Cal Poly Pomona | College of Science

DISCOVERY

19th Annual

College of Science Research Symposium

Friday, April 24, 2026
12:00 – 1:30 p.m.
University Quad
(in front of Building 8)

2026 College of Science Research Symposium

Biological Sciences

1. Hippocampal COL6A1 Expression in an Angelman Syndrome Mouse Model

Afnan Saleh, Wenyue Su, Advisor: Xiaoning Bi

Angelman syndrome (AS) is a neurodevelopmental disorder caused by loss-of-function of the maternally expressed UBE3A gene and is associated with severe cognitive impairment and deficits in learning and memory. Emerging evidence suggests that extracellular matrix (ECM) components play a critical role in synaptic plasticity and neuronal stability, and transcriptomic studies in AS mouse models have identified dysregulation of ECM-related genes, including collagen family members such as Col6a1. However, protein-level characterization of these changes within hippocampal subregions remains limited.

In this study, we examined COL6A1 protein expression in the hippocampus of adult wild-type (WT) and AS mice. Coronal brain sections (20 μm; n = 3 mice per group) were processed for COL6A1 immunofluorescence and imaged using confocal microscopy under consistent acquisition parameters. Mean fluorescence intensity was quantified across hippocampal subregions, including CA1 and CA3, and compared between groups using unpaired t-tests.

Immunofluorescence analysis revealed a trend toward increased COL6A1 expression in AS mice relative to WT controls, primarily driven by higher signal in the CA3 region, while CA1 expression appeared comparable between groups. However, these differences did not reach statistical significance.

These findings provide preliminary evidence of region-specific alterations in ECM-related protein expression in AS and highlight COL6A1 as a potential contributor to hippocampal circuit dysfunction. Further studies with larger sample sizes are needed to determine the functional significance of these observations.

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2. Effects of Maternal Exposure to Δ9-Tetrahydracannabinol on Offspring Growth and Glucose Homeostasis in Mice.

Alexandria Stastny, Amanda Terrazas, Ethan Castillo, Angelica Chavez, Thanya Gurrola, Advisor: Dr. Juanita Jellyman

Over the past decade, use of marijuana (Cannabis sativa) has increased, including use by pregnant women. Infants exposed to marijuana in utero had lower birth weights and exposure to the psychoactive phytocannabinoid in Cannabis sativa, delta-9-tetrahydrocannabinol (Δ9-THC), throughout pregnancy decreased birth weight in rodents. This is important because low birth weight is a risk factor for developing chronic diseases, like type II diabetes, in later life. The current study determined whether maternal exposure to Δ9-THC during pregnancy alters offspring growth and glucose in mice. We hypothesized that maternal exposure to Δ9-THC decreases birth weight and impairs glucose regulation in the offspring.

All studies were approved by the IACUC at Cal Poly Pomona. Time-mated female Swiss Webster mice were used in the study. Pregnant mice were injected intraperitoneally (IP) from gestational day (GD) 11 to 18 with Δ9-THC (5 mg/kg in ethanol; cremaphor, saline; THC-treated group; n=3) or vehicle (ethanol, cremaphor, saline 1:1:18; Injected Control; n=3) or had no injections (Untreated Control; n=3). Offspring body weights were measured at birth and averaged within each litter. Litters were standardized to six pups (three males and three females) on ~postnatal day 3. Offspring were weaned on postnatal day 21 and housed in same-sex groups. Glucose tolerance tests were performed ~3 days after weaning. After a 5-6 hour fast, mice were injected with glucose (2 g/kg of 25% dextrose; IP). Blood glucose was measured in tail vein blood immediately before (0 min), and at 15,30,45,60, and 120 minutes after injection using a hand-held glucose meter (One Touch).

Mean birth weight tended to be lower in mice that were exposed to vehicle and Δ9-THC during pregnancy. There were no differences in basal blood concentrations of glucose between the groups in either male or female mice after weaning. Administration of glucose increased blood concentration of glucose within 15 minutes in all the groups. The peak and area under the glucose curve tended to be higher in the injected control and Δ9-THC offspring in males only.

Taken together these preliminary data suggest maternal exposure to Δ9-THC may decrease birth weight in mice. In addition, exposure to vehicle or Δ9-THC may impair glucose regulation in male offspring after weaning.

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3. Halgerda Bergh, 1880 (Mollusca, Gastropoda, Nudibranchia) from New Caledonia

Andres Camacho-Juarez, Advisor: Dr. Ángel A. Valdés

In this study, we analyzed 85 specimens of the sea slug genus, Halgerda, collected from New Caledonia to assess species diversity and identify potential new species. So far, we examined molecular marker: cytochrome c oxidase subunit I (COI). Bayesian phylogenetic analysis of the COI gene was conducted to evaluate genetic differences between our specimens and publicly available sequences from GenBank. Bayesian Poisson Tree Processes (bPTP) and Assemble Species by Automatic Partitioning (ASAP) species delimitation analyses were also performed to assign specimens to putative species. Both phylogenetic and species delimitation analyses revealed the presence of seven potential new species of Halgerda. Photographs of specimens are provided for morphological comparisons. These results help address knowledge gaps in the biodiversity of Halgerda in the understudied region of New Caledonia. The next steps will include examining both 16S rRNA, and histone H3 gene, with additional morphological analyses.

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4. Differentiating Morphologically Similar Swiftlet Species Using Acoustic Spectrogram Analysis

Andrew A. Hernandez, Advisor: Dr. Elizabeth Scordato

The ability to distinguish closely related species by using their vocalizations is key in environments where a researcher's visual identification skills could be limited. Swiftlets tend to nest in dark caves, which makes it particularly difficult to differentiate without capture or direct observation methods. In our focal species, Edible-Nest Swiftlet (Collocalia fuciphaga) and Black-Nest Swiftlet (Aerodramus maximus), we know that they tend to co-occur in the same environments in mixed colonies, where it remains unclear whether their calls can be used to separate them reliably. Here, we used auditory recordings from these species and analyzed them to determine whether we could reliably distinguish them by analyzing their call variables. Using Raven Lite 2 to analyze the spectrograms and RStudio to create density plots and run principal component analysis (PCA), our results showed a substantial overlap between species, with little evidence of clear clustering or bimodality. We were only able to observe weak clustering in our recordings of unidentified swiftlets, which was also observed in the density plots. These findings suggest that vocalizations alone may not be sufficient to be used for identification in these swiftlets. This supports the idea that a push towards separate auditory analysis of echolocation clicks could be more reliable for distinguishing our swiftlet species. This study is one of many, that highlight the challenges of the acoustic distinguishing process in classification for species that may be morphologically and/or behaviorally similar.

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5. The Importance of Elevating Cognitive Activity in Reducing Alzheimer's Disease-Associated Neuroinflammation via DAMP Regulation

Andrew Mitchell, Logan Whitaker, Hans Rabea, Advisor: Dr. Glenn Kageyama

Following a computerized cognitive training program, participants experienced an increase in anti-inflammatory molecules like IL-10, TGFβ, IL-4, brain-derived neurotrophic factor (BDNF) and monocyte chemoattractant protein 1 (MCP-1) with a decrease in pro-inflammatory cytokines and markers like IL-17A, CX3CL1, CCL-11, IL-6, and TNFα (all of these being DAMP-associated molecules). One notable effect this simultaneous upregulation of anti-inflammatory molecules and downregulation of proinflammatory ones has on the innate immune system is the reduction of C1q complement tagging in the brain tissues, thus lessening the activity of synapse elimination pathways. The excessive tagging of neural synapses (this being a defining characteristic of Alzheimer's) results in overactive microglia, which may begin to "prune" normal synapses through phagocytosis and eventually cause cognitive decline. This induced overactivity is also true for astrocytes, which through cell signaling also contribute to synapse degradation/remodeling. The simultaneous upregulation of anti-inflammatory molecules and downregulation of proinflammatory ones also affects the rate of cell cycle reentry (CCR) in neurons, where neurons attempt to divide, fail, and experience apoptosis. This phenomenon is a main cause of Alzheimer's associated neurodegeneration, with the upregulation of TNFα acting as the strongest factor in whether neurons experience CCR. While not directly related to Alzheimer's Disease-associated CCR, there is evidence the pro-inflammatory cytokines IL-17A, CCL-11, and IL-6 act as significant inflammatory factors that exacerbate neurodegeneration via CCR.

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6. Genetic Identification of Dopamine Neurons Required for Circadian Food Anticipatory Activity in Mice

Andrew Villa, Justine Wong, Andrew Steele, Advisor: Dr. Andrew Steele

Anticipating daily environmental changes, such as food availability, is critical for survival. Dopamine (DA) is implicated in promoting food anticipatory activity (FAA), but the specific DA subtypes involved remain unclear. We conditionally deleted tyrosine hydroxylase (Th) in dopamine transporter (DAT)-expressing neurons, causing midbrain DA depletion and severe FAA deficits. Restoring TH in substantia nigra (SN) DAT+ neurons rescued this phenotype. To refine the critical DA population, we used Cre drivers (Crhr1, Foxp2, Ntsr1, Sox6, Vglut2) to delete Th in DAT+ subtypes, with minimal effects on FAA. In contrast, Calbindin1-Cre-mediated Th deletion caused severe FAA deficits despite affecting a small SN DA subset. Notably, Calbindin1-Cre TH knockouts retained anticipatory food seeking (measured by FED3) but failed to increase wheel running. These results identify Calbindin1+ SN DA neurons as essential for the locomotor component of FAA and suggest that anticipatory motivation and movement may be genetically dissociable.

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7. Genomic Sequencing and Functional Analysis of Listeria ivanovii subsp. londoniensis ATCC 49954T Isolated from Food in France

Anthony Villagomez, Charlize Dao, Diana Duenas Alejandre, Rekha Seshadri, Advisor: Dr. Wei-Jen Lin

We report the genome sequence of Listeria ivanovii subsp. Iondoniensis ATCC 49954T, a type strain isolated in 1989 from a food source in France. The genome has 2.96 Mbp and a guanine-cytosine content of 36.85%. The Listeria ivanovii Pathogenicity Island 2 was found in the genome with several virulence genes important for the internalization and survival of the bacterial in the host cells. The complete genome sequence will facilitate studies of L. ivanovii and its pathogenic potential in ruminant animals and humans.

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8. Lipotoxicity Drives Neuroimmune and Membrane Dysfunction

Sarah Flores, Aubrey Castro, Kaitlyn Moreno, Advisor: Dr. Glenn Kageyama

Lipotoxicity, defined as cellular dysfunction caused by the accumulation of excess or oxidized lipids in non-adipose tissues, is increasingly recognized as a key contributor to Alzheimer's disease (AD) pathogenesis. Dysregulated lipid metabolism promotes the accumulation of saturated fatty acids and polyunsaturated fatty acids (PUFAs), which are highly susceptible to lipid peroxidation. This process generates reactive oxygen species (ROS) and toxic lipid-derived aldehydes, including 4-hydroxynonenal (4-HNE), which act as potent inflammogens. These molecules induce oxidative stress, mitochondrial dysfunction, and endoplasmic reticulum (ER) stress, thereby disrupting neuronal and glial homeostasis. Emerging evidence also highlights the role of membrane lipid transport in AD progression. Lipid flippases, composed of P4-ATPases and the regulatory subunit TMEM30A, maintain phospholipid asymmetry required for vesicular trafficking and endosomal function. In AD, the amyloid precursor protein metabolite βCTF interacts with TMEM30A, impairing flippase activity and disrupting membrane lipid distribution. This dysfunction leads to endosomal trafficking defects, an early hallmark of AD, which promotes aberrant amyloid precursor protein processing and increased amyloid-β (Aβ) production. These upstream disturbances converge on inflammatory signaling pathways, particularly activation of nuclear factor kappa B (NF-κB), which primes the NLRP3 inflammasome. Inflammasome activation results in the release of pro-inflammatory cytokines such as interleukin-1β (IL-1β), amplifying chronic neuroinflammation. Within this environment, dysregulated neuroimmune signaling drives two major pathological pathways. First, complement-mediated synapse elimination is initiated by C1q tagging and C3 deposition, leading to microglial phagocytosis and progressive synapse loss. Second, sustained cellular stress induces aberrant neuronal cell cycle re-entry (CCR), triggering apoptosis and neuronal loss. In parallel, impaired autophagy limits the clearance of Aβ, damaged organelles, and lipid peroxidation products, further amplifying ROS and inflammatory signaling. Together, these processes position lipotoxicity as a central upstream driver of AD, linking lipid dysregulation to synaptic dysfunction, neurodegeneration, and cognitive decline.

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9. Lead-Induced Oxidative Stress in Avian Species: A Systematic Review and Meta-Analysis

Brooke Yeatts, Andrea Bonisoli Alquati, Advisor: Dr. Andrea Bonisoli Alquati

Lead (Pb) is a ubiquitous and highly toxic environmental pollutant. Toxicological studies indicate that Pb exposure can generate reactive oxygen species (ROS) and inhibit normal antioxidant functioning, thus potentially causing oxidative stress. However, studies on Pb-induced oxidative stress in birds are inconsistent in the direction and magnitude of biomarker responses. This may be driven by biological variation among species, differences in the sensitivity and reliability of biomarkers of the multifaceted antioxidant system, or other methodological features. To quantify Pb effects on oxidative status and explain variation among studies, we are conducting a systematic review and meta-analysis that examines differences in how the antioxidant system responds to Pb, and identifies the biological and methodological factors that drive species, tissue, and biomarker sensitivities. We identified 90 relevant papers, yielding 781 estimates of Pb effects on oxidative status. The estimates were from 48 species from 12 orders, and 29 biomarkers for Pb effects, antioxidant capacity, oxidative damage, and oxidative status, from lab and field studies. Overall, exposure to Pb significantly decreased antioxidant capacity, and increased oxidative damage. Pb effects also differed among species, which may be attributed to ecological variation in their tropic level, diet, habitat, or life history. Pb exposure differences between treatment and control groups were twice as large in lab compared to field studies, indicating a lack of ecological realism in lab studies. Future developments will compare the sensitivity of specific biomarkers, and test for phylogenetic effects on sensitivity to Pb exposure. Our results may help select sensitive biomarkers and tissues that maximize the detection of Pb exposure and effects, and identify species most at risk from its toxicological effects.

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10. Assessing Mussel Condition and Giant Kelp Distribution Between the Santa Clara and Los Angeles River

Brandon Koehn, Becca Prezgay, Advisor: Dr. Andrea Bonsioli Alquati

Coastal ecosystems are influenced by inputs from adjacent watersheds, including contaminants in the forms of nutrients, sediments, and various toxicants like pesticides. These inputs can vary substantially between urban and agricultural systems, potentially leading to different ecological responses in nearshore environments. This study compares patterns in giant kelp (Macrocystis pyrifera) canopy cover and California mussel (Mytilus californianus) condition between an urban watershed (Los Angeles River) and an agricultural watershed (Santa Clara River) in Southern California. Satellite imagery from the Santa Barbara Coastal LTER (2023 – 2025) were used to quantify seasonal differences in canopy area comparing wet (Q1) and dry (Q3) periods. Distances from river mouths were calculated to evaluate spatial gradients. Mussels collected from both sites were measured for shell length, total weight, and tissue weight, with standard a standard condition index being calculated. Linear models were used to assess relationships between kelp canopy, season, and distance, while mussel conditions was compared between watersheds. Kelp canopy exhibited seasonal variations, with higher values observed during the dry season (Q3). Relationships between kelp canopy and distance from river outflows were weak, though statistically significant, and differed between watersheds. In contrast, the mussel condition index was consistently higher at the agricultural watershed, indicating strong site level differences. This suggests that different trophic levels may be more sensitive to the influence of river runoff, as well as a scaling issue when it comes to looking at how giant kelp is affected by differing watersheds.

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11. No Jelly Left Behind: Cassiopea Habitat Selection & Host Preference of a Parasitic Nudibranch

Brandon Koehn, Clayton Patterson, Jonathan Villegas, Advisors: Dr. Jeremy Claisse, Dr. Ángel A. Valdés

A survey of Cassiopea habitat selection in the Bocas del Toro Archipelago documented a total of 21 individuals of C. xamachana and 49 C. frondosa in 3 survey sites – Pete's Reef, Casablanca, and STRI. We compared the presence of a parasitic sea slug, Dondice parguerensis, reported in southwest Puerto Rico on C. xamachana and C. frondosa with measurements made in the Bocas del Toro Archipelago, to better understand its host preference. This sea slug spends its entire life on the sea jelly, feeding on its tentacles. This study was conducted under the Spring 2024 BIO 4550/L Field Biology (Panama Tropical Marine Ecology) class. Here, we demonstrate empirical findings from the Bocas del Toro Archipelago, suggesting that D. parguerensis prefers C. xamachana as a host. Additionally, we show Cassiopea habitat preference differed between both species based on site abundance. Data was collected via a roving method; three individuals combed the subtidal zone beyond the seaward fringe in a parallel line. Recorded Cassiopea species were then measured individually and carefully inspected for D. parguerensis presence; recovered Dondice were placed onto a slate and extended for consistent measurement. Our data suggests that Cassiopea species distribution differed based on site location: C. xamachana presented a higher population density at STRI compared to Pete's Reef and Casablanca (Fig. 4). Furthermore, D. parguerensis demonstrated exclusive host preference towards C. xamachana. Our time spent conducting this Pilot study provided a lot of insight into the general research process. Conducting research can often be a difficult process, and adapting to changes in the field or elsewhere is vital to conducting a successful study.

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12. Translating Pesticide Use into Toxicological Impact Through Total Applied Toxicity

Carissa Valenzuela, Aaron Zhang, Advisor: Dr. Andrea Bonisoli Alquati

Agricultural pesticide use poses a great risk to non-target species, such as farmland birds, but current exposure assessment methods do not account for differences in compound-specific toxicity. Traditional pesticide exposure assessment relies on metrics like total mass of applied pesticides, but this is not sufficient as pesticides vary in potency, mode of action, and persistence in the environment. These factors mean equal application amounts may result in substantially different ecological impact. There is a growing need for a framework that can integrate toxicological data and ecological factors to link pesticide use to biologically relevant outcomes. This study develops a methodology to quantify pesticide exposure in toxicity units for passerine bird populations. Ecotoxicological endpoints, specifically mean lethal dose (LD50) values extracted from the Environmental Protection Agency's "ECOTOXicology Knowledgebase" database. When multiple values are available, ranges will be averaged to ensure the most sensitive conditions are accounted for without overshooting the pesticide's toxicological relevance. Preference is given to studies reporting higher chemical purity in order to relate the effect to focus pesticides and eliminate false attribution. The representative avian species of the mallard duck (Anas platyrhynchos) and the northern bobwhite quail (Colinus virginianus) are used to standardize toxicity benchmarks. Pesticide application mass data will be integrated with toxicity benchmarks to generate toxicity equivalent units. This framework enables the conversion of pesticide data into standardized toxicity units, which will allow for comparison of toxicological impact across chemical compounds and pesticide classes. Linking application data to potential effects on organisms and populations will improve risk assessment methods. The development of toxicity adjusted exposure metrics will provide a scalable method to evaluate pesticide impact on the environment and will support sustainable agricultural practice.

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13. Identifying Transposable Elements in Argiope bruennichi, the Wasp Spider

Cristina Mejia, Advisor: Dr. Peter Arensburger

Transposable Elements (TEs) are self-replicating sequences of DNA that are capable of moving, or “transposing”, within genomes. They contribute to genetic variation and evolution by altering genetic structure and regulating genes in their vicinity. Transposable elements are found in the genome of nearly all eukaryotic organisms researched to date. In our study, we characterized and catalogued the different “species” of transposable elements within the Argiope bruennichi genome.

We observed and documented TE sequences using a Linux Ubuntu virtual environment, in which the DNA sequences of multiple transposable elements were compared to identify different “species” of TEs present within the genome. We did this in order to identify the transposable elements present in the genome of Argiope bruennichi, and gain insight into its genetic composition. In doing so, we aim to broaden the understanding of transposable elements, their abundance, and role in genomic variation and evolution.

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14. Identification of Anti-Fungal Compounds from Trichostema lanatum for Treatment of Fusarium Diseases

Danielle Galicia, Advisor: Dr. Wendy J. Dixon

Fungi are ubiquitous in the environment and play a dual role in agriculture, promoting plant growth while also contributing to plant disease. As resistance to conventional antifungal treatments increases and concerns about traditional pesticides grow, natural product-derived compounds are becoming increasingly important. Trichostema lanatum, commonly known as woolly bluecurls, is a plant native to Southern California with reported antibacterial and immunomodulatory properties.

The goal of this study is to find antifungals from the T. lanatum plant against pathogens that are responsible for the diseases Fusarium wilt and Fusarium root rot. Previously in the laboratory, T. lanatum methanolic extracts were shown to have antifungal activity against Fusarium roseum. In this current study, methanolic extracts from T. lanatum and compounds potentially identified by mass spectrometry of T. lanatum extracts were tested for antifungal activity. The extract was tested against fungal isolates including Mucor spp., Fusarium oxysporum, and Fusarium roseum. The results show compounds with antifungal activity against F. roseum and F. oxysporum including compounds effective at the micromolar level and thus could potentially work as treatment for Fusarium wilt or Fusarium root rot. These results indicate that T. lanatum should be a rich source for effective antifungal compounds and support the continued exploration of the chemical nature of the T. lanatum.

