affect your thinking and feeling. The present study was designed to investigate the cognitive emotional relationship with mood instability. So far, the present study developed a behavioral task and three measures to conduct a pilot study with 37 college students over 18 years old. The scales used were the ALS scale (Affect Liability Scale), AIM scale (Affective Intensity Measure), and the RRS scale (Ruminative Response Scale). E-prime and Excel will be used to identify statistical relationships between emotion and cognition interactions and mood instability.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.4 Danielle Greene (2023); Royette Dubar (Psychology)

PICK YOUR POISON: DIFFERENCES IN SLEEP-WAKE BEHAVIORS FOR NON-, INFREQUENT, AND REGULAR USERS OF VAPING DEVICES, MARIJUANA, AND ALCOHOL

Past research indicates an adverse relationship between substance use and good sleep quality. Substance use has been shown to increase during the college years. More recent studies have also demonstrated increased substance use during the COVID-19 pandemic. However, the relation between substance use and various sleep characteristics among college students during the COVID-19 pandemic has been understudied. The current study assessed differences in sleep-wake behaviors among frequent (once a week or more), infrequent (less than once a week), and non-users (not used in the past 30 days) of vape devices, alcohol, and marijuana. Participants were 619 undergraduate students who completed surveys in May-June 2020. Results of one-way Analysis of Variance tests showed that vaping was most closely related to poor sleep outcomes in terms of insomnia symptoms and sleep onset latency. Frequent marijuana use was also associated with longer sleep onset latency as opposed to non-use. There were no significant differences among the subgroups for alcohol, nor did any of the groups differ on their sleep duration. This study adds to the growing literature on substance use among emerging adults at college during the pandemic. Future research should use longitudinal data to understand the long-term implications of substance use during the COVID-19 pandemic.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.5 Gunter Haug-Pavlak (2023); Michael Perez (Psychology)

Responses to Racial Violence: Colorblindness and Perceptions of Black Forgiveness

Previous research has discussed the societal consequences of forgiveness for racism (Johnson & Fisher, 2019; Wedderburn & Carey, 2017). This research suggests that when White people commit acts of racial violence against Black people, there is often an encouraged and normative expectancy of Black people to forgive (Johnson & Fisher, 2019; Wedderburn & Carey, 2017). This expectation has primarily been explored through the analysis of forgiveness rhetoric; however, it has not been investigated experimentally. The purpose of this research was to empirically test the notion of expected Black forgiveness and specificaly how colorblind ideology (Bonilla-Silva, 2003; e.g., ignorance to racial differences) may reproduce a Black forgiveness expectation. We used a 2 (Racial Narrative: colorblind/multicultural) X 2 (Forgiveness Narrative: forgive/did not forgive) between subjects factorial design in order to test this expectation. Participants (N = 211) read either a colorblind or multicultural narrative followed by a fictional news story that contained a violent, racist event targeted at a Black victim. In response to the event, the victim either publicly forgave or did not forgive his transgressor. Our results suggested that participants viewed Black victims who forgave more positively than victims who did not forgive, and participants also reported a higher tendency to forgive when reading the Black forgiveness narrative.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.6 Maeve Hoffman (2023), Alexia Pollack (2024); Matthew Kurtz (Psychology)

A Meta-Analytic Investigation of Metacognitive Therapies for Schizophrenia-Spectrum Illness

Schizophrenia-spectrum disorder is a psychiatric disorder characterized by a variety of symptoms which impair aspects of everyday life. Individuals with schizophrenia-spectrum disorder often experience erroneous thinking patterns, which contribute to the establishment of delusions (false beliefs that are inconsistent with reality). Metacognitive therapy is a growing field in schizophrenia that targets these distorted thinking patterns in order to improve symptoms in people with schizophrenia-spectrum disorder. This therapy follows a group-based structure, where therapists aim to raise individual's metacognition, or awareness of their thoughts. Prior research shows the effectiveness of metacognitive therapeutic models on improving metacognition in people with schizophrenia-spectrum disorder, as well as reducing symptoms. The present study is a meta-analysis to investigate the efficacy of all types of metacognitive interventions on targets of treatment (specific symptoms, cognitive biases, narrative organization), and on measures of generalization (psychosocial function, insight).