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15. Daple-FLT3 gene fusion activates and localizes through a distinct mechanism from FLT3-ITD

Darren Kao, Michael Acquazzino, Arnel Ibarra, Elena Valenzuela, Hailey Mai, Kimberly Aguilar, Advisor: Dr. Jason Ear

Gene fusions are stable protein products often occurring from chromosomal rearrangements. These chimeric proteins typically contain distinct molecular entities from each parent gene, and thus, create a product with altered or aberrant function. Gene fusions are frequently found in cancers, including Leukemia. Here, we characterize the kinase activity and subcellular distribution of the Daple-FLT3 (CCDC88C-FLT3) fusion oncoprotein—a rare, but recurrent gene fusion found in patients with hematological malignancies. The protein contains the FLT3 kinase domain and is activated without ligand stimulation. This leads to activation in STAT5a, AKT, and MAPK signaling, which can be modulated by the tyrosine kinase inhibitor (TKIs) sorafenib and to the most specific FLT3 inhibitor quizartinib. The fusions localize to the pericentrosomal space, a unique subcellular localization pattern that is different compared to the well-known FLT3-ITD mutation. We further demonstrate that localization and maximal kinase activation is dependent on the Daple coiled-coil domain. These findings provide evidence that targeting Daple-FLT3 outside of its kinase domain (i.e. the coiled-coil region) may be a complementary approach with TKI therapy.

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16. Molecular Insights into the Evolution of Hypselodoris Sea Slugs from New Caledonia Using COI Analysis

Diana Castillo, Advisor: Dr. Ángel Valdés

Sea slugs are diverse organisms that showcase a wide range of adaptations and play underexplored roles in marine ecosystems. There are about 6,000 known species worldwide and many new ones are continuously being discovered. My research focuses on classifying chromodoridid sea slugs of the genus Hypselodoris, which is exclusive to the Indo-Pacific region. Hypselodoris comprises colorfully patterned species with elongated bodies. I am specifically examining over 290 specimens of Hypselodoris collected from New Caledonia. The existence of cryptic species in this group prevents identification based solely on morphology and has led to classification controversies. To address this challenge, I am employing a combination of genetic and morphological data to provide insights into the relationship between species of the genus Hypselodoris. This combined approach will help me to identify and classify new species while exploring their evolutionary relationships. To date, I have processed 120 specimens and preliminarily identified 43 species. My research aims to enhance our understanding of the genus Hypselodoris and contribute valuable insights into marine biodiversity in New Caledonia. Each new discovery brings us closer to understanding the rich diversity of these remarkable sea slugs.

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17. How does Sea slug abundance vary across site & Halimeda algae species across Bocas del Toro (Caribbean Sea)?

Diana P. Castillo, Audreanna Y. Maragliotti, Angelina C. Nadaya, Daniel A. Risser, Advisors: Dr. Jeremy T. Claisse, Dr. Ángel A. Valdés

The sea slug species Elysia velutinus (Sacoglossa) is typically associated with Halimeda spp. algae. However, there are still questions on how Elysia velutinus is distributed in relation to density of Halimeda spp. or geographic location.

The objective of this study was to determine if high density aggregations of Halimeda spp. contain more Elysia velutinus than lower density ones. Sacoglossa species are important members of tropical coral reef systems due to their unique photosynthetic capabilities. Understanding their abundance and distribution can help us determine coral reef health.

Sea slugs were collected in four locations: Casa Blanca, Pete's Reef, Soropta Peninsula, and Smithsonian Tropical Research Institute (STRI). From each location, two divers collected two 850mL bags of Halimeda spp. in low density and two in high density areas utilizing a 1x1m quadrat. The algae were then placed in two trays, and the other two members of the team examined the algae collected, searching for sea slugs.

We found that Elysia velutinus abundance may be related to the density of Halimeda spp. and site. Beyond serving as a food source, the calcified thalli of Halimeda creates a structurally complex habitat that provides refuge from predation, supports camouflage during feeding, and offers a substrate for egg-laying, all of which likely contributes to the success of this specialized herbivore. Future research should investigate additional variables, including the health, depth distribution, and spatial positioning of Halimeda spp. relative to the mainland and reef patches, to better understand the drivers of this relationship. This highlights the importance of protecting and conserving alga and coral reef ecosystems in these localities to help conserve biodiversity.

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18. Examining Transposable Elements in Uloboridae diversus

Don Dao, Advisor: Dr. Peter Arensburger

Uloboridae diversus is a spider which lacks venom altogether, a rare trait among spiders. Spiders in general are understudied for genome studies, particularly in the area of transposable elements. In an effort to better understand transposable elements, their evolution, and their possible relationship to lacking venom, annotations of DDE transposable elements were carried out on Uloboridae diversus genomes. These annotations focused on identifying transposable element specific features such as Target Site Duplications (TSDs) and Terminal Inverted Repeats (TIRs) to mark and confirm transposable elements identified using perl scripts in Ubuntu.

The current progress of these reviews is about 66% (100 out of 150 elements reviewed). Preliminary results show that the genome possesses most commonly “TA” elements, followed by 8bp and then 4bp length TSDs. Of the 8bp and 4bp TSDs, these usually are variable amongst different samples; the main exception being that there are a few 4bp TSDs of the form “TTAA”. No connections to lacking venom have been identified or posited yet with this data. Heavily degraded elements with unrecognizable TSDs and TIRs have also been identified, which may help with piecing together TE evolutionary history. Completion of reviewing possible DDE elements in Uloboridae diversus is underway.

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19. Mapping changes in GLT-1 expression of the mPFC-nRE-Ca1 neural circuit during chronic T. gondii infection

Elijah Huang, Venjaminne Fua, Advisor: Dr. Tatiane Lima

Toxoplasma gondii is an obligate intracellular parasite that infects approximately one-third of the global human population. This parasite causes toxoplasmosis, a pathogenic infection that is neglected and underrepresented in science and medicine. Although most acute infections are mild or asymptomatic, T. gondii can cross the blood-brain barrier and establish a chronic infection in the brain. Recent evidence indicates that chronic T. gondii infection causes a decrease in the expression of the astrocytic glutamate transporter (GLT-1), inducing an increase in extracellular glutamate and subsequent neuronal damage. The medial-prefrontal cortex (mPFC), nucleus reuniens (RE), and Ca1 hippocampus is an important neural circuit bridging memory and executive function. Our previous behavioral studies have shown poor memory and executive function during chronic infection. It is currently unknown how T. gondii can affect neurons in the mPFC-nRE-Ca1 circuit. Given that decreased GLT-1 expression leads to neuronal damage, our study aims map changes of GLT-1 expression in mPFC-nRE-Ca1 circuit during chronic T. gondii infection. To map these changes, we will surgically dissect and isolate protein homogenates from these circuit regions of mock and chronically infected C57BL/6 mice and use western blot to assess changes in GLT-1 expression. We expect to see a decrease in GLT-1 expression within this circuit during chronic T. gondii infection. Given that T. gondii can manipulate host cell signaling, our future studies aim to utilize CRISPR-Cas9 to remove specific parasite factors that could be disrupting GLT-1 transcription.

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20. Daple-PDGFRB contains an active tyrosine kinase in leukemia cells

Elizabeth Sheets, Advisor: Dr. Jason Ear

Leukemia is a type of blood cancer that affects the white blood cell count. Various mutations have been identified in leukemia patients, with a significant proportion of patients harboring gene mutations specifically known as gene fusions. Gene fusions occur when parts of two different genes are fused together, forming a new gene product. In several leukemia patients, a novel fusion between the scaffold protein Daple and the cell-surface receptor PDGFRB has been identified. In all cases of the Daple to PDGFRB gene fusion identified, the N-terminal domain of Daple fused to the kinase domain of PDGFRB. The function of this novel gene product derived from such a fusion has not been well-characterized. It is hypothesized that this gene fusion will be constantly active and lead to high signaling activity downstream of RTK pathways, such as STAT5 kinase activation. To evaluate if RTK activity alone is directly causing constitutive activation of downstream signaling pathways, a site-directed mutagenesis was done on the tyrosine kinase domain on Daple-PDGFRB. Both wild-type and mutant genes were electroporated into cells, followed by analysis of the STAT5 pathway through Western blotting with phospho-specific antibodies. Immunoblotting reveal that ablating kinase activity on Daple-PDGFRB prevented TAT5 activation. This suggest that directly targeting the kinase domain on Daple-PDGFRB may suppress oncogenic pathways in patients harboring Daple-PDGFRB.

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21. Anticoagulant Rodenticides in Adult Red-tailed Hawks in Southern California

Ella Eleopoulos, Hal Batzloff, Alex Eagleton, Lauren Genger, Scott Weldy, Peter Bloom, Andrea Bonisoli-Alquati, Advisor: Dr. Andrea Bonisoli-Alquati

Anticoagulant rodenticides (ARs) are a class of pest control agents that are environmental pollutants due to their effects on non-target species who feed on rodents, such as raptors. ARs inhibit blood clotting ability, and in raptors this can cause anemia, dull mentation, and death, when chronically exposed. To characterize ARs' prevalence and effects in populations of raptors, studies with sublethal non-opportunistic sampling that represent a wide range of habitats are critical to accurately assessing risk of exposure. By measuring signs of stress in our samples and comparing ARs prevalence across landscape characteristics, this research aims to understand the threat of ARs to Red-tailed Hawks (Buteo jamaicensis), and to test the efficacy of recent bans on the use of ARs in California. We have collected blood samples from approximately 43 adult Red-tailed Hawks in Orange, Los Angeles, and San Diego counties. Specifically, we aim to quantify eight ARs: brodifacoum, bromadiolone, difethialone, difenacoum, diphacinone, warfarin, chlorophacinone, and coumachlor. We will test whether ARs concentrations are positively associated with indicators of stress, such as decreased hematocrit and increased heterophil lymphocyte (H/L) ratio. We will also use spatial analysis to test for environmental predictors of ARs exposure, including anthropogenic landscapes, the wildland-urban-interface, greater building density, and ecosystem productivity, as indexed by remotely-sensed vegetation indices. Our sample collection locations span a broad range of land cover types, with the proportion of anthropogenic to natural land ranging 2 - 82%, and average building density ranging from 0–1,000 buildings/km2 in the capture sites of adults. The results of these analyses and tests will help quantify risks from ARs to natural populations of raptors, and direct future management and regulatory actions.

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22. Using Remote Sensing to Assess the Influence of Temperature and Vegetation Structure on Arthropod Biodiversity in Agricultural Landscapes

Emily Montes, Advisor: Dr. Erin Questad

The conversion of diverse natural ecosystems into uniform agricultural areas can lead to habitat homogenization, reduced vegetation structural complexity, and the subsequent loss of biodiversity. Vegetation structure modifies local temperature conditions through solar radiation reflection and microclimate creation, which is important for temperature-sensitive arthropod communities that provide essential ecosystem services such as pest control. However, the combined effects of thermal properties and vegetation structure on arthropod biodiversity remain understudied, especially at spatial scales relevant for agricultural management and conservation. We examined the relationships between vegetation, temperature, and arthropod biodiversity in lemon and avocado orchards as well as in the natural riparian corridor of the Santa Clara River Valley (SCRV), a globally important agricultural and conservation region in Southern California. 3D vegetation structure was measured with uncrewed aerial vehicle light detection and ranging (lidar). Thermal characteristics were measured with iButton temperature sensors in the field and with NASA's Landsat 8-9 Operational Land Imager/Thermal Infrared Sensor Level 2, Collection 2 to measure surface temperature. Arthropods were sampled with sticky traps and pest control advising surveys, with a focus on sampling insect pests and natural enemies. We used linear and generalized linear models to test the following questions: 1) do 3D vegetation and thermal metrics differ between site type, distance from the Santa Clara River, and distance from edge of orchard blocks (transect distance); 2) how do 3D vegetation characteristics relate to thermal properties; and 3) how do 3D vegetation and thermal characteristics relate to arthropod biodiversity, including abundance and richness of pests and natural enemies. Mean height differed by site type ($F_{2,17}$ = 4.43, p = <0.05), and foliage height diversity (FHD) differed with transect distance ($F_{2,34}$ = 10.08, p = <0.01). FHD was the strongest negative predictor of all five temperature metrics, including mean surface temperature (β = −4.66 ± 1.87, p < 0.01) and mean air diurnal temperature range (β = −6.25 ± 1.66, p < 0.001), meaning that sites with greater vertical canopy complexity had lower and less variable temperatures. Sticky trap pest and natural enemy abundance differed by transect distance (pests: χ^2 = 9.77, p < 0.01; enemies: χ^2 = 6.17, p = <0.05), and natural enemy abundance differed by site type (χ^2 = 7.60, p = < 0.05). Higher surface temperature predicted greater pest

abundance ($\chi^2 = 5.16$, $p = < 0.05$) but lower pest Simpson's diversity ($F_{1,38} = 21.30$, $p = <0.001$). These results show that vegetation structural complexity moderates local temperatures and influences pest and natural enemy communities in agricultural landscapes.

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23. Potential impacts of insecticide-fungicide interactions on insect floral visits and fruit yield in pumpkin

Emily Roman, Advisor: Dr. Joan Leong

Pumpkin cultivation in California faces significant pest challenges, notably from cucumber beetles (Diabrotica undecimpunctata) (Fig. 1b), (Acalymma trivittatum) and squash bugs (Anasa tristis) that impact crop quality and yield. Effective pest management often involves the use of insecticides and fungicides, but these can adversely affect pollinators, crucial for pumpkin pollination. This study investigates potential pesticide effect on foraging and pollination behavior, primarily on honey bees (Apis mellifera) (Fig. 1a), the presence of native squash bees Xenoglossa (Xenoglossa) strenua, Xenoglossa (Peponapis) pruinosa, and cucumber beetles. Conducted at Spadra Farm, Cal Poly Pomona University, the study examines how treatments of imidacloprid (a neonicotinoid insecticide) and Rhyme (a fungicide), both individually and in combination on FarMoreIF400 seeds, influence pollinator floral visitation patterns. Key parameters include insect floral visit frequency between treatment groups, particularly in honey bees and cucumber beetles.Preliminary hypotheses suggest that pesticide treatments will reduce floral visitation and interaction frequencies, potentially impacting fruit yields. The findings revealed that while thesetreatments did not significantly affect honey bee visitation to flowers, they did influence cucumber beetle visitation, with FarMoreI400 and Rhyme-treated flowers receiving more visits than FarMoreI400 and Imidacloprid treated flowers.

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24. Garlic increases TNF-α secretion from LTA induced murine macrophages in a cell dependent manner

Ethan Ford, Advisor: Dr. Nancy E. Buckley

Garlic is known to have immunoregulatory effects. Key immune cells include macrophages. When challenged with bacteria associated molecules such as lipoteichoic acid (LTA), macrophages produce immune regulatory proteins such as the cytokine tumor necrosis factor-alpha (TNF-α). Macrophages are the major producers of TNF-α. It has been shown that garlic modulates LPS-induced TNF-a secretion in a time-dependent and cell-dependent manner. LTA is a Gram-positive bacteria cell envelope component. Litte is known on the effects of garlic on LTA-induced TNF-α secretion from macrophages. The present work focused on determining an effective LTA concentration to use to investigate the effects of garlic on LTA-induced TNF-α secretion from two different murine macrophage cell lines. To this end, J774A.1 and RAW264.7 murine macrophages were grown concurrently at a concentration of 6.25 × 104 cells/mL. After 24 hours, conditioned media was removed and replaced with complete media containing LTA, with and without garlic. Varying concentrations of LTA between 2.5-20 µg/mL were used. Following 24 hours of treatment, the cell supernatants were collected. Enzyme-linked immunosorbent Assay (ELISA) was used to determine TNF- α secretion. Preliminary findings suggest that garlic increases TNF-α secretion from both J774A.1 and RAW264.7 cells with increasing LTA concentrations. However, at 100 µg/mL there was possible cytotoxicity. Future experiments will determine which concentration within the 1-2 µg/mL range will be most effective. Additionally, garlic's effect was more pronounced in J774A.1 compared to RAW264.7. In J774A.1, garlic induced an increase of TNF-α secretion twice that of RAW264.7, suggesting garlic operates in a cell-dependent manner.

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25. Genome Sequence and Annotation of Myroides phaeus DSM 23313T Isolated from Human Oral Cavity

Nathalie Leon, Rebecca Roytman, Farzad Ahmed, Dimitrios Stamatis, Danielle Graham, Markus Göker, Vera Thiel, Advisor: Dr. Wei-Jen Lin

We report the genome sequence and functional analysis of Myroides phaeus DSM 23313T, a type strain isolated from the oral cavity of a student at Weifang Medical University in China. Genomic DNA was sequenced using the Illumina HiSeq-2500 1TB platform, resulting in 4,885,032 reads for a total of 732.8 Mbp of DNA. The final draft genome consists of 60 contigs and 58 scaffolds with 265.4x coverage. Genome annotation was performed using the Integrated Microbial Genomes (IMG/M) pipeline v.4.11.2. The assembled genome is approximately 2.97 Mb in size with a GC content of 33.19% and contains 2,661 predicted genes. Whole-genome phylogenetic analysis using the Type Strain Genome Server identified Flavobacterium visosum as the closest relative of M. phaeus. Genome annotation indicates extensive β-lactam resistance and reveals the presence of blaR1 and blaI regulatory genes, but the absence of blaZ, a key component of the bla operon which encodes Staphylococcal Class A β-lactamase. Instead, M. phaeus encodes an OXA-type Class D β-lactamase capable of hydrolyzing a broad range of β-lactam antibiotics, including carbapenems. These findings provide a genomic basis for further investigation of alternative regulatory and resistance mechanisms the genes blaR1 and blaI may be involved in.

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26. Developing and efficient tissue culture procedure for Aquilegia and Delphinium

Francizka N Graves, Elyas M. Ashtijou, Irelynn R. Nelson, Joshua J. Shinn, Paola A. Martinez, , , Advisor: Dr. Bharti Sharma

Plant tissue culture is an in vitro plant regeneration technique. Using Murashige and Skoog (MS) plant growth media with varied hormone concentrations, the current objective of our study is to develop an efficient tissue culture protocol for the regeneration of Aquilegia and Delphinium. This study has three aims - Aim 1. Developing an efficient seed germination protocol. Aim 2. Testing the effect of auxin 2,4D on callogenesis using cotyledonary leaves and hypocotyls as explants. Aim 3. Testing the effect of cytokinin BAP on shoot regeneration. Seeds were germinated on MS media containing full-strength salts supplemented with vitamins and sucrose. Germinated seeds were dissected, and explants were inoculated on MS media supplemented with varying plant growth regulator concentrations (0.5 mg/L, 1.5 mg/L, 2.5 mg/L, and 5.0 mg/L). Measurements of callus growth and shoot regeneration frequency are taken to assess treatment efficacy. Optimizing the tissue culture protocol will facilitate future developmental and functional genetic studies.

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27. Locals Only: Algal community structure is site and depth dependent in Caribbean Panama

Gwyneth R. Stolo, Sean J. Taylor, Advisors: Dr. Jeremy Claisse, Dr. Ángel A. Valdés

This pilot study examined patterns of algal community structure across four marine sites in Bocas del Toro, Panama as part of the spring 2026 BIO 5550/L Field Biology course (Panama Tropical Marine Ecology). Transect-based surveys were used to quantify the percent cover of predetermined focal algal types and evaluate variance in algal community structure among sites, microhabitats (i.e. coral reef, coral rubble, and sand) and depths (i.e. shallow and deep). Based on prior observations during exploratory snorkeling days, we hypothesized that algal community structure would be primarily driven by microhabitat differences due to potential variation in substrate complexity and herbivory pressure. To test this, we utilized 20-meter transects and conducted uniform point contact surveys across three microhabitats (coral reef, coral rubble, and sand) and two depth strata (shallow and deep) at each site. The dominant algal type was recorded every 0.5 m to estimate percent cover and compare community structure between the different variables. Ultimately, the data revealed that algal community structure was more dependent on site, and to some extent depth, as opposed to microhabitat. This pilot study provided insight into the challenges associated with marine fieldwork and required us to adapt our approach to the limitations of time and resources. Overall, this course was an overwhelmingly positive experience that cannot be replicated in the classroom!

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28. Physiology & Phenology of Species in Disturbed Coastal Sage Scrub

Hannah Herrick, Izzy Changaran Kumarath, Gaby Negrete, Bryce Dahlstrom, Julia Hernandez, Cesar Gomez, Advisor: Dr. Edward Bobich

Coastal sage scrub (CSS) communities are found throughout California's coastline but are heavily threatened by habitat loss due to development and invasive species. Native plants in CSS communities are typically dominated by drought deciduous and, to a lesser extent, evergreen soft-wooded shrubs. Information regarding leaf-level physiology in CSS communities has been historically limited and there is little to no information on the carbon balance and evapotranspiration of this once widespread Californian community. The purpose of this study was to relate the vegetative growth and reproduction of individual plants in the CSS plant community to their leaf-level physiology and to eventually relate these responses to ecosystem level measurements. The research took place in the Voorhis Ecological Reserve on native species, including Artemisia californica, Diplacus aurantiacus, Eriogonum fasciculatum, and Salvia mellifera, and invasive species, like Brassica nigra and Marrubium vulgare. Surprisingly, most of the species maintained significant levels of gas exchange in the late summer, even some invasive annuals, which are dead by that time. All species responded quickly to early season rains and maintained physiological activity even after a month without significant rainfall. All of these measurements will be used to determine which individual species are contributing most to the seasonal ecosystem fluxes of water and carbon dioxide in the CSS throughout the year.

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29. The Importance of a Healthy (Anti-Inflammatory) Gut Microbiome in Reducing the Risk of Developing Dementia Associated with Alzheimer's Disease

Hans Rabea, Lara Chahinian, Alan Munoz, Advisor: Dr. Glenn Kageyama

Alzheimer’s disease (AD) and related dementias are increasingly linked to alterations in the gut and oral microbiomes that promote chronic innate immune activation. This continuation of our previous research examines how microbiome-derived pathogen-associated molecular patterns (PAMPs) contribute to neuroinflammatory pathways involved in AD. Dysbiosis in AD is associated with reduced beneficial short-chain fatty acid (SCFA)-producing bacteria and increased pro-inflammatory taxa that generate lipopolysaccharides (LPS), bacterial amyloids, peptidoglycan fragments, gingipains, and metabolites such as trimethylamine N-oxide (TMAO). These microbial products may cross compromised intestinal and blood-brain barriers and activate pattern-recognition receptors including Toll-like receptors and inflammasomes. A key downstream consequence is activation of NF-κB, which promotes pro-inflammatory cytokine production and sustained glial reactivity. Chronic inflammatory signaling may also drive complement dysregulation, including C1q deposition on vulnerable synapses, marking them for glial-mediated elimination through complement-dependent pruning pathways. Thus, microbiome-driven immune activation may contribute not only to neuroinflammation, but also to synapse loss, an early feature strongly associated with cognitive decline in AD. Neuronal injury further releases damage-associated molecular patterns (DAMPs), amplifying this inflammatory cycle. In contrast, protective microbiome-derived metabolites such as SCFAs may help preserve barrier integrity and suppress excessive inflammatory signaling. Together, these findings support a model in which microbiome dysbiosis promotes AD-related neurodegeneration through PAMP-triggered innate immune signaling, NF-κB amplification, and C1q-associated synapse elimination, highlighting the microbiome as a modifiable target for early intervention.

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30. The Effectiveness of Physical Activity in Reducing the Risk of Developing Dementia Associated with Alzheimer's Disease

Kailyne Zaarour, Hans Rabea, Logan Whitaker, David Yuauw, Nadia Mitchell, Jayda Maajoun, Hiba Kattih, Advisor: Dr. Glenn Kageyama

Alzheimer's disease (AD) is characterized by chronic neuroinflammation driven by damage-associated molecular patterns (DAMPs) that activate pattern recognition receptors, converging on inflammatory hubs such as NF-κB and the NLRP3 inflammasome. While previous work has focused on upstream inflammatory activation, emerging evidence highlights downstream mechanisms linking these pathways to neurodegeneration. NF-κB and NLRP3 activation promote complement-mediated synapse elimination through C1q tagging, contributing to early synaptic loss. Additionally, inflammatory signaling induces aberrant neuronal cell cycle re-entry (CCR), leading to apoptosis due to the inability of post-mitotic neurons to divide. These processes collectively drive cognitive decline in AD. Exercise serves as a non-pharmacological intervention that attenuates these mechanisms by reducing DAMP release, suppressing NF-κB/NLRP3 activation, and limiting downstream synaptic and neuronal loss. This study highlights exercise as a key modulator of both upstream inflammatory signaling and downstream neurodegenerative pathways.

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31. The Role of Diet in Alzheimer's-Related Neuroinflammation and Cognitive Decline

Hiba Kattih, Hans Rabea, Kailyne Zaarour, Isabella Finianos, Aileen Diaz, Yanel Sanchez, Advisor: Dr. Glenn Kageyama

Alzheimer's disease is linked to long term inflammation in the brain, loss of synapses, and cognitive decline, and this project looks at how diet may affect those changes through the innate immune system. When cells are damaged, they release danger signals called DAMPs, while microbes and their byproducts introduce PAMPs, and both of these signals can be recognized by pattern recognition receptors that trigger immune responses. If this happens over and over, microglia can stay activated and keep producing inflammation that may damage neurons over time. Certain diets may make this worse. Diets high in saturated fat and ultra processed foods may weaken the gut barrier and allow more lipopolysaccharide, or LPS, to enter the bloodstream, where it can activate TLR4, trigger NF κB signaling, and prime the NLRP3 inflammasome. Processed and high heat cooked foods may also increase exposure to advanced glycation end products, or AGEs, which interact with RAGE receptors, increase oxidative stress, and add to inflammatory signaling. Together, these pathways may connect to the C1q complement system, which can tag synapses for excessive removal by glial cells, contributing to synapse loss and eventually dementia. In contrast, anti inflammatory dietary patterns such as the Mediterranean, MIND, and DASH diets may help reduce these inflammatory triggers and support neuroprotection. Overall, the research suggests that diet is a realistic factor that may either worsen or help reduce the inflammatory processes involved in Alzheimer's disease.

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32. How do Diverse Agricultural Landscape Variables Associate with Bee Functional Traits in Southern California Orchards?

Ian Garcia, Carson Loudermelt, Emma Miller, Advisor: Dr. Elizabeth Scordato

Bees play very significant roles in food production. 75% of the world's crops depend on animal pollinators, with bees being the most dominant animal group, and wild bees fulfilling roughly 20% of these pollination services. Pollination needs have roughly tripled in the last 50 years; however, managed honeybee colonies are declining roughly 1% annually and wild bee abundance has seen a 23% decline from 2013 – 2018. Beyond declines in abundance, losses of bee functional diversity—the range of traits that influence resource use, environmental tolerance, and pollination efficiency—can reduce the stability and resilience of pollination services and community structures. There are large associations with bee decline and habitat loss/change, but not all forms of habitat alteration are equivalent. Urban landscapes are largely characterized by impervious surfaces, whereas agricultural systems often retain elements of native ecosystems to maintain natural ecosystem services. This study aims to better understand how environmental variables in agricultural landscapes are associated with bee functional and taxonomic diversity. We are combining wild bee field surveys with landscape scale environmental variables, and lab and literature functional trait data to assess how agricultural land use features influence bee community composition. By identifying landscape features that support diverse bee communities, this work seeks to inform growers on how to enhance natural pollination services while promoting wild bee biodiversity and conservation. Results show positive associations with certain functional traits and environmental variables at the local and landscape level.

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33. Synergistic DNA Damage by cigarette smoke Benzo[a]pyrene and Cell-derived Hydrogen peroxide

Isabel Carbajal, Advisor: Dr. Steve Alas

Benzo[a]pyrene (B[a]P) is a human carcinogen primarily found in tobacco smoke, automotive exhaust, and charred or grilled foods. Metabolic activation of B[a]P within the body's cells leads to the formation of reactive metabolites that create DNA adducts and stimulate the production of reactive oxygen species (ROS), which induced significant oxidative damage to the DNA. Hydrogen peroxide (H_2O_2) is a stable reactive oxygen species that can easily diffuse through biological membranes and cause DNA injury. Alcohol (ethanol) consumption is also linked to increased cancer risk and genotoxicity, though it often acts indirectly through its primary metabolite, acetaldehyde, which can induce DNA strand breaks.

This study employed the Comet Assay, a sensitive method for detecting nuclear DNA strand breaks and alkali-labile sites in individual cells, to investigate the genotoxic potential of these agents in human blood, using HL-60 lymphocytic cells. We specifically examined the synergistic effects of combining B[a]P with H_2O_2 and B[a]P with ethanol. Our results revealed that the combination of benzo[a]pyrene and hydrogen peroxide caused a synergistic increase in DNA damage. Conversely, the combination of benzo[a]pyrene and alcohol did not produce a synergistic effect in this cellular model. These findings suggest a potent interaction between environmental benzo[a]pyrene and hydrogen peroxide produced by our cells in the induction of blood DNA damage.

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34. Ultra-Processed Foods and Alzheimer's-Related Inflammasome Activation

Ashley Gomez, Jafnell Zapata, Advisor: Dr. Glenn Kageyama

Ultra-processed foods (UPFs) currently make up about 70% of the modern food supply. These foods are often made from industrial ingredients such as oils, starches, hydrogenated fats, and artificial additives rather than whole, natural ingredients. Because they lack the natural structure of whole foods, they are digested and absorbed very quickly, which may contribute to metabolic problems, inflammation, and other negative health effects. Unlike minimally processed foods, UPFs are often designed to imitate "real" foods while providing less nutritional value. The goal of this, is to examine what counts as processed food, as well as the distinct types of foods that have been processed, and what food additives are.

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35. Effects of Repellent Treatment on Biting Flies and Cattle

Jane Rumpak, Advisor: Dr. Juanita Jellyman

Horn flies and stable flies are biting pests of cattle that feed on blood and cause painful bites. Cattle respond with fly-repelling behaviors such as head shaking, leg stamping, tail flicking, and cutaneous muscle twitching (Mullens et al. 2006), which disrupt normal feeding, reproductive, and resting behaviors (Taylor et al. 2012). Biting fly activity also increases plasma concentrations of the stress hormone cortisol (Vitela-Mendoza et al. 2016) and reduces weight gain and milk production in cattle (Brewer et al. 2021). The economic impact of biting flies on the U.S. cattle industry is estimated at $2.3 billion annually (Kunz et al. 1991). Low-toxicity, plant-derived fly repellents offer a safer alternative to conventional insecticides and pose minimal risk to animals, non-target organisms, and the environment. However, it remains unclear whether repellent treatment reduces behavioral or physiological responses in cattle. We hypothesized that repellent treatment would decrease plasma concentrations of cortisol in association with reduced fly counts and fewer fly-repelling behaviors.

Ten cattle were used in the study during summer, when biting fly activity was highest. Animals were restrained in a squeeze chute and treated on the dorsum with UltraCruz fly repellent at the label rate (Treatment Group; n=5) or with an equal amount of water as a sham control (Control Group; n=5). Blood samples were collected from the jugular vein (3 mL) before treatment and at 24- and 48-hours post-treatment. Samples were centrifuged, and plasma was stored at -80℃ until cortisol concentrations were measured using an enzyme-linked immunosorbent assay kit (ELISA; Invitrogen). One hour after blood collection, visual counts of horn flies and stable flies were recorded, along with a 5-minute observation of fly-repelling behaviors to estimate biting fly activity.

Data collection from cattle was completed in August 2024. The current poster will include analysis of the relationship between the independent variables (number of flies, fly repelling behaviors per animal) and the dependent variable (plasma cortisol) determined using multiple regression analysis. We expect to associate cortisol concentration with fly numbers and the frequency of fly-repelling behavior to evaluate the impact of biting fly activity on animal physiology.

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36. Investigating the Effects of Garlic on Cell Signaling Leading to LPS-induced TNF- α Secretion in Murine Macrophages, J774A.1 and RAW264.7

Janet Pelayo, Advisor: Dr. Nancy E. Buckley

Garlic (Allium sativum) is known to have diverse health benefits, including antidiabetic, anti-inflammatory, antibacterial, and immunomodulatory effects. The immunomodulatory effects of garlic include modulation of cytokine production by immune cells such as macrophages. Tumor necrosis factor-alpha (TNF-α) is a key cytokine produced by macrophages when stimulated with pathogenic agents, such as lipopolysaccharide (LPS), an outer membrane component of Gram-negative bacteria. In this study, J774A.1 and RAW264.7 murine macrophage cell lines were treated with LPS (1ng/mL, 10ng/mL, or 100 ng/mL) in the presence or absence of aqueous garlic extract (1:500). TNF-α secretion was measured from cell supernatants 24 hours (h) post-treatment using sandwich enzyme-linked immunosorbent assay (ELISA). We observed that aqueous garlic extract enhanced LPS-induced TNF-α secretion in J774A.1 cells at 100 ng/mL of LPS, while reducing TNF-α secretion in RAW264.7 cells under the same conditions. Our data suggest that garlic modulatory effects on LPS-induced TNF-α secretion are both cell-dependent and dose-dependent. LPS stimulates macrophages by binding to Toll-Like Receptor-4 (TLR-4), triggering intracellular signaling pathways that activate transcription factors, such as NF-κB. Activation of NF-κB leads to the production of proinflammatory cytokines, including TNF-α. The objective of this project is to investigate whether garlic affects NF-κB signaling cascade triggered by LPS binding in J774A.1 and RAW264.7 cells. Thus, cells were treated with LPS (100 ng/mL) in the presence or absence of aqueous garlic extract (1:500). Cell lysates will then be subjected to SDS-PAGE and western blotting to assess NF-κB translocated into the nucleus.

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37. The Search for Genes That Won't Sit Still. Transposable Elements in the Common House Spider, Parasteatoda tepidorarium

Johnny Bui, Advisor: Dr. Peter Arensburger

The genomes of living organisms are commonly thought to be inactive, as any change would cause detrimental mutations. However, large portions of the genome can be rearranged by the movement of transposable elements or jumping genes. Transposable elements are regions of DNA that are selfish, they want to maintain their DNA sequences within the genome of an organism. They accomplish this by transposing themselves or "jumping" around the genome to avoid detection by the organism's defensive systems. When transposable elements are detected, they may be frozen in place by the genome. These "frozen" sequences will degrade over time, and until they decay completely, they provide a record of past movements in the genome. Identifying and documenting the evolution of such sequences is important because they have been used in laboratories for applications such as gene editing and have been used in combination with CRISPR-Cas systems. Identifying transposable element sequences can be challenging because they can be extremely diverse, degraded, and dispersed throughout the genome. In our laboratory we use in-house developed scripts to identify potential transposable element sequences. However, these scripts cannot always determine whether a DNA pattern is an actual transposable element or a pattern that happened to look like a transposable element (i.e. a false positive). To reduce the number of such errors, a second level of checks done by undergraduate researchers in Dr. Arensburger's laboratory manually review the script outputs. So far, the scripts have identified a number of transposable element sequences accurately, but some false positives were also found. The manual annotations provided by undergraduate researchers are used to improve script accuracy. These scripts are used to search for transposable elements in genomes with only elementary annotations

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38. Quantifying Genetic Load and Potential Purging in Mainland and Island Populations of Oceanic Swallows

Jordyn Scott, Advisor: Dr. Elizabeth Scordato

Bottleneck and inbreeding events can increase the accumulation of deleterious alleles, leading to the reduced population adaptability, survival, and reproduction. However, purifying selection may purge highly (loss-of-function) deleterious alleles, thus, reducing the populations' genetic load and enabling its persistence. Evidence suggests smaller populations characterized by more frequent and longer runs of homozygosity may effectively purge highly deleterious alleles, while larger, more resilient populations can tolerate a higher burden of deleterious variants. In this study, I quantify genetic load and evaluate island populations exhibit purging of high impact alleles compared to larger, mainland Pacific swallow populations of Southeast Asia and Oceania. To explore these objectives, I annotated variants for mutational impact using SNPeff then calculated the total genetic load, realized (homozygous) load, masked (heterozygous) load, and relative load (realized load scaled by the inbreeding coefficient) across populations. To specifically estimate potential for purging, I generated pairwise Rxy estimates for each mutation impact across seven island-mainland comparisons and evaluated high impact mutation enrichment in long runs of homozygosity. By untangling the underlying genetic mechanisms of evolutionary persistence, this study will provide insight into how populations can recover following disturbance or bottleneck events.

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39. Antimicrobial effects of Curcumin on Staphylococcus aureus and E. coli

Juan Juarez, Advisor: Dr. Wei-Jen Lin

Studies of curcumin, the active ingredient of turmeric, have increased in the past few years due to its potential anti-inflammatory, anti-cancer, and antimicrobial effects. The aim of this study is to understand how curcumin affects the bacteria and how solubility of curcumin affects its antimicrobial effect. Solubility of curcumin was tested in pure water and various concentrations of DMSO, and the best solvent was 100% DMSO. Antimicrobial effect against E. coli and Staphylococcus aureus were tested for various concentrations of curcumin in DMSO. Our results show minimal inhibition against either strain by the zone of inhibition method on agar plates. When measured in broth media, antimicrobial effect was observed for S. aureus, but not E. coli. Curcumin at 200 µg/ml exhibited the best antimicrobial effect in Mueller Hinton medium and less in the TSB medium. The results conclude that S. aureus, and possibly other Gram-positive bacteria, is more susceptible to curcumin reduction when compared to the DMSO control.

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40. Inflammation, NF-kB hub and C1q Complement mediated Synapse Elimination Is Central to Cognitive Decline and Alzheimer's Dementia

Justin Hodroff, Anthony Hattouni, Jairo Javier Lazo, Destiny Ramsey, Advisor: Dr. Glenn Kageyama

Alzheimer's disease (AD) affects 50 million people with no cure and lifestyle and genetic factors like APOE-4 account for 40% of cases. Amyloid-beta (Aβ) aggregates into plaques driving tau tangles, but synaptic loss triggered by DAMPs best correlates with dementia. Non-demented Alzheimer's disease (NDAN) is a rare neuroprotective AD phenotype with blocked Aβ synaptic binding, increased neurogenesis, and anti-inflammatory microglia. Additionally, breakdown allows complement proteins to flood AD brains, driving neuroinflammation and microglial activation via Membrane Attack Complex (MAC). Aβ plaques trigger complement and Membrane Attack Complex driven synapse loss, as regulatory proteins like CD59, function, fail to compensate in AD. MAC driven complement activation and microglial neurotoxicity are shared mechanisms across AD, Parkinson's, and ALS. Aβ plaques activate complement and MAC, causing bystander neuronal damage through dystrophic neuronal cascades. Mechanisms include C1q tagging synapses for microglial phagocytosis and also adaptive immunity targeting DAMPs unlike innate responses. C1q binds to externalized phosphatidylserine (PS) which indicates damage. C1q targets the NF-KB Flippase, and CD47 can have a neuroprotective effect. The inflammatory complex is also differently activated by many environmental factors. Complement proteins C1q are dramatically overexpressed locally in AD brain regions like the hippocampus. C1q binds Aβ early, activating C3 convertase to tag synapses for microglial pruning, driving AD neurodegeneration before plaque formation.

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41. Novel Ntsr1-Flp Mouse Line Enables Dual-Recombinase Strategy to Target Midbrain Neuron Subtypes Involved in Feeding and Obesity

Justine Wong, Advisor: Dr. Andrew D. Steele

Diet-induced obesity (DIO), driven by excessive consumption of high-calorie diets, is a major global health concern linked to diabetes and cardiovascular diseases. Mouse models of DIO provide critical insight into how brain circuits regulate feeding and weight gain. Previous work using dopamine receptor 1 knockout mice demonstrated that dopamine signaling in the suprachiasmatic nucleus (SCN), the brain's central circadian clock, is required for the development of DIO. Previously, our lab identified that neurotensin receptor 1 (Ntsr1) marked a subset of ventral tegmental area (VTA) dopaminergic neurons implicated in feeding regulation and DIO. Ntsr1-expressing midbrain neurons are a large class of DA neurons, and it would be desirable to study these subsets with flippase (Flp)-based genetic tools to enable selective access. Ntsr1-Cre Th cKO mice have shown to resist weight gain on a high-fat diet and did not experience an increase in day eating unlike their wild-type littermate controls. Here, we characterize a novel Ntsr1-Flp mouse line and combine it with existing Cre and Flp lines for Slc6a3 (dopamine transporter) and Ntsr1 to enable intersectional genetic approaches. Across the four genotypes (Dat-Cre;Dat-Flp, Dat-Cre;Ntsr1-Flp, Ntsr1-Cre;Dat-Flp, and Ntsr1-Cre;Ntsr1-Flp), Ntsr1-Flp showed strong compatibility with Cre-based strategies, allowing efficient dual-recombinase labeling of defined neuronal subpopulations. Quantitative analyses revealed that Ntsr1-expressing neurons include both dopaminergic and non-dopaminergic subtypes, with an unexpectedly large population of non-dopaminergic Ntsr1 neurons in the substantia nigra compared to the VTA. These findings establish the Ntsr1-Flp line as a precise and flexible tool for targeting Ntsr1-expressing midbrain neurons, enabling refined causal studies of neuronal subtypes involved in feeding and obesity.

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42. Family Gastropteridae from New Caledonia

Kathrina Garcia, Advisor: Dr. Ángel A. Valdés

Gastropteridae (bat-winged sea slugs) are a widely distributed but understudied family of cephalaspidean heterobranchs, with limited molecular representation and unresolved phylogenetic relationships. To address these gaps, we analyzed over 100 specimens collected from New Caledonia using a multilocus approach combining mitochondrial (COI, 16S) and nuclear (H3) markers with anatomical observations. Concatenated phylogenetic analyses recovered substantial structure among specimens, with 16 unique species identified from the New Caledonia material and 18 species total across all sampled specimens. Two species were represented by multiple clades. Morphological variation in the buccal mass and reproductive structures corresponded with several molecular groupings, supporting species-level differentiation in some cases. These results highlight previously unrecognized diversity within Gastropteridae and demonstrate the importance of expanded regional sampling and integrative approaches for resolving phylogenetic relationships in understudied marine invertebrate groups.

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43. Not So Damsel:Defensive Chase Behavior in Damselfish

Rene Romo, Kieran Murray, Valentina Eppers, Advisors: Dr. Ángel A. Valdés, Dr. Jeremy Claisse

This study was looking at three spot damselfish, Dascyllus trimaculatus (Rüppell, 1829), a reef fish commonly found in the Caribbean known for its territorial and aggressive behavior. This study aimed to quantify Dascyllus trimaculatus aggressive territorial interactions to see if they had differing levels of aggression towards specific species and if the damselfish age had influence on aggression level. We hypothesized that Dascyllus trimaculatus age would influence aggression, and that all ages would be more aggressive towards herbivore and other damselfish invaders compared to carnivorous ones. We collected aggression data at three reef sites in Almirante Bay, Panama. Data was collected by observing individual damselfish for 3-minute increments and quantifying each territorial aggressive interaction and classifying the invader fish species. Damselfish were classified into three age class groups: Adult, Young adult, and Juvenile. Our data shows that Dascyllus trimaculatus were less aggressive towards carnivorous invaders than either herbivorous or other damselfish ones. We also report that juvenile ones were less aggressive to other damselfish compared to adults or young adults, while showing similar aggression levels towards herbivores. It is known that damselfish territorial aggression is done to protect their algal/invertebrate grazing sites. This is constant with our data, as carnivores would not be in competition for algal grazing sites with the damselfish. Therefore, there is only risk of being eaten for damselfish to be aggressive towards carnivores, with no ecological benefit. This project was done as part of the Spring 2026 BIO 4550L Field Biology (Panama Tropical Marine Ecology) hosted by ITEC, Dr. Peter Lahanas, and Dr. Leonor Ceballos.