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.7 Jinjia Hu (2023); Royette Dubar (Psychology)

What Does It Mean To Be Single: The Effect of Relationship Status on Attachment Anxiety, Intolerance of Uncertainty, Identity Distress, and Extraversion Among Emerging Adults

Prior research indicates that compared with people who are in a steady relationship, single-status individuals have lower levels of well-being. Some studies have also shown the association between relationship status and attachment preference and hierarchy. However, it is significant to recognize the difference in dating motives among single individuals. Single individuals who are seeking someone to date might have a different personality and experience from single individuals who are satisfied with their current single status. Moreover, the pandemic has been bringing greater conundrums for emerging adults to establish and maintain romantic relationships. In order to thoroughly evaluate these gaps, this study examines whether relationship status groups would differ in terms of attachment anxiety, identity distress, intolerance of uncertainty, and personality, among emerging adults at university. Participants were 341 undergraduate students, and the data were collected in October and November 2020. With the use of multivariate analysis of variance (MANOVA), the result suggests that emerging adults showed similar levels of attachment anxiety and intolerance of uncertainty, regardless of their relationship status. Nevertheless, young adults who were single and not wanting to date were significantly less extroverted than those who were in a relationship. There was also a significant difference in identity distress among different relationship groups, with the single and wanting to date group having the highest score. This study differentiates between different single groups and assesses various aspects of psychosocial functioning among emerging adults. Future studies should include more diverse populations and use longitudinal data to further assess relationship status in relation to psychosocial functioning.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.8 Gloria Kang (BAMA); Andrea Negrete (Psychology)

Predictors of Critical Motivation Amongst Asian Immigrant Adolescents

The purpose of this study is to examine predictors of critical motivation among Asian immigrant-origin adolescents. Previous research suggests that immigration policies directly impact immigrant-origin youth in many aspects of their lives such as health and education. However, this research expands on previous findings to examine how restrictive immigration policies relate to critical motivation to challenge injustice and whether that relationship varies depending on personally knowing someone who is affected by immigration policies. Using a multi-group path analysis, the research will assess the relationships between levels of restrictive state immigration policies and critical motivation through mediating variables of trust in the American promise and anger towards social injustice. Furthermore, the study will examine moderation by whether participants report knowing someone who is impacted by immigration policies. A Pearson correlation test depicted statistical significance among the mediator variables and critical motivation; however, through this preliminary data analysis, a more representative way to measure the level of restrictive state immigration policy seems necessary to fully examine the conceptual model. Findings from the proposed study seek to increase understanding of the role of macrostructures such as state immigration policies on the sociopolitical development of Asian immigrant youth. This study attempts to serve as a case to better understand how the critical motivation of Asian immigrant-origin adolescents develops through such oppressing macrostructures.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.9 Lilli Liu (2024); Kyungmi Kim (Psychology)

The Incidental Self-Reference Effect in Patients with Schizophrenia

Healthy individuals exhibit the self-reference effect (SRE) where memory is enhanced for information encoded in relation to the self. The SRE occurs when people explicitly evaluate information with reference to their self-knowledge (evaluative SRE) and when a self-relevant cue (e.g., one's own name) is co-presented with information in the absence of any explicit task demand to evaluate the information's self-relevancy (incidental SRE).The evaluative SRE has been attributed to enhanced elaboration/organization of incoming information afforded by the use of a rich network of self-knowledge, while the incidental SRE is suggested to arise due to increased spontaneous attention to self-relevant information. While the evaluative SRE has been shown to be absent or diminished in patients with schizophrenia, how schizophrenia affects the incidental SRE remains to be examined. In the present study, during encoding, schizophrenia patients and matched healthy controls judged the location of words in relation to a centrally-presented name (the participant's own or a public figure's name). In a subsequent surprise recognition test, both patients and healthy controls showed better memory for words that were presented with their own name vs. another name, with no significant difference between the groups in the magnitude of this incidental SRE. Though preliminary, our findings suggest that a spontaneous form of self-related processing that underlies the incidental SRE may be preserved in schizophrenia.

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.10 Meiwen Shao (2023); Barbara Juhasz (Psychology)

Wesleyan University

SUMMER RESEARCH POSTER SESSION

10.11 Kristina Tran (2024); Nicole Watkins and Royette Dubar (Psychology)

Perceived Influence of Social Networks' Opinions and Beliefs on Emerging Adults' Romantic Relationships

Social networks play an important role in emerging adults' development. The opinions from these relationships can significantly influence how emerging adults perceive social relations, especially romantic relationships. This study aimed to explore how emerging adults view the influence of their social networks on their romantic relationships and also further investigate if the influence and importance of one's social network's attitudes and opinions differ for male versus female emerging adults. Participants were 761 unmarried emerging adults from ages 18 to 29 in the US, M = 21.39, SD = 3.42. The results show that the approval of the mother's, siblings, and friend's opinion of one's romantic relationship was significantly higher for female than male emerging adults. These findings highlight that family opinions influence and carry more pressure on female emerging adults compared to male emerging adults.