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Biological Sciences

44. Leveraging Plant Traits for Hedgerow Species Selection in Southern California Agriculture

Kyle Osornia, Francine Nikolai A. Salvador, Elizabeth Garcia, Corey Kelsey, Emily Montes, Erin Questad, Advisor: Dr. Erin Questad

Native hedgerows are used in integrated pest management programs to enhance pollination and natural biocontrol, yet their performance varies widely. A trait-based approach may provide insight into this variability by identifying plant traits that influence arthropod community assemblages. We evaluated plant trait-arthropod relationships in hedgerows within citrus and avocado orchards in California's Santa Clara River Valley. Seven species were sampled in 2025 for functional traits related to growth, floral resources, leaf economics, and water relations. Arthropods were surveyed using visual surveys and vacuum sampling and identified to the lowest possible taxonomic level. Using generalized linear mixed models, we tested whether plant traits explain variation in arthropod richness and abundance. Preliminary results from 100 plants indicate that pollinator and pest abundance and richness increased with floral density, and pollinator abundance also increased with plant volume. In contrast, natural enemy responses increased with physiological and leaf traits: enemy abundance increased with leaf dry matter content (LDMC), while enemy richness increased with higher predawn water potential, photochemical efficiency, and LDMC. These findings suggest that selecting species for high floral output may enhance pollinators but also elevate pests, whereas physiological and leaf traits are more closely linked to natural enemy diversity, highlighting tradeoffs in trait-based hedgerow design.

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Biological Sciences

45. Fight or Fear: How Scared Do These Worms Get?

Logan DeBoer, César Gómez, Advisors: Dr. Jeremy Claisse, Dr. Ángel A. Valdés

This study examined the behavioral responses of feather duster worms (Sabellastarte magnifica, Acromegalomma spp., and Anamobaea orstedii) to simulated predator disturbance as part of the Spring 2024 BIO 4550/L Field Biology course (Panama Tropical Marine Ecology). Fieldwork was conducted across multiple reef sites in Bocas del Toro, Panama, focusing on how environmental and biological factors influence defensive and recovery behaviors in these sessile marine invertebrates. The objective of this project was to determine how factors such as feather duster worm species and size, fish presence, as well as microhabitat affect the total time it takes for feather duster worms to reopen after an initial disturbance. We hypothesized that variables such as increased perceived predation risk (e.g., higher fish presence), greater exposure (i.e., individuals not protected by surrounding rock or coral), and increased size would lead to longer recovery times. Data was collected by approaching individual worms in the field and recording their response to a standardized disturbance. For each individual, we measured time to initial reopening, time to full extension, and recorded associated variables including species, size class, fish presence, clustering, protection, and habitat type. Results showed that species and fish presence had significant effects on total recovery time, with worms in areas of higher fish activity taking longer to reopen. Additionally, differences among species suggested variation in behavioral strategies, while microhabitat, clustering behavior, and site had weaker or inconsistent effects. This study highlights the importance of future investigation into ecosystem health affecting feather duster worm population dynamics.

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46. "Forever Chemicals" and Genomic Toxicity: DNA Injury Induced by PFOA and Hydrogen Peroxide

Miriam Khalil, Beatriz Jimenez, Advisor: Dr. Steve Alas

Perfluorooctanoic acid (PFOA) is widely recognized as a "forever chemical" due to its extreme environmental persistence and long biological half-lives in humans. Extensively used in industrial and consumer products such as nonstick cookware, waterproof fabrics, and firefighting foams, PFOA is a known immunotoxin and has been classified as possibly carcinogenic to humans. Hydrogen peroxide (H_2O_2) is a stable, non-radical reactive oxygen species (ROS) that can readily diffuse through biological membranes. At high concentrations, H_2O_2 induces significant cell injury and DNA damage, often through the localized production of highly reactive hydroxyl radicals.

This study investigated the potential for interaction between these agents in HL-60 cells, a human blood cell line frequently utilized for genotoxicity and apoptosis research. We employed the Comet Assay (single-cell gel electrophoresis), a sensitive method for detecting nuclear DNA strand breaks and alkali-labile sites, to evaluate the genotoxic impact of these substances. Our results revealed that the damage caused by the combination of perfluorooctanoic acid and hydrogen peroxide was synergistic. These findings indicate that the presence of persistent "forever chemicals" can significantly amplify the genotoxic effects of oxidative stressors in blood cells, potentially increasing the risk of accumulated mutations in humans.

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Biological Sciences

47. Evaluating ROH Patterns Across Genome Assemblies and Populations in Pacific Swallows

Nathaniel Carl, Jordyn Scott, Advisor: Dr. Elizabeth Scordato

Runs of homozygosity (ROH) are genomic regions characterized by a lack of genetic variation, where individuals are homozygous across many consecutive sites, reflecting inbreeding and population history. We analyzed ROH patterns in Pacific swallows (Hirundo tahitica) across seven populations using both fragmented and pseudochromosome assemblies. ROHs (≥250 kb) were identified with PLINK and summarized in R.

Pseudochromosome assemblies produced longer, more continuous ROHs, while fragmented assemblies were dominated by shorter ROHs due to artificial breaks. Population-level differences were also evident: Fiji (FIJ) and Okinawa (OKI) showed the highest ROH counts and longest ROHs, whereas Malaysia (MAL) and Borneo (BOR) exhibited fewer and shorter ROHs.

These results demonstrate that both assembly quality and population history shape observed ROH patterns, emphasizing the importance of genome assembly choice in population genomic analyses.

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48. The Developmental and Molecular Analysis of Floral Organ Abscission in Aquilegia coerulea

Marianellie Bravo, Ana Alcaraz Echeveste, Rene K. Romo, Miles P. Crafa, Advisor: Dr. Bharti Sharma

Abscission is a highly regulated developmental process essential to the separation of plant organs. Regulated molecular changes in specialized cell layers known as abscission zones (AZs) facilitate organ separation. Although abscission is necessary for reproductive success, seed dispersal, and tissue turnover, premature floral organ separation presents a challenge for the flower industry. Horticultural growers and shippers seek varieties with extended floral longevity and structural integrity during storage and transport. Core eudicot model systems such as Arabidopsis thaliana have been used to identify the genetic pathways that regulate abscission, with the goal of developing strategies to delay this process in horticulturally important crops. However, it remains unclear if these pathways are conserved across angiosperm lineages. Here, we propose Aquilegia coerulea (‘Kirigami’ columbine), an early-diverging eudicot, as a model system to investigate the genes involved in abscission zone development in sepals and petals.

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49. Exposure to Legacy and Current Use Pesticides in Sea Urchins of Aquaculture and Fisheries Interest

Rebecca Prezgay, Varenka Lorenzi, Dr. Jeremy T. Claisse, Dr. Andrea Bonisoli-Alquati, Advisor: Dr. Andrea Bonisoli-Alquati

The use of pesticides has changed over time, with old ones being phased out due to their toxic effects, and new ones being synthesized in an attempt to reduce deleterious effects on non-targeted species. Despite evidence of 'legacy' and current-use pesticides in marine waters and sediments in southern California, we have limited knowledge of how pesticides are accumulating in species of aquaculture and fishery interest. Red sea urchins (Mesocentrotus franciscanus) and purple sea urchins (Strongylocentrotus purpuratus) are collected in fisheries throughout southern California. Pesticides may negatively impact the health of these species and, in turn, reduce their value in aquaculture and fisheries, yet there are no assessments of pesticide contamination of their edible tissues. The proposed research will quantify pyrethroids, fipronil, organophosphates, and organochlorines in red and purple sea urchins at reefs near the outputs of two rivers, the Santa Clara (SC) River (an agricultural watershed) and the Los Angeles (LA) River (an urban watershed). We predict that urchins collected near the SC River will have higher concentrations of current-use pesticides. Conversely, we predict urchins near the LA River will have higher concentrations of organochlorines, due to legacy contamination issues. The samples will be solvent-extracted, then quantified using gas chromatography-mass spectrometry. We will use gonad indices (i.e., weight of gonad tissue/total body measurement) to estimate the body condition of the sampled urchins to see if high pesticide load is associated with smaller gonad indices. Preliminary analyses showed that the two urchin species differed in their gonad index differences between the two watersheds. Red urchins sampled near the LA River (5.9% ± 2.8% SD) had larger gonad indices than those near the SC River (4.0% ± 1.9% SD). On the contrary, purple urchins near the LA River (3.9% ± 3.1% SD) had smaller gonad indices than those near the SC River (4.8% ± 2.9% SD). By comparing the measured pesticide concentrations with published toxicity reference values for urchins, we will assess toxicological risks to urchins and health risks to humans consuming them. By measuring exposure to agricultural pesticides in species of aquaculture and fishery interest, this research will help ensure that this growing sector delivers clean food products to the people of California.

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Biological Sciences

50. Nmur1 and Cckar fail to support functional genetic access in adult dopamine neurons and challenge GPCR atlas assignments

Renqi Wu, Moueez Shah, Fernando Garcia, Andrew Villa, Advisor: Dr. Andrew Steele

Recent transcriptomic analyses have identified G protein–coupled receptors (GPCRs), including Nmur1 and Cckar, as candidate markers of midbrain dopamine (DA) neuron subpopulations. Because such markers are used to guide genetic targeting strategies, it is essential that they reflect functional expression in adult neurons. Here, we evaluated Nmur1 and Cckar expression in adult mouse midbrain using Cre-dependent reporters, in situ hybridization, conditional genetic approaches, and adeno-associated virus (AAV)-based functional assays. Using both intracranial and systemic AAV-based Cre-dependent reporters, we find minimal or no evidence of adult recombination in DA neurons for either line. Consistent with this, Nmur1 is not detectably expressed in adult DA neurons and fails to drive recombination, whereas Cckar-driven recombination is marginally observed despite minimal adult expression, consistent with transient developmental activity. These findings indicate that Nmur1 and Cckar do not reliably define adult DA neuron subpopulations and highlight the need for functional validation of transcriptomic markers used for circuit targeting.

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51. Garlic's effects on Candida albicans-induced TNF-a secretion in J774A.1 and RAW264.7 Murine Macrophages

Rosita Mohanty, Advisor: Dr. Nancy E. Buckley

Garlic has immunomodulatory properties; however, its effects on immune responses to fungal pathogens is not completely understood. Candida albicans (C. albicans) is an opportunistic, polymorphic fungus and a major cause of invasive fungal infections in clinical settings. While we and others have found that garlic inhibits C. albicans growth, this work aimed to compare the effects of garlic on heat-killed C. albicans (HKCa)–induced TNF-α secretion between two murine macrophage cell lines, J774A.1 and RAW264.7, and to determine whether these effects are macrophage concentration– and/or time-dependent. We heat-killed C. albicans to ensure its morphology was a ballistoconidia and to expose the β 1,4 -glucans on its cell surface, which are recognized by macrophage receptors.

Macrophages play a central role in the innate immune response to combat pathogens and are a primary source of tumor necrosis factor alpha (TNF-α), a key pro-inflammatory cytokine involved in immune cell recruitment and activation. Thus, macrophages were plated at varying concentrations (0.65×10^5, 1.25×10^5, 2.5×10^5, and 5.0×10^5 cells/mL) and challenged with HKCa in the absence or presence of pyrogen-free water (PFW) or aqueous garlic extract. Time-course experiments were conducted by collecting culture supernatants at 14, 19, and 24 hours, and TNF-α levels were quantified using enzyme-linked immunosorbent assay (ELISA).

Preliminary results indicate that garlic stimulates HKCa-induced TNF-α secretion from J774A.1 cells but not in RAW264.7 cells, suggesting that garlic's immunomodulatory effects are cell dependent, potentially due to intrinsic differences in macrophage signaling or activation states.

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52. Comparison of floral handling behaviors of honey bees and squash bees in male and female zucchini flowers in Southern California

Sara Witt, Advisor: Dr. Joan Leong

Squash bees are critical pollinators of cultivated and native Cucurbita species. Two squash bee species, Xenoglossa pruinosa and Xenoglossa strenua, are widespread, native solitary bees that are oligolectic on squash flowers. Although there are numerous investigations of the pollination value of Xenoglossa across North America, studies of small-scale floral handling behaviors of squash bees are rare. We compared the durations of several floral handling behaviors of two Xenoglossa species and Apis mellifera in male and female zucchini flowers at two southern California farms in Chino and Hemet. Replicate 10 min. video observations were made between 0600 and 1000 PDT at male zucchini flowers at randomly selected 1m2 plots while simultaneously recording at nearby female flowers. Videos were analyzed to quantify floral visit frequencies and duration of handling behaviors within flowers. Behaviors analyzed included the duration of time in contact with: the upper petal interior, the flower base while consuming nectar, the floral reproductive parts while consuming nectar and when not consuming nectar. Female Xenoglossa contacted stigmas (while nectaring) 3x longer (Chino) and 8x longer (Hemet) than A. mellifera. At male flowers, female Xenoglossa also contacted anthers longer than A. mellifera while nectaring: 20x and 5x longer in Chino and Hemet, respectively. Similarly, male Xenoglossa contacted anthers (Chino: 17x; Hemet: 4) and stigmas (Chino: 7x; Hemet: 6x) longer than A. mellifera while nectaring. During a floral visit, honey bees spent much less time in direct contact with the reproductive organs of zucchini flowers while nectaring, than native Xenoglossa bees.

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53. From Menopause to Neurodegeneration: How Estrogen Decline May Promote Metabolic Stress in Alzheimer's Disease

Sarah Flores, Kathryn Huntington, Maria Lule Licea, Jennifer Hernandez, Advisor: Dr. Glenn Kageyama

Nearly two-thirds of individuals diagnosed with Alzheimer's disease (AD) are women, a disparity that cannot be explained solely by differences in lifespan. Increasing evidence indicates that metabolic dysfunction plays a central role in AD pathogenesis, prompting some researchers to describe AD as "type 3 diabetes," characterized by brain insulin resistance and impaired glucose metabolism. The menopausal transition represents a major neuroendocrine shift unique to women and may interact with metabolic and immune mechanisms to increase vulnerability to AD.

Estrogen is a key regulator of neuronal bioenergetics and supports brain metabolism by promoting glucose uptake, enhancing mitochondrial function, regulating insulin signaling pathways, and limiting oxidative stress. During perimenopause and menopause, declining estrogen levels are associated with reduced cerebral glucose metabolism, mitochondrial dysfunction, and increased oxidative damage. Impaired neuronal glucose utilization may contribute to glucotoxicity, characterized by chronic metabolic stress, insulin resistance, and excessive production of reactive oxygen species. In response to reduced glucose availability, the brain may shift toward increased lipid utilization for energy. This metabolic compensation may promote lipotoxicity, in which excess lipid metabolites, oxidized fatty acids, and ceramides accumulate, contributing to mitochondrial dysfunction, inflammation, and neuronal dysfunction.

Glucotoxicity and lipotoxicity may also increase the burden of cellular damage signals, including misfolded proteins, oxidized lipids, and mitochondrial components that function as damage-associated molecular patterns, thereby activating microglial innate immune pathways. Estrogen decline may further exacerbate neurodegeneration by increasing complement C1q-mediated synaptic opsonization and microglial synapse elimination, processes linked to cognitive decline. In contrast, testosterone declines more gradually in men and remains present with aging, while aromatase-mediated conversion of testosterone to estrogen may provide additional

neuroprotection. Together, endocrine aging, metabolic stress, and innate immune activation may converge to increase synaptic vulnerability and neurodegenerative risk in women.

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Biological Sciences

54. Evaluating Double Loop AAVs for Blood Brain Barrier Crossing

Sawyer Hardy, Idalina Bonham, Victoria Enciso, Andrew Villa, Advisor: Dr. Andrew Steele

Adeno associated viruses (AAVs) have been increasingly implicated as possible vectors for gene therapy through targeted gene delivery (Wang et al. 2024). We engineered double loops on validated AAVs from Voyager Therapeutics to improve blood brain barrier crossing and target the central nervous system (CNS) before analyzing transduction using fluorescence analysis with confocal microscopy. We found that double loop AAVs either perform the same or significantly worse at CNS transduction efficiency. Based on our sample set, it is the base capsid that influences the binding affinity when adding a double loop, rather than the added loop itself. Our findings indicate that the addition of double loops either do not influence or inhibit blood brain barrier crossing. Despite this, AAVs remain a promising target for engineering to optimize their specificity and efficiency with future uses as vectors for gene therapy technology.

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Biological Sciences

55. The Relationship Between Anticoagulant Rodenticdes, Trophic Position, and Clotting Time in Red-shouldered Hawks

Shourjya Majumder, Advisor: Dr. Andrea Bonisoli Alquati

Anticoagulant rodenticides (ARs) are a group of pesticides that interfere with the synthesis of clotting factors, leading to hemorrhage and death in targeted rodents. However, untargeted wildlife that consume exposed rodents may also be secondarily poisoned by ARs. Such risk of exposure, however, is mostly estimated from raptors brought to rehabilitation centers, with limited information about the exposure and effects of ARs on wild raptor populations. This research aims to measure AR exposure, assess its physiological effects, and examine the associated ecological and environmental factors in Red-shouldered Hawks (Buteo lineatus). ARs will be quantified in hawks captured in anthropogenic and natural areas, expecting higher exposure in hawks from more urbanized areas and from sites at the wildland-urban interface. We will also measure clotting times by conducting coagulation assays, specifically the prothrombin assay, which measures the extrinsic coagulation pathway by detecting deficiencies of clotting factors and low fibrinogen concentrations. We hypothesize that clotting time will increase at a faster rate as exposure to ARs increases in hawks from anthropogenic areas, due to greater stress in these birds. To test for the potential biomagnification of ARs, we will conduct stable isotope analysis (of carbon and nitrogen) using breast feathers. We predict stable isotopes that mark a higher trophic position and a more aquatic diet to be associated with greater ARs concentrations. ARs will be analyzed using liquid chromatography and mass spectrometry (LC-MS). We will be analyzing total ARs concentrations summed across the different compounds detected as a function of land cover using generalized linear mixed models, with land cover type and stable isotopes values as covariates, and collection site as a random effect. When analyzing the coagulopathy data, we will instead use ARs as a continuous predictor, along with land cover type and stable isotopes values. This investigation of the ecological and environmental drivers of AR exposure in Red-shouldered Hawks may prove crucial to conserving their populations.

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Biological Sciences

56. Localizing changes in astrocytic NF-KB expression in the mPFC-nRE-Ca1 neural circuit during chronic T. gondii infection

Sophie Biehler, Advisor: Dr. Tatiane S. Lima

Toxoplasma gondii is an obligate intracellular parasite, infecting one-third of the global human population. T. gondii infection is neglected in science and medicine. Acute infection with T. gondii is mild or asymptomatic; however, T. gondii crosses the blood-brain barrier and establish chronic infection in neurons. Recent evidence indicates that chronic T. gondii infection causes decreased expression of astrocytic glutamate transporter 1 (GLT-1), inducing excess extracellular glutamate and deleterious effects on neuronal health. The medial-prefrontal cortex (mPFC), nucleus reuniens (RE), and Ca1 hippocampus is an important neural circuit bridging memory and executive functioning. Nuclear Factor kappa-B (NF-κB) is an essential transcription factor that contributes to the regulation of GLT-1. It is currently unknown how chronic T. gondii infection disrupts transcription of GLT-1; therefore, we aim to investigate if NF-κB expression in astrocytes within the mPFC-nRE-Ca1 circuit is decreased during chronic T. gondii infection. To assess these molecular changes, we utilized C57BL/6 mice injected with PBS (mock) or 400 T. gondii tachyzoites. After chronic infection (28 Days Post Infection) we surgically dissected these circuit regions, isolated cells from tissue, and processed through flow cytometry. Additionally, we will harvest whole brains from mock or chronically T. gondii-infected mice and utilize confocal microscopy to localize changes in astrocytic NF-κB expression within the mPFC-nRE-Ca1 circuit. Our behavioral findings showed increased latency in the Barnes maze during chronic T. gondii infection, underscoring a hippocampal-dependent deficit. Given these findings, we expect to see decreased NF-κB expression in hippocampal astrocytes, leading to poor hippocampal neuronal health. Given that chronic T. gondii infection compromises neuronal health and the mPFC nRE-Ca1 circuit is key for memory and executive function, mapping these molecular mechanisms lays a potential avenue for targeted therapeutic intervention. Future studies aim to develop transgenic T. gondii strains lacking specific parasite factors that could disrupt NF-κB/GLT-1 cell signaling.

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Biological Sciences

57. Eaton Fire and the Effects on Edge Species

Soroush Azizi, Clayton Patterson, Advisor: Dr. Janel Ortiz

Wildfires visibly devastate landscapes, but some of their most significant impacts occur beyond the burn perimeter, where urban wildlife communities are forced to rapidly respond to changing environmental conditions. This study focuses on the Eaton Fire, which burned for 24 days from January 7th to January 31st in 2025. The fire consumed over 14,000 acres and affected communities within Altadena, Pasadena, Sierra Madre, Monrovia, and parts of the Angeles National Forest. While the fire's impact on human populations was substantial, its ecological consequences, particularly for wildlife living at the urban-wildland interface, remain less understood.

To investigate these effects, we deployed 23 wildlife camera traps along a rural-to-urban gradient, collecting data across seasonal intervals (Winter, Spring, Summer, and Fall). Using the web-based program called WildTrax, we identified wildlife images, which were used to quantify detection rates over time. This study focuses specifically on "edge species", mammals that can persist in highly urbanized environments while still relying on nearby natural habitats. In Southern California, the edge species considered were the American black bear (Urus americanus), gray fox (Urocyon cinereoargentus), bobcat (Lynx rufus), cougar (Puma concolor), and coyote (Canis latrans).

By integrating wildlife detection data with environmental variables and air quality metrics (PM2.5 concentrations, temperature, precipitation), this project aims to understand how large-scale fire events influence mammalian population dynamics and behavior outside of the immediate burn zone. Ultimately, this research provides insight into how wildlife responds to disturbance in increasingly urbanized landscapes, contributing to more effective conservation and management strategies in fire prone regions.

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Biological Sciences

58. Anticoagulant Rodenticides in Red-tailed Hawks and Observer Effects on White Blood Cell Counts

Teresa Aquino, Advisor: Dr. Andrea Bonisoli Alquati

Pest control uses anticoagulant rodenticides (ARs), exposing non-target species to these chemicals. Due to their bioaccumulative nature, these predators face a significant risk of secondary AR exposure. Red-tailed Hawks (Buteo jamaicensis) consume poisoned rodents, which impairs their blood coagulation, causing anemia and even death. Their capacity to hunt is hindered, making them vulnerable to these toxicants. The risk of AR exposure and adverse health effects in red-tailed hawks in Southern California remains unknown, as does the extent of the threat to their survival. The overall objective of this study is to test the repeatability of cell counts as a reliable method to estimate physiological stress caused by AR exposure, using hematocrit and the heterophil-lymphocyte (H/L) ratio. For this research, we will collect blood and blood smears from red-tailed hawks, and capture will take place at Irvine Ranch Conservancy, Camp Pendleton, Prado Wetlands (Norco), Romona, and Lancaster.

Once established, this approach can demonstrate consistency and validate the cell-counting technique for assessing stress. 43 adults are included in our sample, and 10 unique slides were scored by three observers twice, using blinded and unblinded methods to differentiate WBCs and assess their welfare in wild settings. The counting method and individuality are crucial for diagnosis.

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59. Genome Sequence and Functional Analysis of Sulfuritortus calidifontis DSM 103923T Isolated from a Hot Spring Microbial Mat

Tessa Pulgar, Juan Juarez, Advisor: Dr. Wei-Jen Lin

Here we report the genome sequence of Sulfuritortus calidifontis DSM 103923T, a species isolated from a hot spring microbial mat. The genome contained 2.6 Mbp and predicted genes necessary for dissimilatory sulfur reduction, in addition to the documented ability to oxidize sulfur. Whole genome sequencing of this bacterium will assist in further research into sulfur metabolism pathways and understanding their role in the environment.

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Biological Sciences

60. Genome-wide divergence between migratory and non-migratory welcome swallows (Hirundo neoxena)

Valentina Eppers, Advisor: Dr. Elizabeth Scordato

Migration is a behavior observed across many different species, and it allows organisms to leave unfavorable environments for areas with greater resources. Anthropogenic changes to natural landscapes and climate can impact crucial behaviors like migration. However, we still have a poor understanding of the genetic mechanisms that underlie changes in migratory behavior. In this study, we are examining the genetic basis of variation in the migratory phenotype of welcome swallows (Hirundo neoxena). Welcome swallows are found throughout Australia and self-colonized New Zealand approximately 60 years ago. Welcome swallows were likely able to establish a population in New Zealand due to the abundance of man-made structures to build nests on and have subsequently expanded rapidly in population size. After arriving in New Zealand this population subsequently lost their migratory behavior and are now sedentary. Welcome swallows are therefore a perfect candidate to look at genetic variation in the migratory phenotype because they have recently lost their migratory behavior. In this study, we are using whole-genome sequence data and analyses of selection to identify genomic regions associated with differences in migratory behavior between Australian and New Zealand populations of welcome swallows. By identifying areas of the genome that are under selection in closely related populations with different migratory phenotypes, this study will provide insight into how human activities are impacting the genetic mechanisms that drive rapid behavioral changes in wild populations.

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Biological Sciences

61. TickTracker: Engorged Tick Surveillance Across Southern California

Victoria Cubias, Advisor: Dr. Janel L. Ortiz

As climate change allows for longer warmer seasons in Southern California, improving tick survival conditions and enhancing their reproductive cycles. Understanding tick distributions through surveillance is an important first step in preventing vector-borne diseases in companion animals, humans, and wildlife. The objective of this project is to describe the scutal index (total body length (mm) /scutum width (mm)) of engorged ticks sampled from domestic dogs across Southern California as an estimate of the potential pathogen transmission risk in the region. It has been found that engorgement level directly corresponds to time spent feeding on the host. Ticks of the Rhipicephalus sanguineus (n=408) and Dermacentor sp. (n= 41) species were sampled directly from canines in animal shelters and veterinary clinics from five counties across Southern California from July 2024 to October 2025. Subsequently, ticks were stored in sealed tubes with 95% ethanol, identified to species, sex, and life stage via a stereo microscope, and measured to determine scutal index using a 0.1 mm microscope calibration slide. Preliminary results show that out of all the ticks collected that were observed by primary and secondary observers (n=449) only 26.06% were confirmed to be engorged (n=117). Ticks had scutal indices ranging from 3.1-11.8. The ticks with the greatest scutal index ranging from 8.7-11.8 (n=14) were primarily found in Los Angeles, San Bernardino, and Orange Counties and made up 11.97% of all engorged ticks. Regions with the greatest level of engorgement can use these scutal indices to inform public education of tick prevention measures, such as tick preventives for domestic species and habitual tick checks during peak season to control transmission risk of pathogens in Southern California for companion animals, wildlife, and humans alike.

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Biological Sciences

62. The Secret Lives of Panamanian Stingrays

Victoria Gronwald, Rebecca Prezgay, Advisors: Dr. Jeremy Claisse, Dr. Ángel A. Valdés

Stingrays are bottom-dwelling cartilaginous fishes that prefer soft bottoms. They are often hidden within substrates, camouflaging from predators, ambushing prey, and staying protected while they rest, or are seen swimming in the water column. Stingray behavior and substrate use may vary due to a multitude of reasons. This pilot study was done through the Spring 2026 BIO 4550L/5550L Field Biology (Panama Tropical Marine Ecology) during an eleven-day field trip to Panama. We explored where three species of stingrays (Caribbean Whiptail Stingray, Southern Stingray, and Yellow Stingray) are found at multiple sites around Bocas del Toro. Their substrate type, behavior, and sand coverage were noted upon initial observation, since many of them (with human presence acknowledged) would swim away. The substrate types observed were silt, sand, and grass. Each substrate was sampled equally when present at each site (some sites had ⅔ substrates). Behaviors included eating, hiding, resting, and swimming. Sand coverage was observed as not covered, semi-covered, and fully covered. Results showed varying habitat use for the substrate use among species. The Caribbean Whiptail Stingray used all three of the substrates, with the highest observed being 54% found in silt. The Southern Stingray was found in sand-dominant areas 50% of the time, and 50% in grass-dominant areas. The Yellow Stingray was found 67% of the time in sand and 33% of the time in silt. Only one species, the Caribbean Whiptail Stingray, was seen doing all four behaviors, with 36% being spotted swimming and 36% resting. Due to a lack of data, a complete conclusion on the behaviors of stingrays in Panama could not be drawn. More research should be conducted to further analyze where stingrays spend their time, and what behaviors they exhibit during that time.

2026 College of Science Research Symposium

Chemistry and Biochemistry

63. Synthesis and Applications of 4,5-diphenyl-1-(2,4,5-trimethylphenyl)-1H-imidazole in Carbon-Fluorine Bond Activation

Adam Bryant, Ana Garcia Alvarez, Diego S. Huerta, Advisor: Dr. Chantal E. Stieber

Forming and breaking carbon-fluorine (C-F) bonds is of interest due to their applications in pharmaceuticals, catalysis, and materials science. However, breaking C-F bonds is challenging and there is interest in understanding how the presence of different functional groups and steric hindrance can influence how C-F bonds are broken. This research is based on the synthesis of 4,5-diphenyl-1-(2,4,5-trimethylphenyl)-1H-imidazole, which subsequently reacts with xylylene dibromide to form a new bis(imidazolium) salt product. This salt is then deprotonated at the carbene carbon with a strong base, followed by the addition of Ni(COD)2 to form an organometallic complex. This complex was tested in C-F activation reactions with aromatic[CS1] substrates that contain a nitro group and varying fluorine substituents in the ortho, meta, and para positions. The products were analyzed by 1H NMR and 19F NMR spectroscopy. Further directions include 2-D NMR, optimizing the yield and purity of product, and crystallographic characterization. Computational studies are also underway to understand the mechanism and selectivity of the reaction.

2026 College of Science Research Symposium

Chemistry and Biochemistry

64. Carbon Paste Nanoelectrode and Its Application in Single Nanoparticle Measurement

Angel Maritnez, Kenneth Oda, Peng Sun, Advisor: Dr. Peng Sun

A carbon paste nanoelectrode (CPNE) platform was employed to investigate the electrochemical behavior of individual palladium nanoparticles (Pd NPs) with nanoscale spatial resolution. Conventional ensemble measurements obscure particle-to-particle variability due to differences in size, morphology, and surface structure. The CPNE approach enables the isolation, capture, and direct characterization of single Pd NPs, allowing intrinsic electrochemical properties to be measured without ensemble averaging.

CPNEs were fabricated through laser-pulling of capillaries, toluene carbonization, and pyrolytic wire connection. Single-particle attachment was confirmed through nucleation signatures in cyclic voltammetry and size-dependent transient responses in chronoamperometry. Potentiometric measurements revealed that the equilibrium potential of the $Pd/PdCl_4^{2-}$ redox couple varies with nanoparticle radius, though no simple linear correlation was observed, suggesting additional influences such as crystal facets and structural defects. Voltammetric studies in acidic media showed characteristic Pd oxidation and PdO reduction features, while notably no hydrogen adsorption behavior was detected at the single-particle level, in contrast to bulk Pd.

These results demonstrate that CPNEs provide a robust platform for probing nanoscale redox behavior and resolving size-dependent electrochemical properties of individual nanoparticles.

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Chemistry and Biochemistry

65. Towards Understanding Local Atmospheric Chemistry: Characterization of a Nitrous Acid Generation System

Angela Hui, Brenda Vargas, Advisor: Dr. Stephanie Mora Garcia

The Inland Empire, where CPP resides in, is known for its warehouses and truck traffic. Specifically, diesel trucks that frequent the area and emit a lot of diesel exhaust particulate matter (DEPM). In addition, in this urban polluted environment, there are atmospheric pollutants such as oxides of nitrogen (NOy). The NOy cycles are especially important in atmospheric chemistry due to their production of ozone radical nitrogen containing species within the cycle. One substance in the NOy cycle is nitrous acid (HONO), whose formation and sources are severely understudied. Additionally, HONO itself is a source of hydroxyl radicals, which play a huge role in the formation of ozone and other harmful atmospheric pollutants. To begin to understand the environment of interest, a system to produce HONO consistently is required. The steps to produce HONO in a controlled lab environment are not easy. Previous studies have shown their process only with complex glassware and procedures, often ending with large uncertainties. A custom glassware was created to provide continuous HONO generation in controllable concentrations. This system uses sodium nitrite and sulfuric acid, which was found to be the safest option compared to others. Ion chromatography (IC) is used to determine nitrite, nitrate, and sulfate calibration curves to characterize the HONO generation system.

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Chemistry and Biochemistry

66. Imine/Amine Synthesis Using Reductive Amination

Ava McPherson, Claire Rabor, Diego Bustamante, Mindy Wu, Silvi Petrosyan, Advisor: Dr. Alex John

This project explores organic molecules containing an amine and imine functional group with a focus on their synthesis through the "Reductive Amination" reaction. This is a widely used method in organic chemistry for the formation of carbon-nitrogen bonds. Reductive amination involves the reaction of aldehydes or ketones which are carbonyl compounds with a primary amine under acidic conditions to form an imine intermediate, which is then reduced through hydrogenation or with a hydride reagent into a secondary amine. This poster outlines several common synthetic methods for amine formation, including nucleophilic substitution and nitrile reduction, emphasizing the efficiency and selectivity of reductive amination. It also provides naming conventions of this functional group and other important compounds that imines and amines can be found in. In addition, it discusses amine and imine groups that are found in nature and their relevance to biology, such as with amino acids and neurotransmitters (e.g., serotonin and dopamine), and in the pharmaceutical world, with compounds like amphetamine and other stimulants. This reductive amination process was tested in an experiment between ortho-vanillin with para-toluidine, where nuclear magnetic resonance (NMR) analysis was used to confirm a successful synthesis. Overall, this project highlights the importance of reductive amination as a versatile and efficient method in organic synthesis, with broad applications.

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Chemistry and Biochemistry

67. Development of Nickel-Catalyzed Cross-Coupling Reactions of Oxetanes and Azetidines

Berthy Aroche, Advisor: Dr. Taylor Thane

The exploration of azetidine chemistry is important for drug discovery, materials development, and synthetic methodologies. Azetidines are four-membered azaheterocycles that contain a nitrogen atom and have a high ring strain energy. The synthetic accessibility, unique reactivity, biological activity, and wide-ranging applications of azetidines make them an attractive target for researchers across various disciplines. Azetidines are reactive intermediates that make them attractive precursors for cross-coupling reactions. Previous development of nickel catalyzed cross-coupling reactions of aziridines provides valuable insight into the ring-opening of highly strained rings to develop efficient and versatile methodologies to access acyclic sulfonamides. We report the development of a nickel-catalyzed cross-coupling reaction of azetidines to make acyclic sulfonamides.

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Chemistry and Biochemistry

68. Nickel-Cross Coupling Reactions of Azetidines

Berthy Aroche, Advisor: Dr. Taylor Thane

Azetidines are unique linchpin motifs as they are prevalent in a variety of biologically active molecules and are reactive intermediates due to their inherent ring strain. As such azetidines are attractive intermediates for ring-opening reactions and downstream functionalization of complex molecules that contain azetidine motifs. Nickel-catalysis has become a powerful tool for carbon-carbon bond formation and is an attractive alternative to traditional precious metal catalysis. This work aims to combine the power of nickel-catalysis with reactive azetidine intermediates. Herein, we detail initial efforts in azetidine synthesis and reaction development.

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69. Development of Nickel-Catalyzed Cross-Coupling Reactions of Oxetanes

Camila Delgado, Advisor: Dr. Taylor Thane

Metal-catalyzed cross-coupling reactions are powerful tools for constructing new carbon-carbon bonds and allowing for the rapid development of complex molecules. Nickel catalysis has become a desirable alternative to precious metal catalysis as the demand for more sustainable catalytic transformations continues to grow. This work aims to develop a nickel catalyzed cross-coupling reaction of oxetanes. Due to their inherent ring strain, oxetanes are promising precursors for nickel catalyzed transformations. Herein, we report our starting material synthesis and our initial reaction development with nickel and titanium catalysts

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Chemistry and Biochemistry

70. The Unexplored Chemistry of Diesel Emissions: Photochemical Reactions of Diesel Exhaust Particulate Matter and Nitrogen Oxides

Clarissa Padilla, Will Lara, Advisor: Dr. Stephanie Mora Garcia

It is widely known that the sources of atmospheric pollutants such as nitrogen oxides, sulfur oxides, particulate matter, volatile organic compounds, and heavy metals are dependent on the source. One source is diesel exhaust particulate matter (DEPM), which are carbonaceous particles that are formed from the exhaust of diesel-operated vehicles and can stay airborne or deposit onto surfaces depending on the size and phase. Previous studies have shown that complex organic systems like humic substances and urban grime can lead to the reintroduction of nitrogen oxides after deposition from undergoing photochemical reactions. Currently, there is inadequate research on whether DEPM affects nitrogen oxides concentrations in the atmosphere in a similar manner. This raises the question of how local atmospheric chemistry changes in areas known as logistic hubs, which are used as central points for warehouses that sort, distribute, and transport goods, because of their increased operations of heavy diesel-operated vehicles. Importantly, this is an environmental justice issue, as air quality can be negatively impacted by the operation of logistic hubs and the respective diesel-operated trucks. This research project investigates the reactions of diesel exhaust particulate matter proxy organic compounds with nitrogen oxides. Raman spectroscopy is used on solid and liquid samples of the chosen organic molecular proxies, 4-benzoyl benzoic acid and ethylene glycol, and sodium nitrate and nitrite. To explore the chemical changes that may occur on the adsorbed surfaces of the proxies, thin films will be exposed to nitrogen dioxide gas and be compared to their unreacted spectra.

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71. Synthesis and characterization of HDAC 6 inhibitor HPB

Crystal Wilcox, Emily Oliva, Zola Cervantes, Advisor: Dr. Adaickapillai Mahendran

Histone deacytelase 6 (HDAC6) is unique among other HDAC's due to its ubiquitin zinc-binding domain and its two catalytic domains. This research describes the total synthesis and characterization of N-hydroxy-4-[(N(2-hydroxyethyl)-2phenylacetamido)methyl benzamide)] (HPB), a small molecule that has been found to selectively inhibit HDAC6. Studies have shown that by blocking cell growth of normal and transformed cells– without killing normal cells, it may induce tumor suppression, therefore making HPB an attractive molecule for treating cancer cells. This research describes the synthesis of HPB from commercially available compounds, starting with Methyl 4-(hydroxymethyl)benzoate and sequentially performing reactions in order to reach the desired product. Reactions detailed in the synthesis include protection, mesylation, coupling, nucleophilic substitution, and deprotection. The compounds were characterized using nuclear magnetic resonance spectroscopy (NMR). In the future, success of this synthesis and the chemical profile of HPB is desired to aid in the creation of alternative synthetic pathways and future studies of HDAC6 inhibitors.

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Chemistry and Biochemistry

72. Development of Nickel-Catalyzed Cross-Coupling Reactions of Azetidines

Daevon Skinner, Advisor: Dr. Taylor Thane

Nonprecious metal catalysts such as nickel, copper and iron are rapidly gaining attention as cost-effective and sustainable alternatives to traditional precious metal catalysts like palladium and iridium. These earth-abundant metals are used in transition metal-catalyzed cross-coupling reactions to form carbon-carbon bonds from simple building blocks. Such reactions are vital in the synthesis of complex molecules, particularly those used in drug development. Azetidines are unique motifs that are rapidly gaining wider interest due tot heir diverse range of biological properties and their inherent ring strain which makes them susceptible to ring opening reactions. With our focus on nickel, we aim to develop a nickel-catalyzed cross-coupling reaction of azetidines. Herein, we report the synthesis of our model starting material, 2-napthylazetidine, that will be examined in the target nickel-catalyzed cross-coupling reaction.

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Chemistry and Biochemistry

73. Development of Mo & W based photocatalysts for water remediation

David Pitones, Advisor: Dr. Matt Capobianco

Pesticides and industrial chemicals contain persistent organic pollutants (POPs), which have found their way into freshwater sources. While there are various water remediation methods, the most promising is photocatalysis since it is ecologically friendly, inexpensive, and highly efficient. Photocatalysis utilizes sunlight which is free, abundant and a renewable energy source. Photocatalysts use light to form hydroxyl radicals in water which then mineralize POPs into carbon dioxide and water. Although promising, the most popular photocatalysts either cannot sustain the creation of hydroxyl radicals or only work in the ultraviolet light range. My proposal is the creation of molybdenum and tungsten photocatalysts. To date, we have successfully synthesized molybdenum(VI) oxide and tungsten(VI) oxide by mixing molybdenum or tungsten precursors in ethanol for an hour at room temperature, and drying the mixture in the oven; we are currently attempting the synthesis of the mixed photocatalyst. The characterization of our samples is carried out using Raman spectroscopy and X-ray diffraction. Photocatalyst efficiency testing will be carried out by utilizing rhodamine B and methylene blue as model pollutants. The degradation of the aforementioned chemicals will be measured over time using UV-Vis spectroscopy. These photodegradation trials will be carried out under both dark and light conditions. From our understanding, we plan to synthesize molybdenum tungsten disulfide as it is of interest for its potential to sustain electron-hole pairs, allowing for more hydroxyl radical formation. Our work eventually aims to create a new prominent photocatalyst in water remediation and lead to a better understanding of photocatalyst design.

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74. Density Functional Theory for understanding the formation of (MesNHC2Me)Ni(SO4) and (tBuNHC2Me)Ni(SO4)

Diego Huerta, Advisor: Dr. Chantal Stieber

Sulfur is common in many pharmaceuticals, however there are limited methods for late stage functionalization of sulfones and sulfates. Most research is driven by the organic functionalization community, with less of a focus on the metal catalysts. This work builds upon a previous report by our lab of a bis(bidentate) N-heterocyclic carbene nickel sulfonyl (MesNHC2Me)Ni(SO2) which contains a Ni(II) center and activated SO22- moiety. The current work reports the synthetic formation of new (RNHC2Me)Ni(SO4) complexes (R = tBu, Mes) from (RNHC2Me)Ni(SO2). This reaction demonstrates the feasibility for using (RNHC2Me)Ni(SO2) in further functionalizations of sulfur. Density Functional Theory (DFT) calculations were undertaken using the ORCA program to conduct geometry optimizations and determine the electronic structures of all complexes. Both starting and ending products are best described as Ni(II). Relaxed surface scans to elucidate a reaction mechanism for the formation of (RNHC2Me)Ni(SO4) from the addition of O2 (RNHC2Me)Ni(SO2). Combined, these results have implications for developing new nickel catalysts to form new sulfur bonds.

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75. Depolymerization via Transesterification of Polyethylene Terephthalate Using Metal Catalysts

Gabriel Martinez, Advisor: Dr. Alex John

Polyethylene terephthalate (PET), a polymer synthesized from petrochemicals derived from crude oil, is an abundant material present in textiles and in plastic bottles, and is very durable. For those reasons, it is also a known pollutant, as it ends up in landfills and streets and occupies a portion of the oceans. Chemical recycling efforts of PET have shown promising results via strong catalysts, such as iron (III) trichloride, and the conversion of PET into bishydroxyethyl terephthalate (BHET) using sodium acetate and ethylene glycol has proven viable processing pathways. Yet the process of converting PET into diethyl terephthalate (DET) via sodium acetate and ethanol has not been fully researched. The various aspects of metal catalysts, such as the metal cation and the conjugate base, showcase varying effects on the conversion of PET into DET. This is being investigated via alterations of the metal, from sodium, potassium, zinc, and various lanthanides, as well as changing the conjugate base, from acetate, benzoate, chlorine, and triflate. The various alterations investigate how the cationic charge of the metals affects depolymerization, specifically in drawing negative charge within the PET polymer, and how the electronegativity of the conjugate base affects the process, specifically in the deprotonation of the ethanol solvent.

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76. Assessment of Color-Performance Relationships in Cotton-Bound Photocatalysts for Sustainable Organic Synthesis

Isabella Goveia, Advisor: Dr. Rohit Bhide

Traditional synthesis of pharmaceutical drugs relies on the use of toxic metals which poses limitations in sustainability. Currently, homogeneous photocatalysis, which uses light illumination to drive organic reactions, has been shown as a solution. However, the sustainability of reactions with these catalysts is poor as there are challenges with their recovery and reuse. In this work, I propose the development of photocatalyst-bound cotton that will exhibit higher reaction yields, selectivities and effective recovery and reuse in organic syntheses. The photocatalyst-bound cotton is synthesized by covalently attaching molecular photocatalysts to the primary hydroxyl groups on the surface of cotton fabrics. This is done through a two step process. The first being, a silanization reaction to covalently attach (3-aminopropyl)triethoxysilane (APTES) to cotton. In the second step, a nucleophilic acyl substitution reaction between APTES-functionalized cotton and perylene-3,4,9,10-tetracarboxylic dianhydride. These photocatalyst-bound cotton samples will be characterized using colorimetry, a common technique in the textile industry used to quantify color. Furthermore, the applicability of these photocatalysts will be tested through their use in the oxidation of sulfide to a sulfoxide group, a functional group present in many pharmaceuticals. We will use nuclear magnetic resonance spectroscopy (NMR) to monitor the reaction kinetics, yield and selectivity for the sulfide oxidation reaction. With this NMR analysis and the colorimetry results I will merge the textile and chemistry fields to develop a calibration curve to offer an easy comparison between the shade of the photocatalyst and the rate of reaction. In addition, I will investigate how the heterogeneous nature of our photocatalysts will offer ease of recovery and reuse via the separation technique of filtration. Overall, this work will serve as a foundation in the development of low cost textile-bound photocatalysts in sustainable and efficient synthesis which can be applied to pharmaceutical drug syntheses.

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77. C-F Activation of Octafluorobiphenyl with Nickel(0) N-Heterocyclic Carbene Complexes

Joshua Soo, Advisor: Dr. Chantal Stieber

The synthesis of fluorinated compounds is important for material sciences, pharmaceuticals, and environmental protection. Carbon-fluorine (C-F) activation, or the cleaving of the C-F bond, is a tool used in forming these compounds, though this is made difficult by the high C-F bond energy and the large difference in electronegativity between carbon and fluorine. N-heterocyclic carbenes (NHCs) are heterocyclic systems containing a carbene atom and at least one nitrogen atom that can be coordinated to metal atoms to facilitate C-F activation. In this work, a (bis)imidazolium salt containing tert-butyl wingtips was reacted with Ni(COD)2 to create the initial catalyst, (tBuNHC2Me)Ni(COD), which was found to promote selective C-F activation of an octafluorobiphenyl substrate. Confirmation of C-F activation was done primarily through 19F NMR analysis and X-ray diffraction crystallography. This has the potential to undergo further hydrodefluorination and cross-coupling to form novel organic products that may be of interest in pharmaceutical development.

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78. Assessment of the Photocatalytic Performance of Silica-Bound Photocatalysts For Sulfide Oxidation

Kaitlyn Miller, Advisor: Dr. Rohit Bhide

Studying the surface of heterogeneous photocatalysts has been a long-standing challenge in the catalysis community. This project investigates the effect of surface loading on the properties and performance of colloidal photocatalysts. Using detailed spectroscopic analyses, this research addresses challenges with catalysis and will help understand how surface engineering influences the properties of photocatalysts in different organic solvents. These studies will help improve synthesis of complex organic compounds and high recovery rates for the photocatalysts used for catalyzing reactions. To synthesize our photocatalyst particles, (3-Aminopropyl)triethoxysilane (APTES) was bound to silica particles before covalently attaching the photocatalyst perylene tetracarboxylic acid dianhydride (PTCDA). The photocatalysts were characterized using several spectroscopic and chemical analyses. To assess the performance of these catalysts, the oxidation of sulfide to sulfoxide with the PTCDA-bound modified silica was tested in a photoreactor using 450 nm blue LED light over 12 hours. This reaction has wide applications in the synthesis of commercial pharmaceutical drugs making it the best reaction to test these silica particles. The photocatalytic oxidation of sulfide was monitored by thin layer chromatography and nuclear magnetic resonance. The catalytic performance at varying photocatalyst loading on silica was tested. Analyses of these data showed a faster rate with lower photocatalyst concentration which is the opposite of expected results. A plausible reason for this observation could be attributed to the effect of photocatalyst loading on their excited state lifetimes. Excited states of photocatalysts can be more effectively quenched at higher surface concentrations, leading to poor catalytic performance. To test this hypothesis, the surface loading-photophysical property relationships will be further assessed. Moreover, careful photochemical studies were performed to confirm that both the photocatalyst and the light illumination were required to drive sulfide oxidation. With this collected data, more experiments will be conducted to test the reproducibility of observed outcomes.

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79. Synthesis of a Bifonazole-based Bis(imidazolium) Salt and Complexation with Silver for CO2 Reduction

Mario Moreno, Dr. Benjamin Goka, Dr. Chantal Stieber, Advisor: Dr. Chantal Stieber

The development of new ligand systems for metal coordination is important for advancing catalytic applications, including carbon dioxide reduction. In this work, a bifonazole-based bis(imidazolium) salt was synthesized as a precursor to an N-heterocyclic carbene ligand and subsequently complexed with silver to generate a new metal complex. The bis(imidazolium) salt was prepared through a benchtop reflux synthesis and characterized by 1H NMR spectroscopy, which showed diagnostic peaks consistent with the expected product. Metal complexation was then carried out using Ag2O in CH2Cl2, yielding a new silver complex. Additional 1H NMR data supported successful carbene activation and silver coordination. These results demonstrate the successful synthesis of both the ligand precursor and its corresponding silver complex, establishing a foundation for future studies evaluating its potential for CO2 activation and reduction.

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80. Nickel Catalyzed Cross-Coupling Reactions

Matthew Polino, Advisor: Dr. Taylor Thane

Suzuki-Miyaura cross-coupling reactions play a key role in the development of synthetic and pharmaceutical industries, being one of the top executed reactions. However, the expensive and toxic palladium catalysts driving the reactions are unsustainable. There is ongoing investigation for sustainable alternatives, such as nickel catalysis, but the metal's reactivity has not been thoroughly explored with a wide range of substrates. Oxetanes, highly strained four membered heterocyclic rings, are promising precursors for nickel-catalyzed cross-coupling reactions. This work aims to examine the compatibility of the oxetane motif in nickel catalyzed cross-coupling reactions with boronic acids as coupling partners. Recent studies have illustrated successful nickel catalysis of oxetanes upon addition of a dual cobalt catalyst. This work details our progress in the development of nickel-catalyzed cross-coupling reactions of oxetanes with boronic acids. We generated an oxetane precursor in a four-step synthesis. The oxetane was then subjected to an array of nickel catalyzed cross-coupling reactions. A combination of different catalysts, ligands, and temperatures were tested to find optimal reaction conditions, but no expected cross-coupling products have been observed. Further combinations of variables, including different oxetane precursors, will be examined to discover a catalog of efficient cross-coupling reactions. The development of these reactions would allow for a more sustainable approach to molecule synthesis.

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Chemistry and Biochemistry

81. Towards the Synthesis of Tiliageine and Cepharanthine Cores: Synthesis of a Key Diamine Precursor to Bisbenzyltetrahydroisoquinolines

Minh Lu, Advisor: Dr. Thomas Osberger

Natural products have long been central focuses and targets in organic synthesis towards drug discovery due to their diverse structures and optimized interactions with biological systems. However, there has always been a major challenge in extracting and purifying these products. Bisbenzyltetrahydroisoquinolines (BBTHIQs) are alkaloids that possess characteristic benzyltetrahydroisoquinoline units (BTHIQs) linked together by carbon-carbon bonds or ether linkages. Their diversity comes from various substituents on aromatic rings and different types of connections between BTHIQ units. Cepharanthine (CEP) is a member of the BBTHIQs and an approved drug in Japan, which has long been used to treat different conditions. Recently, it has been reported to be a potential anti-COVID-19 agent. We are interested in exploring efficient synthesis pathways towards Cepharanthine and its analogs, optimizing yields for these molecules in a laboratory setting, to serve drug discovery purposes. This work focuses on the synthesis of Tiliageine's core (a CEP analog) through a proposed synthetic pathway involves a challenging Ullmann-type cross-coupling reaction to form a diaryl ether that possesses two functional groups, which then goes through functional group interconversions to obtain a key diamine intermediate. Pictet-Spengler cyclodimerization of this diamine and one other molecule will ultimately yield Tiliageine's core. All compounds were characterized by NMR which demonstrated good purity. The coupling step is currently being optimized and analyzed using GC/MS in order to obtain an optimal yield. These results have accomplished key transformations towards the target diamine molecule and will be useful for BBTHIQ core synthesis.

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82. Exploring Amide Coupling Reagents for Multi-Substituted Cyclobutane Synthesis

Nhi Le, Advisor: Dr. Thomas J. Osberger

Cyclobutane is found in plants and marine species, so the molecule is characterized as natural products. Cyclobutane is a useful structural element in pharmaceuticals such as carboplatin, which is an anticancer compound being used in chemotherapy treatment. Our group is interested in the synthesis of novel, multi-substituted cyclobutane compounds. This project focuses on amide coupling reactions of cyclobutane carboxylic acids with amines to form trifunctional cyclobutane molecules. The goal is to apply a combinatorial approach to produce a family of such molecules. To identify suitable amide coupling conditions, we tested different amide coupling reagents and analyzed their yield and ease of purification. Two different reagents, HBTU and EDC-HCl, were explored to compare differences in its product. The first synthesis was with Hexafluorophosphate Benzotriazole Tetramethyl Uronium (HBTU). The obtained product was recrystallized and 48.4% yielded crystals containing white powdered crystals and large brown rods. The second synthesis replaced HBTU with 1-Ethyl-3-(3-dimethylaminopropyl) Carbodiimide Hydrochloride) (EDC-HCl). This reagent produced white crystals that were uniform in shape and color with 9.6% yield crystals. The purity of the EDC coupling product after an acid wash and recrystallization was similar, indicating easier purification of EDC reactions. These results set the stage for future coupling reactions to produce a collection of trifunctionalized cyclobutane compounds for biological testing. According to the success of EDC-HCl, a different reagent named Triethylamine was used and purified by column chromatography with a mixture of Ethyl Acetate and Hexane. These results set the stage for future coupling reactions to produce a collection of trifunctionalized cyclobutane compounds for biological testing. The crude percent yield increases in an amine coupling product including Bis (2-ethylhexyl) amine.

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83. Biogeography of Soil Catalases at Cal Poly Pomona

Alexis Padilla, Reagan Jezisek, Advisor: Dr. Rakesh Mogul

Soil catalases are important enzymes involved in the control of oxidative stresses arising from microbial respiration, ultraviolet exposures, desiccation, and pollutants. Catalases break down H_2O_2, a reactive oxygen species, to yield H_2O and O_2. In this presentation, we will show that the kinetic parameters of soil catalases are sensitive to irrigation, land cover, mulching, and microbial abundance. Our catalase assay is based on volume displacement and requires <2 min per sample. We are currently measuring the catalase specific activities and Michaelis-Menten parameters for several soil samples from the Cal Poly Pomona campus. The samples are being collected from well and poorly irrigated locations, flower beds, under treetop canopies, and agricultural pastures. Catalase specific activities were obtained by measuring reaction rates in 330 mM H_2O_2 and expressing the final rates per gram of dry weight of the soil (gdw). Michaelis-Menten kinetics are being performed using 25-600 mM H_2O_2. For all soils, we are also obtaining the 16S rRNA copy number per gdw, which serves as a proxy for biomass, and the geochemical composition of the soils (using commercial services). Thus far, our results show that (a) catalase specific activities from well-irrigated soils correlate to increases in biomass ($P < 0.05$), (b) decreases in soil irrigation yields lower catalase specific activities, (c) changes in soil dryness impact the Michaelis-Menten parameters, and (d) mulching decreases the catalase specific activities. Current efforts are focused on expressing the catalase kinetic terms per biomass and conducting statistical analyses to reveal correlations between soil type, geochemistry, and catalase activity. Thus, assays for catalase activity could serve as an important biochemical tool to assess the health of soils.

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84. Glass Beads vs Cotton Threads As Photocatalysts For Synthesizing Complex Organic Compounds

Ryan Jolin, Advisor: Dr. Rohit Bhide

With the rising cost of pharmaceutical drug synthesis, new ways of creating base molecules like sulfoxide are high in demand. The state-of-the-art methods for these oxidation reactions involve toxic heavy metals like chromium and vanadium as catalysts, which have long reaction times and require many purification steps. However, perylene-based compounds like perylenetetracarboxylicdianhydride (PTCDA) and perylene diimide (PDI) have shown very promising results when replacing these metals. These organic compounds are non-toxic and have the potential to be reusable when attached to different substrates, for instance, glass beads and cotton thread. When varying the amount of photocatalyst that is loaded onto the surface, the catalytic performance would, theoretically, be affected. Also, with varying concentrations, the color shade should also get darker with more concentrated solutions. Due to this correlation with the color shade and concentration, we seek to relate the color shade to its photocatalytic performance, which has not been done before. Cotton thread was pretreated using a base bath and then reacted with APTES to provide adequate binding area. Then, they were treated with PTCDA. Glass beads have been etched utilizing a base bath followed by an acid bath. Then, the beads were refluxed in a toluene-PDI mixture for 48 hours to covalently attach the PDI photocatalyst. After washing, the beads and thread were shown to retain a light pink to dark red color, proving that the attachment was successful. In the future, the beads will be characterized using colorimetry shade analysis and Fourier-Transform Infrared Spectroscopy. The photocatalytic performance of the photocatalyst-attached beads will be assessed by monitoring the rate of sulfide oxidation using Thin Layer-Chromatography and Nuclear Magnetic Resonance.

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85. Activation Energies of Cellular Division for Spacecraft-Associated Acinetobacter

Sofya Khodyush, Spencer Ward, Derek Pineda, Isaac Aguirre, Kieran McAllister, Advisor: Dr. Rakesh Mogul

Robust cleaning procedures for robotic spacecraft are critical to maintaining the integrity of habitability-focused missions and preventing false positive signals of biology. In this presentation, will we show that cultures of spacecraft-associated Acinetobacter require minimal energy to divide under nutrient restricted conditions. This project focused on A. radioresistens 50v1, a Gram-negative bacterium that was isolated from the surface of the Mars Odyssey orbiter prior to launch. Our methodology included measuring the growth rates of A. radioresistens 50v1 at differing temperatures (24–32 ℃) in two differing media. Nutrient rich cultivations were conducted in lysogeny broth (LB), which is rich in peptides, carbohydrates, vitamins, and minerals. Nutrient restricted cultivations were conducted in diluted minimal media (0.2x M9) containing ethanol, as a sole carbon source, and a defined mixture of trace elements. Growth curves were fitted to obtain the time in lag phase, growth rates, and the maximum cellular abundance. Arrhenius plots were constructed to obtain the free energies of activation (ΔG‡) associated with cellular division. Our results show that the ΔG‡ in 0.2x M9 (17 kJ mol^-1) is ~5-fold lower than the value in LB (91 kJ mol^-1). Growth rates were slower in 0.2x M9 likely due to the carbon restriction. Comparisons revealed that the low ΔG‡ in 0.2x M9 was comparable to the values for psychrophiles and lower than many mesophiles. These results suggest that proliferation of the 50v1 strain in spacecraft facilities or favorable environments on Mars or Europa could be supported by the low ΔG‡ value.

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86. Synthesis of bisphosphine containing amino acid

Soma Yamakawa, Advisor: Dr. Alex John

Monophosphines like triphenylphosphine and other bisphosphines are used as ligands for regulating the reaction rate and selectivity of metals like palladium, rhodium, etc. in organometallic catalysis. Chiral phosphine ligands can coordinate with metals in several ways and stereochemical differences alter the selectivity and reactivity of these metals. Incorporating the phosphine group in amino acids enables us to synthesize novel ligands which allow for easier stereochemical change due to spatial folding of peptides. Based on prior research that altered the hydroxyl group in tyrosine to diphenyl phosphine, the current project aims to synthesize a bisphosphine amino acid ligand. The synthesis consists of four steps, (a) esterification of L-3,4-dihydroxyphenylalanine (b) boc protection of the amino acid ester salt, (c) triflation of Boc protected amino acid ester, and (d) carbon-phosphorus cross-coupling of the amino acid. The triflate was synthesized in a 41% yield after purification using column chromatography and characterized by 1H and 19F NMR spectroscopy. A model carbon-phosphorus cross-coupling was conducted with a synthesized catechol ditriflate and nickel catalyst to verify the experimental conditions. Efforts are currently underway to complete the final carbon-phosphorus cross-coupling to synthesize the bisphosphine ligand.

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87. Development of Electrochemical In-Situ Room Temperature Flow EPR Techniques

Stephanie F. Jauregui, Feven L. Gebresilassie, Jenny Y. Yang, Ryan J. Jones, Advisor: Dr. Chantal Stieber

Rising CO2 levels have sparked interest in reactive capture and conversion (RCC) to directly convert CO2 into valuable fuel and chemicals such as methane, formic acid, and methanol. However, electrochemical reduction of CO2 can be hindered by electrode corrosion, and the characterization of reaction intermediates is challenging. Electron paramagnetic resonance (EPR) could be used to detect species formed in solution during electrolysis that have an unpaired electron. EPR studies typically use freeze-quench methods to capture intermediates at a given time point, so there is a critical knowledge gap in developing in-situ room temperature EPR. This work aimed to develop an in-situ room temperature flow EPR method to track species formed in real time during electrochemical CO2 reduction to determine kinetics and mechanisms for reduction. This work built a new flow EPR system to successfully track the kinetics of copper corrosion during electrolysis by the detection of a Cu2+ species. The system was also applied to study radical CO2 reactions with unsaturated olefins. Combined, these studies establish a new spectroscopic technique for probing complex electrochemical reactions, and identifies copper corrosion products in electrochemical CO2 reduction. These results will ultimately lead to more effective CO2 reduction strategies.

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Chemistry and Biochemistry

88. Assessment of the Effect of Shade on the Performance of Photocatalyst-Dyed Cotton

Theneza Ross Metra, Advisor: Dr. Rohit Bhide

This project focuses on immobilizing the photocatalyst Eosin Y onto cotton fabric and evaluating its potential as a reusable, solid-supported catalyst for photoredox reactions. In the first phase, Eosin Y was successfully dyed and immobilized onto pre-treated cotton, as indicated by the bright pink coloration of the fabric. This was performed by first converting Eosin Y from a carboxylic acid form to a reactive acid chloride form using N,N'-Dicyclohexylcarbodiimide (DCC) as the coupling agent. Thin Layer Chromatography (TLC) was performed to monitor the formation of the acid chloride derivative; however, no significant difference in Rf values was observed with or without the use of DCC. The acid chloride form was then reacted with cotton samples to covalently attach Eosin Y to the surface of the fabric. Repeatability of the process was tested, and samples showed slight shade variations, reflecting natural differences in dye uptake during the immobilization process. Tests to further confirm the covalent attachment of the photocatalyst to cotton are in progress.

In the second phase, the Eosin Y treated cotton was tested for its photocatalytic activity in the oxidation of benzyl sulfide. The reaction mixture containing benzyl sulfide and the photocatalyst-attached cotton was illuminated with blue light (450 nm) over 72 hours. TLC was used to track the reaction progress, and it showed the formation of benzyl sulfoxide, demonstrating that the photocatalytic system is active.

The next steps of the project will focus on standardizing the immobilization procedure by increasing replicates, improving fabric submersion, and adjusting both reaction steps to achieve more uniform dye loading.

2026 College of Science Research Symposium

Chemistry and Biochemistry

89. Reflux-Sonication Route to Obtain MoS2 2D Quantum Dots

Vincent Pham, Advisor: Dr. Matt Capobianco

The development of efficient synthetic methods to obtain 2D quantum dots is crucial for advancing applications in energy conversion. Though there are various possible synthesis methods, many are complex, costly, or limited to specific materials, restricting any large-scale applications. In this study, a reflux pretreatment sonication approach was used to obtain 2D quantum dots from layered MoS_2. The reflux step was done in a MoS_2 solid combined with a 70/30 isopropanol-water mixture in order to promote interlayer expansion and enhance the MoS_2 material's susceptibility to exfoliate. The amount of time the system was exposed to sonication was varied. This procedure is followed by ultrasonication to promote the breakdown of bulk materials into a smaller, nanoscale quantum dots, which are then isolated via centrifugation. Upon extended reflux time, it resulted in a higher yield of quantum dot products compared to a shorter reflux duration. This is a poossible indication that extended pretreatment can enhance the efficiency of exfoliation and quantum dot formation in turn. We look towards attaching these quantum dots to metal oxides as photosensitizers in solar cells. Sensitization of a metal oxide resulted in an enhanced light absorption of MoS_2, indicating an improved interaction and possible potential for more efficient energy transfer. This method provides a simple universal route for producing 2D quantum dots and can offer a scalable pathway in the future where it could be possible to generate nanomaterials with tunable properties for future technological applications.

2026 College of Science Research Symposium

Computer Science

90. Exploring SATCOM Vulnerabilities Through Passive SDR-Based Analysis

Aditya Makwana, Nicholas Tsimerekis, Aumkaareshwar DS, Nathan Lee, Advisor: Dr. Mohammad I Husain

Satellite communication (SATCOM) systems are critical for global connectivity but expose unique security challenges across RF, protocol, and device layers. This work presents a security analysis of satellite communication systems (SATCOM) that combines a review of publicly reported vulnerabilities with hands-on, non-intrusive experimental observation. Focusing on representative broadband terminals and Low Earth Orbit (LEO) satellite phone systems. Using commodity software-defined radio (SDR) and opensource tools an passive RF observation experiments wa conducted to characterize Iridium L-band downlink activity. The results support prior findings regarding control-plane observability and metadata exposure while emphasizing ethical constraints and reproducibility. Overall, this work highlights the continued need for SATCOM security assessment approaches that reflect real world operational conditions and are conducted within legal and ethical boundaries

2026 College of Science Research Symposium

Computer Science

91. Exploiting Private 5G: Unauthenticated Access to Databases and Control Plane DoS via Fuzzing

Aumkaareshwar Dhutthe Srinivas, Nathan Lee, Advisor: Dr. Mohammad Husain

Private 5G networks are more commonly used for critical infrastructure purposes, however, they operate under the erroneous belief that network isolation is enough for security purposes. This paper provides a full-scale security assessment of a live deployment of a private 5G Core network to determine the resistance of its service-based architecture. The results showed several misconfigurations in relation to network storage, logging, monitoring, and signaling services.

Namely, the researchers uncovered that there was unauthenticated access to the primary MongoDB instance of the network that stored the cryptographic secrets of SIM cards, including the Master Key (K) and the Operator Key (OPc), making the SIM card cloning and real-time tracking possible. The second misconfiguration involved the absence of any form of access control on the central Kibana monitoring tool and the backend REST API of Elasticsearch.

In addition, we managed to find out another major vulnerability in the input validation process in the Access and Mobility Management Function (AMF). In particular, through the utilization of our boofuzz-built fuzzing tool, we managed to carry out a DoS attack on the signaling interface of the AMF. Due to the injection of malicious binary data into the signaling process, memory corruption occurred, and the AMF service crashed. The attack resulted in the permanent "No Service" state for all User Equipment devices that were then unable to receive any network traffic until a reboot took place.

These results show that the use of network segmentation alone in current 5G deployments is not enough. Such research clearly illustrates the crucial importance of implementing Zero Trust architecture, RBAC, and protocol input validation within 5G infrastructures.

2026 College of Science Research Symposium

Computer Science

92. CROSS-CONSOLE MUSIC REMASTERING USING HYBRID AI

Benjamin Tran, Advisor: Dr. Fatemeh Jamshidi

This research presents an AI-assisted pipeline and interactive application for remastering legacy game music across multiple console-era audio styles. The system accepts symbolic game music in MIDI format and produces two parallel outputs: (1) a deterministic baseline remaster that remaps channels to console-specific instrument programs using curated soundfonts, and (2) a machine learning–based audio generation path employing a fine-tuned MusicGen model conditioned on a short audio prompt derived from the baseline render. Target hardware styles include the Game Boy Advance, Nintendo DS, and Nintendo Wii. The principal technical contribution is a hybrid framework that integrates controllable symbolic remapping with multi-style neural audio generation, enabling direct comparison between rule-based remastering and learned stylistic synthesis across distinct console generations. The system is evaluated using a two-pronged methodology that combines objective content-preservation metrics, specifically, melodic contour similarity and onset alignment F-measure, with subjective listening tests assessing perceived style fit, faithfulness to the source material, and overall audio quality. Deliverables include a reproducible dataset workflow, the core inference modules, and a web-based application that enables users to upload MIDI files and compare remastered outputs side by side. This work contributes to research in controllable music generation, style transfer, and the preservation and reinterpretation of historical video game audio.

2026 College of Science Research Symposium

Computer Science

93. Reinforcement Learning Techniques using Deep Deterministic Policy Gradient Variants for Astronomical Observation Scheduling

Caoialinn Johnsson, Hadya Rohin, Advisor: Dr. John Korah

The problem of scheduling the visitation of astronomical observations is computationally challenging. Astronomical observations involve utilizing expensive resources that are shared across the scientific community. To ensure adequate utilization of observatory resources, creating an efficient astronomical observation schedule is critical. The Traveling Salesman Problem (TSP) is an NP-hard problem that aims to find the shortest path among a set of cities. The Astronomer's Traveling Salesman Problem (Astro-TSP) is a TSP variant that aims to create an optimal astronomical observation schedule under various constraints. As a solution, we propose two alternate implementations of the Deep Deterministic Policy Gradient (DDPG) reinforcement learning method. The Twin-Delayed DDPG utilizes clipped double Q-learning and delayed policy updates that keep action space conservative, minimizing convergence times and increasing observations visited. Distributed Distributional DDPG combines a distributional critic with an N-step return to provide a richer learning signal. Their performances will be compared against the traditional DDPG model to determine whether the variants improve performance. It is expected that the experimental validation will help in their future deployment for more efficient scheduling for larger observational sets and possibly extend to other TSP-based and NP-hard optimization problems.

2026 College of Science Research Symposium

Computer Science

94. BeatSync: Music-Driven Motion in Virtual Reality

Hung Nguyen, Advisor: Dr. Fatemeh Jamshidi

This research presents BeatSync, a virtual reality (VR) rhythm-based game designed to deliver an immersive and engaging dance-oriented experience through the integration of automated audio analysis and upper-body motion tracking. The system performs feature extraction on user-selected audio tracks to identify tempo, beat onsets, and amplitude envelopes, which are subsequently used to procedurally generate movement patterns, or beat maps, synchronized with the music. Real-time interaction is enabled through motion tracking of the head and hand joints, allowing players to match their physical movements to music-driven visual cues rendered within the VR environment. By coupling audio-feature extraction with embodied motion input, BeatSync aims to enhance user engagement and presence during gameplay. Furthermore, the automation of beat map generation eliminates the need for manual authoring, enabling scalable content creation across arbitrary music libraries. The proposed framework contributes a reproducible pipeline for music-driven interaction in VR and offers a foundation for future work examining the effects of rhythm-based VR exergames on engagement, motor coordination, and potential therapeutic applications.

2026 College of Science Research Symposium

Computer Science

95. SPOT Assistant Model Integration

Jonathan Francisco, Chelsea Kathleen T. Ocampo, Gabriel Alfredo Siguenza, Janice Lachan, Julianna Arias, Advisor: Dr. Daisy Tang

Our model provides a complete integration of research concepts such as object detection, robotic integration, and natural language processing. Optimization of human-computer interaction advances the range of opportunities in multiple fields of work such as medicine, defense, and patient care. Our final model utilizes a general program to provide the user with direct assistance in retrieving objects. Utilizing YOLO models and SPOT libraries, the robot autonomously operates to achieve the desired result. The completion of our program provides a base model for further research in providing efficient, accurate, and consistent outcomes in robotic assistive technology.

2026 College of Science Research Symposium

Computer Science

96. End-to-end symbolic music generation with transformer model

Javi Wu, Advisor: Dr. Fatemeh Jamshidi

Recent advances in generative AI have produced powerful text-to-music systems, yet most prioritize raw audio output over symbolic structure, yielding fixed waveforms that musicians cannot easily edit or refine. This project addresses that gap by developing an end-to-end symbolic music generation pipeline built around a decoder-only Transformer trained on large-scale MIDI data. Rather than synthesizing audio directly, the system models music as sequences of discrete tokens encoding pitch, duration, velocity, and timing, enabling the model to learn temporal, harmonic, and structural dependencies in a compact and learnable form. The pipeline consists of three stages: (1) a preprocessing and tokenization module that cleans and normalizes MIDI files into consistent event sequences; (2) a Transformer-based autoregressive model that leverages multi-head self-attention and positional encodings to capture long-range musical context; and (3) a piano-roll interface that allows users to inspect, edit, and iterate on generated output. Experimental results show that the model produces coherent multi-measure sequences with stable rhythm and clear musical structure, maintains continuity over extended contexts without collapsing into repetition, and generalizes across diverse stylistic inputs, outperforming simple baselines on sequence coherence and next-event prediction. By combining symbolic representation with interactive editing, this work advances the case for editable, musician-driven generative systems. Future work will extend the tokenization scheme to capture expressive timing, articulation, and multi-track structure for richer compositional control.

2026 College of Science Research Symposium

Computer Science

97. The Architecture of Auditory Emotion: Utilizing MERT Embeddings and Deep Learning for Musical Emotional Recognition

Jay Wageni, Elena Hernandez, Keita Katsumi, Advisor: Dr. Fatemeh Jamshidi

Music evokes emotion, but translating subjective auditory experiences into learnable computational signals remains difficult: emotions are continuous, context-dependent, and poorly captured by low-level audio features alone. This work develops a deep learning framework for music emotion recognition (MER) that pairs modern self-supervised audio representations with a vector-space model of emotion.

Audio is encoded using MERT, a large-scale self-supervised music representation model, producing high-dimensional embeddings that capture timbral, harmonic, and structural content. These embeddings are then mapped to Russell's valence-arousal plane through two regression architectures, a Convolutional Neural Network (CNN) and a Transformer.

Both are trained and evaluated using the DEAM dataset, with further fine-tuning using a private dataset of 204 classical pieces performed by orchestral ensembles through the music conservatory group "iPalpiti". We conduct a comparative analysis of the CNN and Transformer models across valence and arousal prediction tasks, evaluating performance using R^2 and mean squared error (MSE) to investigate the extent to which attention-based models can recover emotional structure from pretrained audio embeddings without task-specific feature engineering. These results aim to assess the viability of embedding-plus-regression pipelines for downstream applications such as emotion-aware music search and recommendation. Ongoing work extends the comparison to recurrent and hybrid architectures and examines how embedding layer choice within MERT affects emotional fidelity.

2026 College of Science Research Symposium

Computer Science

98. SpotAgent: LLM-Powered Task Planning and Execution for Quadruped Robots

Kai Xue, Viet Nguyen, Advisor: Dr. Mohammad Husain

Robotic systems are becoming increasingly capable and are being deployed in a wide range of environments ranging from industrial facilities to public spaces and research laboratories. Despite being adopted into different domains, these advanced robotic systems often require specialized knowledge of the robot's middleware and software to operate them reliably. For example, commanding a Boston Dynamics Spot robot typically involves interfacing with ROS2 topics, services, and actions, which demands familiarity with robotic software frameworks. While such specialized knowledge enables fine-tuned control, it limits accessibility for users who lack this expertise. Recent advances in Large Language Models (LLMs) have demonstrated their ability to interpret natural language instructions and produce structured outputs, making them a viable bridge between human intent and robotic execution. By leveraging an LLM as a planning component, users can express commands in natural language while the system translates them into validated robot actions. This work presents a natural language control interface for the Boston Dynamics Spot robot that integrates an LLM with a ROS2-based control architecture using a planner-executor framework. The planner, powered by an LLM, interprets user instructions and selects structured actions from a predefined toolbox. The executor validates the selected actions through safety checks including tool existence, parameter type verification, and safety limit enforcement before executing them through ROS2 topics, services, and actions. Additionally, a voice input interface allows users to issue spoken commands. This system enables users to issue high-level commands such as velocity-based movement, waypoint navigation, and posture control using natural language without requiring specialized knowledge of robotic middleware.

2026 College of Science Research Symposium

Computer Science

99. 3D Pose-Based Video Understanding for Baseball Pitching Phase Detection

Kellan Young, Advisor: Dr. Hao Ji

This work presents a feature-based method for identifying motion phases in baseball pitching based on 3D pose estimation. Joint keypoints are extracted from videos using RTMPose3D, and features such as joint angles, velocities, and relative distances, are computed from the reconstructed skeleton.

Phase detection is achieved using rule-based analysis of temporal feature patterns, such as peaks and transitions in wrist speed, joint geometry, and lower-body motion. The effectiveness of the proposed phase detection is verified by comparing the output with the ground truth labeled frame set. To further assess robustness, a second pitching video recorded under less controlled conditions is analyzed, demonstrating consistent phase ordering despite differences in motion data quality.

The framework is further adapted to batting by redefining phase structure and introducing motion-specific features, including lead ankle motion for stride, wrist speed for swing initiation, and shoulder–wrist extension for contact detection. The results indicate that joint-based features are an effective and applicable method for phase detection in sports motion.

2026 College of Science Research Symposium

Computer Science

100. Generating Multiview-Robust 3D Adversarial Examples

Michelle Reyes, Advisor: Dr. Hao Ji

Adversarial learning examines the process of attacking deep or machine learning models by perturbing their input, which expose the vulnerabilities of these models. This research is necessary for understanding a model's limitations and developing solutions to navigate them. In the experiment, Multiview inputs were utilized, where a sticker perturbed using the Fast Sign Gradient Method (FGSM) with a small epsilon value of 0.005 was strategically placed based on the model's prediction decision. Using Class Activation Map (CAM) to see the model's decision-making process, enabled the identification of high-value vertices on the mesh. The sticker was then placed at these vertices to maximize the likelihood of deceiving the model and creating adversarial examples. The results demonstrate that with targeted placement, a single sticker can achieve a false-negative rate of 96.91%, effectively producing an almost 100% successful adversarial attack.

2026 College of Science Research Symposium

Computer Science

101. Using Conditional Generative Adversarial Networks (cGANs) to Improve the Quality of Pseudo-Absence Data for Crop Suitability Models

Minh Nhat Doan, Advisor: Dr. John Korah

Agriculture is under increasing pressure from climatic variability, and crop suitability modeling has become an important tool for informing stakeholders about potential impacts and adaptation strategies. Machine learning techniques have emerged as the dominant methodology for modeling crop suitability. However, these require training data that contain location samples, which are suitable (presence points) and which are not suitable for the crop (absence points). However, reliable absence data for unsuitable land are often limited or unavailable, necessitating the use of pseudo-absence (PA) data. Many commonly used PA generation approaches rely primarily on geographic coordinates and may underrepresent ecological conditions relevant to crop growth. This limitation becomes more apparent when working with remote sensing data, which provides high-dimensional multi-band inputs containing rich spectral and spatial environmental information. This study investigates the use of Generative Adversarial Networks (GANs) as a generative AI approach for improving pseudo-absence data generation. GANs do not require extensive feature engineering in order to learn how different nonlinear relationships exist among high-dimensional data. The objective is to develop a Conditional Generative Adversarial Network (cGAN) based methodology to synthesize candidate pseudo-absence feature representations from crop environmental variables. cGAN is used to condition the generation on class-level semantic descriptors. This allows the model to produce class-specific synthetic features, which is important for crop suitability data, as different crops may have varying environmental requirements. The approach is informed by feature-generating zero-shot learning frameworks, in which conditional GANs synthesize class-conditioned feature representations from semantic information for subsequent classification. Within this framework, the study examines whether synthetically generated features can serve as candidate pseudo-absence representations for crop classes with limited or no labeled absence data. The preliminary study uses crop raster data described by 19 bioclimatic variables, with initial experiments centered on two cash crops, namely pitaschio and almond. Validation will involve ecological plausibility checks of the generated candidates and comparison with baseline pseudo-absence methods in suitability models. The work is currently at a preliminary stage: the dataset has been assembled, and the analysis pipeline is under development.

2026 College of Science Research Symposium

Computer Science

102. From Speech to Action: LLM-Based Spot Robot Control

My Lien Tan, Hyewon Kang, Caitlyn Hue, Thuy Linh Pham, Nathanael Garcia, Advisor: Dr. Daisy Tang

This project investigates how large language models (LLMs) can be used to control the Boston Dynamics Spot robot through natural language and verbal commands while maintaining safe and reliable execution. Rather than allowing the model to generate unrestricted code, we will define SPOT's capabilities as structured perceptual and motor schemas that can act as reusable building blocks for execution.

We will design a modular library of schemas that represent core robot behaviors, such as object and color detection, navigation, and manipulation. We will also use a language model that interprets user commands and generates structured task plans by selecting and connecting these schemas. The resulting plans are validated for correctness and safety before being executed by the SPOT robot.

2026 College of Science Research Symposium

Computer Science

103. SPOT TOUR GUIDE

Nicholas Tran, Porter Clevidence, Michelle Villagomez, Jai Sutaria, Andre De La Roca, Advisor: Dr. Daisy Tang

This project examines SPOT''s autonomous navigation and human-robot interaction capabilities within the framework of an offline tour guide system. The system is designed allow users to speak naturally to SPOT, ask questions about tour locations, and command the robot to proceed along a prerecorded route.

To achieve this, we integrated local speech transcription, rule-based command parsing, and a retrieval-augmented generated question-answering pipeline that works concurrently with a navigational framework built around GraphNav from Boston Dynamics' SPOT SDK.

2026 College of Science Research Symposium

Computer Science

104. Vehicle Edge Computing for Intelligent Transportation Systems (ITS)

Rafael Trinidad, Michael Ly, Nathaniel Arifin, Chidiebere Okpara, Youcheng Taing, Theoden Melgar, Tyler Bacong, Advisor: Dr. Yunsheng Wang

The future of transportation faces critical challenges due to computational constraints in autonomous vehicles and limitations of cloud-based solutions. While autonomous vehicles generate up to one gigabyte of data per second, the latency of cloud computing and limited processing power of onboard units create significant bottlenecks in real-time decision-making. This paper introduces a vehicular edge computing platform that addresses these challenges by leveraging small-scale autonomous vehicles (Donkey Cars) and edge computing nodes. We implement a dual-protocol communication system where image data streams via UDP while control commands transmit through TCP, ensuring both speed and reliability. Our platform demonstrates significant performance improvements in real-time processing and decision-making capabilities, achieving up to 99.75% reduction in inference latency compared to local processing, while reducing CPU usage by 66.5% and memory utilization by 68.5%. A second two-vehicle multi-threaded experiment also demonstrates great performance with CPU usage remaining around 20%, consistent memory usage at 0.8%, and inference latency around 10 ms. The results of both experiments suggest that edge computing integration could be a viable solution for future intelligent transportation systems, particularly in scenarios requiring real-time hazard detection and traffic management. Our results reveal significant reductions in inference latency, with future suggested research focusing on GPU acceleration, CHI@EDGE, and more.

2026 College of Science Research Symposium

Computer Science

105. IoT Testbed for Cyber Attack Detection Using Machine Learning

Rayan Zafar, Advisor: Dr. Mohammad Husain

The rapid expansion of Internet of Things (IoT) devices has significantly increased the attack surface of modern networks, as many everyday smart devices lack robust security mechanisms and can be exploited to compromise entire systems. This research presents the development of a controlled IoT testbed designed to detect cyber attacks using machine learning techniques by replicating real-world network conditions. The testbed integrates a variety of smart devices connected through Raspberry Pi nodes and a central network, enabling continuous traffic capture and simulation of realistic attack scenarios, including brute force login attempts, port scanning, denial-of-service (DoS), and spoofing attacks. Over 10,000 packets of device-to-device communication were collected and analyzed, with tools such as Wireshark and Nmap used to identify network services, map communication patterns, and extract statistical and behavioral features. These features were used to construct labeled datasets distinguishing benign and malicious traffic, forming the basis for supervised learning models. Machine learning algorithms, including Random Forest, Support Vector Machines, and Decision Trees, were implemented to classify network activity and detect anomalies, demonstrating strong effectiveness in identifying deviations from normal IoT behavior. The project also explores challenges such as device configuration inconsistencies, synchronization of multi-device traffic capture, and limitations in dataset diversity, all of which impact model generalization. Despite these challenges, the research establishes a scalable and extensible framework for IoT anomaly detection, with future work focused on expanding the range of devices and attack types, improving feature engineering, and integrating more advanced models such as deep learning for sequential traffic analysis. Ultimately, this work contributes toward the development of practical, data-driven cybersecurity solutions capable of protecting increasingly complex IoT ecosystems.

2026 College of Science Research Symposium

Computer Science

106. BUDJ : DJ Mixer VR

Roshan Karimi, Sophia Arce, Emily Chiu, Tony Le, Cyenadi Greene, Advisor: Dr. Fatemeh Jamshidi

DJing requires simultaneous mastery of beatmatching, track selection, and transition timing, a steep learning curve that discourages novice engagement. BuDJ is a virtual reality (VR) system designed to lower this barrier by pairing an immersive mixing environment with audio-feature–based track recommendation and automated transition cueing.

Built in Unity, BuDJ provides an interactive VR interface that simulates real-world DJ workflows through a virtual console, song library, and guided onboarding. A Python-based recommender suggests compatible tracks using audio features such as tempo, energy, and genre similarity, extracted using librosa for low-level audio features, a CNN for timbral representations, and a custom transformer for semantic embeddings. A transition support module analyzes song structure to detect outros and cue optimal mixing points, guiding users toward smooth transitions while preserving creative control.

By integrating immersive interaction with music-analysis techniques, BuDJ targets the gap between consumer DJ games, which oversimplify the craft, and professional software, which overwhelms beginners. An initial pilot study with novice users is underway to evaluate task completion, perceived workload, and user experience. This work illustrates how VR and machine learning can make complex creative practices more accessible without sacrificing expressive depth.

2026 College of Science Research Symposium

Computer Science

107. Comparative Experimental Validation of Human Emotion Recognition and Classification using Physiological Signals

Ryan Wei, Hong Le, Shraya Ramamoorthy, Khadeeja Hussain, Nathan Lee, Advisor: Dr. Mohammad Husain

This study presents a comparative experimental evaluation of emotion recognition and classification tasks using electroencephalography (EEG) and peripheral physiological signals, integrating public benchmarks (SEED and DREAMER) with a newly collected multimodal data set in our laboratory. The work systematically compares classical and deep learning approaches for valence-based emotion classification following standardized preprocessing and normalization across EEG, ECG, PPG, and EDA modalities. Support Vector Machine (SVM), Random Forest (RF), Convolutional Neural Network (CNN), and Long Short-Term Memory (LSTM) models were implemented to examine spatial, temporal, and multimodal representations. CNN achieved the highest accuracy on SEED (90.22%), RF performed best on DREAMER (83.80%), and the in-lab data set produced 98.37% with RF, highlighting strong reproducibility within the subject under controlled conditions. The findings demonstrate that aligning the model architecture with signal characteristics significantly enhances affective decoding performance. In general, this work establishes a unified and reproducible framework for multimodal emotion recognition and underscores the importance of cross-dataset validation to advance robust and generalizable affective computing systems.

2026 College of Science Research Symposium

Computer Science

108. Building an Adaptive Planner for Neurodivergence

Sarah To, Annabel Wen, Sara Downing, Madelyn Isaacs, Advisor: Crisrael Lucero

Many tools exist that assist with planning, both physical and digital. Common productivity strategies include making use of physical calendars, planners, journals, and to-do lists, digital calendars or notes applications, or a combination of both physical and digital resources. Our survey found that many people struggle with procrastination and time management, with a tendency to focus on short-term goals. With such a wide variety of possible productivity tools and strategies, it may be difficult for people to find a solution that aligns with their needs. Studies show that digital applications can beneficially impact certain aspects of Attention-Deficit/Hyperactivity Disorder (ADHD). Our goal is to develop a planning system that helps manage challenges associated with executive dysfunction and ADHD, including difficulties planning and organizing events or finishing tasks. By implementing an AI-based adaptive approach, we individualize and personalize user experiences, allowing users to achieve long-term productivity goals.

2026 College of Science Research Symposium

Computer Science

109. Performance Analysis of Classical and Deep Learning Methods for Drone Classification Using RF Signal Characteristics

Sriman Komaragiri, Carlos Vargas, Alisha Mehta, Xingrong Wang, Minh Khoi Tran, Rehan Alam, Jessica Escalante, Advisor: Dr. Mohammad Husain

This paper presents a comparative analysis of classical machine learning (ML) and deep learning (DL) approaches for drone RF signal classification using raw in-phase and quadrature (IQ) data. Building on prior work that evaluated these methods using an energy detection dataset, this study investigates whether the richer signal representation afforded by raw IQ data yields measurable differences in classification performance. We systematically compare classical algorithms—Support Vector Machines (SVM), Random Forest (RF), Gradient Boosting (XG-Boost), and K-Nearest Neighbors (KNN)—against deep learning architectures including Multilayer Perceptrons (MLPs) and Convolutional Neural Networks (CNNs). By holding the model set constant across both dataset paradigms, we isolate the effect of the input representation on classification accuracy, generalization, and robustness. Results are analyzed to determine whether raw IQ data provides a meaningful advantage over energy-based features, and to identify which model families benefit most from the additional signal fidelity. Experiments are conducted using an RF dataset specifically collected under diverse environments to emulate real-world scenarios. Performance metrics such as accuracy, precision, recall, F1-score, and computational efficiency are reported and discussed. Results indicate the superior accuracy and robustness of DL methods, whereas classical ML algorithms are more computationally efficient, highlighting a clear trade-off valuable for practical deployments.

2026 College of Science Research Symposium

Computer Science

110. Penetration Testing of Agentic AI: A Comparative Security Analysis Across Models and Frameworks

Viet Nguyen, Advisor: Dr. Mohammad I. Husain

Agentic AI introduces security vulnerabilities that traditional LLM safeguards fail to address. Although recent work by Unit 42 at Palo Alto Networks demonstrated that ChatGPT-4o successfully executes attacks as an agent that it refuses in chat mode, there is no comparative analysis in multiple models and frameworks. We conducted the first systematic penetration testing and comparative evaluation of agentic AI systems, testing five prominent models (Claude 3.5 Sonnet, Gemini 2.5 Flash, GPT-4o, Grok 2, and Nova Pro) across two agentic AI frameworks (AutoGen and CrewAI) using a seven-agent architecture that mimics the functionality of a university information management system and 13 distinct attack scenarios that span prompt injection, Server Side Request Forgery (SSRF), SQL injection, and tool misuse. Our 130 total test cases reveal significant security disparities: AutoGen demonstrates a 52.3% refusal rate versus CrewAI's 30.8%, while model performance ranges from Nova Pro's 46.2% to Claude and Grok 2's 38.5%. Most critically, Grok 2 on CrewAI rejected only 2 of 13 attacks (15.4% refusal rate), and the overall refusal rate of 41.5% across all configurations indicates that more than half of malicious prompts succeeded despite enterprise-grade safety mechanisms. We identify six distinct defensive behavior patterns including a novel "hallucinated compliance" strategy where models fabricate outputs rather than executing or refusing attacks, and provide actionable recommendations for secure agent deployment. Complete attack prompts are also included in the Appendix to enable reproducibility.

2026 College of Science Research Symposium

Geological Sciences

111. A Major San Andreas Earthquake Could Trigger a Moderate Earthquake on the Densely Populated Puente Hills Fault

Ann Olesh, Dr. Md Iftekhar Alam, Uzonna Anyiam, Advisor: Dr. Md Iftekhar Alam

When a fault ruptures the released stress can transfer from one fault to the next. In California there are many well-known strike slip faults, such as the San Andreas, and less well known are the thrust faults, such as the Puente Hills. The shearing forces on strike slip faults can influence the compressional forces on a thrust fault to rupture and cause the thrust fault to potentially rupture. The Puente Hills fault is a blind thrust fault located in the Los Angeles Basin. This fault wasn't discovered until 1999 when research was being done on the Northridge earthquake. It was determined that the Puente Hills fault was responsible for the 1987 Whittier earthquake. The Puente Hills fault is surrounded by many active strike slip faults. Should one of the faults ruptures, it is possible that the stress transferred from these faults could cause the Puente Hills fault to rupture as well. Using the Coulomb program, I will determine if the stress transferred from the surrounding strike slip faults will cause a segment of the fault to rupture, or if the full fault will rupture. This study could potentially identify if a single segment of the fault will rupture, or if the full segment will rupture, and the impact to the surrounding area. A full segment rupture has the potential for a large magnitude earthquake causing widespread damage and loss of life.

2026 College of Science Research Symposium

Geological Sciences

112. Geological Mapping, Megascopic Petrology, and Geological Analysis of Old City Quarry, Fairmont Park, Riverside, Ca

Gregorio P. Lira, Advisor: Dr. Nick Van Buer

The geological research purpose of Old City Quarry is to investigate petrology and mineralogy of this former mining quarry site. The method applied was geologically mapping the bed rock units with a (Brunton compass and Google Earth for coordinates, collecting rock hand samples 12 dozen in total, cutting the rock samples with MK Diamond Saw for thin sections, examining the minerals of the thin section by petrological microscopes, geochemistry of granitic plutonic pieces were gathered by a used of steel plate and steel hammer, and finalize data on ArcGIS map to finalize a geological map of the Old City Quarry.

2026 College of Science Research Symposium

Geological Sciences

113. Aquifer Recharge, Impervious Cover, and Urban River Water Chemistry: Los Angeles and San Gabriel Rivers

Jacquelyn Robles-Ernst, Penelope Ornelas, Aleio Morales, Advisor: Dr. Stephen Osborn

The Los Angeles and San Gabriel Rivers drain the San Gabriel Mountains but differ sharply in urbanization and recharge connectivity, making them a natural paired system for examining how land use shapes surface water chemistry using geospatial analysis methods. The LA River is heavily channelized through most of its length, isolating surface water from subsurface processes. The San Gabriel River retains more naturalized reaches and active groundwater recharge zones in the San Gabriel Valley, and visible biota were observed throughout the study reach. Buffer zones around sampling sites were classified for impervious versus pervious cover from land use data and paired with water quality measurements (temperature, pH, Eh) collected at San Gabriel River sites and provided by a collaborating student for the LA River. LA River sites were more variable across the sampling period, consistent with elevated urban runoff and reduced buffering capacity, while San Gabriel River sites were comparatively stable. Impervious cover correlated with higher temperature and redox variability, and pervious cover with more stable pH and Eh, across multiple buffer distances. Targeted expansion of pervious surfaces and restoration of natural channel features, informed by existing channel conditions, offer viable pathways for improving surface water chemistry in urban river corridors.

2026 College of Science Research Symposium

Geological Sciences

114. Gravity modeling of the eastern fold belt of the Bengal Basin

James Hansenbury, Md. Iftekhar Alam, Andrew Katumwehe, Ashraf Uddin, Advisor: Dr. Md Iftekhar Alam

The Bengal Basin, located at the northeast corner of the Indian subcontinent, has one of the highest sedimentation rates on the planet. The geotectonic framework of this region is comprised of three distinct tectonic elements. These include – (1) the Indian Platform flank to the west with shallow occurrence of the basement, (2) the central deep basin, and (3) the folded belt in the east, each characterized by distinctive sedimentary facies.

Difficulties in accessing this location for field work limits the scope and frequency of surveys for data collection, especially in the eastern fold belt region. This dearth of data leaves the subduction of the Indian plate beneath the Burma plate shrouded in uncertainty. The purpose of this study is to better understand the spatial interaction between the Indian and Burma plate, while providing a detailed view of structural distribution. For this study, we have used satellite-derived public gravity data with prior work in the region to generate a digital model of the subsurface on a ~3.5 km grid of the area. The model expands and unifies information collected through a multitude of methods. We are using IGMAS+ to generate crustal models down to Moho. The preliminary results suggest the presence of higher density subsurface material in the eastern side of the basin penetrating deeper than the rest of the basin, which could indicate crustal thickening due to the subduction between Indian and Burma plate involving both attenuated continental and oceanic crust. This overview model is easily adapted to be used in a variety of programs for future research in the area.

We will expand upon the models presented to include a broader view of the basin. The complexity of the model will also be improved to further minimize the error in the residual field.

2026 College of Science Research Symposium

Geological Sciences

115. Geologic Mapping of CalPortland Cement Quarry Mojave, CA

Jimmy M. Allard, Dr. Nicholas J. Van Buer, Kendall Mayfield, Advisor: Dr. Nicholas J. Van Buer

CalPortland Cement company operates one mining quarry near Mojave, CA. The material mined belongs to the Bean Canyon Formation. This formation is composed of a late Paleozoic metasedimentary roof pendant intruded by plutonic rock of Cretaceous age, originating from the Sierra Nevada Batholith. This quarry was mapped using classic field techniques and modern GPS instrumentation. Geologic units identified within the pit include differently textured metamorphosed limestones (foliated to non-foliated), decomposed granites, diorite, volcanic intrusions (mafic to felsic), shale, garnet-bearing schist, quaternary alluvium, and overburden deposits. Limestone (non-foliated) and decomposed granite make up the majority of mapped units. Several small intrusions trend N-S in the pit, with one large igneous intrusion present in the SW portion. Foliated limestones are found near contact with DG. Multiple offset contacts between units suggest concealed faults. Units are thicker towards the western end of the pit, and thinner on the north side. Extensive overburden deposits make contact projections difficult. One diorite unit was mapped in the lowest portion of the pit.

2026 College of Science Research Symposium

Kinesiology and Health Promotion

116. Project LIFT: Concept Development for an Older Adult Fitness Device

Dr. Zakkoyya H. Lewis, Dr. Lara Killick, Eliza E. Muniz, Royce C. Tse, Advisor: Dr. Zakkoyya H. Lewis

Limited access to safe, effective, and user-centered resistance training options contributes to low physical activity participation among older adults, highlighting the need for innovative, accessible fitness solutions tailored to this population. The objective of this project is to complete the concept development phase of the handheld resistance exercise device (HRED) through student-led research. Three specific aims guided this work: (1) conduct focus groups with older adults, fitness professionals, and physical activity program directors to understand the challenges, preferences, and needs related to resistance training; (2) identify key design features, potential barriers to use, and opportunities for customization; and (3) explore potential interdisciplinary partnerships and external funding opportunities to support prototype development. Thirty-four participants were recruited from local retirement communities, fitness centers, and senior community centers to take part in focus groups. Separate focus group were conducted with older adults (n=15) and stakeholders (n=19), using structure guides to elicit feedback on the conceptual design of a device. Within the stakeholders' groups, marketability and potential of weight variability posed to be the greatest determinants of success toward encouraging older adult populations to utilize the device. Stakeholders emphasized implementation of safety measures in place due to the device’s several moving components. Participants suggested the addition of a carrying case or making the device foldable to reduce its size to allow for easier transportation. Implementing a 2lb weight increment was suggested for the ease of adding weight. Visually, offering a variety of device colors is favored. The next steps are to conduct more focus group with older adults in Pomona and more into prototype development.

2026 College of Science Research Symposium

Kinesiology and Health Promotion

117. Sex Differences in Walking-Related Joint Mobility After Prolonged Sitting

Lilliana R. Ceballos, Rana M. Soussan, Christian M. Gonzalez, Riley Garrett, Janet Dionico, Charles A. Reyes, Nathan A. Berio, Advisor: Dr. Minhyuk Kwon

Prolonged sitting is a risk factor for musculoskeletal dysfunctions, subsequently influencing joint mobility and movement patterns. (Daneshmandi et al., 2017) However, Sex difference gait mechanics and sitting behavior (Dunk et al., 2005). However, despite established sex differences in musculoskeletal characteristics, it remains unclear whether prolonged sitting leads to sex-specific alterations in joint mobility during gait. This study aimed to determine whether prolonged sitting results in sex-specific alterations in joint mobility and movement strategies during walking, (OpenCap, Stanford University, USA). Four healthy young men (24.3 ± 5.2 years) and 4 healthy young women (20.5 ± 0.6 years) completed two sessions: baseline walking and walking following 30 minutes of slumped sitting. Lower-extremity kinematics were collected during self-paced overground walking using a markerless motion capture system (OpenCap, Stanford University, USA). Joint range of motion (ROM) and segmental contributions were compared across sessions and sexes. Dynamic joint range of motion (ROM) increased following prolonged sitting in both men and women, particularly at the hip and knee, with no significant between-sex differences. Men demonstrated greater absolute increases in pelvic mobility, including tilt and rotation, whereas women maintained relatively stable pelvic motion. However, when normalized to distal joint motion, women exhibited a higher pelvis-to-distal ratio, indicating a greater reliance on proximal, pelvis-driven coordination. In contrast, men showed a more distal-dominant pattern, relying more on knee joint motion. Prolonged sitting increases joint mobility during gait in both sexes, but coordination strategies may differ. Women appear to favor proximal control, while men rely more on distal joint compensation.

2026 College of Science Research Symposium

Kinesiology and Health Promotion

118. Acute Effects of Intermittent Sequential Pneumatic Compression on Critical Speed and D' During a 3-Minute All-Out Test in Well-Trained Endurance Athletes

Roger Muniz, Ethan Enyeart, Ethan Quezada, Nikko Sarmiento, Chloe Yoon, Jacob Kim, Dean Guillermo, Advisor: Dr. Edward Jo

Intermittent sequential pneumatic compression (ISPC) devices, such as Therabody JetBoots, are increasingly used by endurance athletes to enhance recovery and potentially improve performance through mechanisms including enhanced venous return, reduced muscle soreness, and improved metabolite clearance. However, the acute ergogenic effects of ISPC on high-intensity running performance remain unclear. The 3-minute all-out test (3MT) provides validated estimates of critical speed (CS) and anaerobic work capacity (D'), key determinants of endurance performance, yet the influence of pre-exercise ISPC on these parameters has not been systematically evaluated.

The purpose of this study is to determine whether a single bout of ISPC acutely affects CS and D' during a 3MT in well-trained endurance athletes. Participants will complete three laboratory visits, including a familiarization session followed by two experimental sessions in a randomized crossover design. During experimental visits, subjects will undergo either a 15-minute ISPC treatment or a seated control condition prior to performing a standardized warm-up and 3MT. Running performance will be assessed using tachometer-derived speed data to calculate CS and D', while heart rate and mood state (BRUMS) will also be monitored at multiple time points.

This study will provide insight into whether acute ISPC application confers a measurable performance benefit and inform its practical use in endurance training and competition.

2026 College of Science Research Symposium

Mathematics and Statistics

119. Topology of 3-State Birth-Death Markov Chains

Abel Soto, Salley Baek, Michelle Solares, Arfana Kabir, Dana Bui, Advisor: Dr. Alan Krinik

We investigate the topological structure of the space of three-state birth–death Markov chains through the lens of their stationary distributions. A general three-state birth–death chain is determined by four transition parameters, yet its steady-state distribution depends only on specific ratios among these parameters. This observation naturally leads to an equivalence relation: two chains are equivalent if and only if they share the same stationary distribution.

Using this equivalence, we partition the space of all such Markov chains and study the resulting quotient space. By introducing a reparameterization in terms of auxiliary variables alpha and beta, we obtain an explicit representation of equivalence classes and show that the parameter space inherits a natural topology from R^2. We then prove that the quotient topology on the space of equivalence classes agrees with the subspace topology on (0,infty)^2, establishing a concrete homeomorphism between the quotient space and this parameter domain.

This framework allows us to reinterpret the geometry of stationary distributions. In particular, we relate the quotient space of Markov chains to a modification of the two-dimensional probability simplex, where boundary behavior is carefully accounted for. This leads to our main conjecture: that the space of equivalence classes of three-state birth–death chains is homeomorphic to the simplex without its boundary.

Our approach highlights how probabilistic structure and topological methods interact, providing a new perspective on Markov chains via quotient spaces and parameterizations. This work opens the door to studying higher-dimensional chains and more general stochastic processes using similar topological techniques.

2026 College of Science Research Symposium

Mathematics and Statistics

120. Explicit Formulas for Powers and the Exponential of some Banded Matrices with Applications to Queueing Processes

Dylan Patterson, Advisor: Dr. Hubertus von Bremen

We present explicit formulas for computing positive integer powers A^k and the matrix exponential e^A for a class of special banded matrices A. These matrices have three nonzero diagonals: the main diagonal and the qth super- and sub-diagonals, with real entries that may be q-periodic.

We show that the n x n q-periodic banded matrices A can be transformed, via a similarity transformation using a permutation matrix P, into a block diagonal matrix B=PAP^T, whose diagonal blocks are either tridiagonal (not necessarily Toeplitz or symmetric) matrices or 1 x 1 blocks.

Next, we consider queueing systems with 1-step size transitions, whose transition matrices are tridiagonal. For these matrices, we obtain closed form expressions for the eigenvalues and both left and right eigenvectors, and we use diagonalization and spectral decomposition to compute powers, matrix exponentials, as well as solutions to the forward and backward equations.

We then extend these results to matrices with q-step transitions. Using the similarity transformations, these matrices are transformed into block diagonal form blocks corresponding to 1-step transition matrices, allowing the previous results to be used. We illustrate the methods by presenting example.

2026 College of Science Research Symposium

Mathematics and Statistics

121. Finite-State Markov Chains

Abraham Castelan, Jose Lopez, Jacob McCay, Joezeh Ramirez, Advisor: Dr. Alan Krinik

Birth-death chains are widely used to model stochastic processes such as queueing systems. In this project, we analyze the Birth-Death chain in three settings: the 2-state case, the 3-state case, and cases that do not follow standard scaling behaviors. By analyzing the transition probabilities and steady state distribution, we compare how the system behavior changes with the increase in states. We find that there is a structural pattern that is persistent across all cases; the predictable scaling relationships have cases that fall outside the standard assumption. This result highlights both the general principle that controls the birth-death chain and the limits of scaling in higher state systems.

2026 College of Science Research Symposium

Mathematics and Statistics

122. Finite-state Markov chains

Omar Othman, Edwin Maytorena, Yused Sanchez, Destiny Carillo, Milad Khazani, Advisor: Dr. Alan Krinik

We begin by understanding what a Markov Chain is and understand the general uses. We consider the general Finite-state Markov chains where we beg the question of when do two different Finite-state Markov chains have the same steady state distribution.

2026 College of Science Research Symposium

Mathematics and Statistics

123. Are three-state irreducible Markov processes second order stationary processes?

Viren Kumar, Advisor: Dr. Alan Krinik

Building on the proof that a 2 state birth-death chain is a second order stationary stocastic process (Port and Stone pg 112-114); we attempt to explore 3 node options, hoping to gain some insight into generalization.

2026 College of Science Research Symposium

Physics and Astronomy

124. Expanding Access to Particle Physics: Student Outcomes from an Online Course at Hispanic-Serving Institutions

Alejandro Murillo, Advisor: Dr. Qing Ryan

As part of a National Science Foundation–funded initiative to expand career pathways for physics majors at Hispanic-Serving Institutions (HSIs), we developed and implemented an online upper-division particle physics course through the CSU Fully Online program, collaboratively offered by CSU Fresno and Cal Poly Pomona. The course is designed to broaden access to advanced physics topics while supporting student preparation for research opportunities at CERN, U.S. national laboratories, and R1 institutions.

The course integrates active learning strategies, including pre-lecture videos with embedded assessments, structured office hours featuring think–pair–share activities, guided discussion forums, and term projects on frontier topics in particle physics. We collected data in the fall 2026 semester on student self-efficacy, physics identity, and interest in physics using pre-, mid-, and post-course surveys to evaluate the impact of this instructional design. We will present results in students' self-efficacy and physics identity, alongside sustained or increased interest in pursuing physics-related pathways.

In parallel, we developed a series of short "Concept Probes" centered on the theme of measurement and resolution across physical contexts, from classical waves to particle physics. These probes are designed both to elicit student reasoning for research purposes and to promote deeper conceptual reflection.

2026 College of Science Research Symposium

Physics and Astronomy

125. RNA Packaging Signals Control Icosahedral Capsid Assembly

Anthony Lazo, Jessie Lorenzo, Advisor: Dr. Siyu Li

Icosahedral capsids are ubiquitous among spherical viruses, yet the mechanisms by which viral proteins selectively assemble around their genomes remain poorly understood. In particular, how RNA sequence–encoded packaging signals influence capsid assembly is a computationally challenging problem. Here, we apply coarse-grained molecular dynamics simulations of RNA virus assembly that captures capsid protein diffusion, RNA chain flexibility, and genome–protein electrostatics. This framework applies conformational switching mechanism that mimics protein allostery: capsid proteins remain elastically inactive in solution and activate upon binding. Using this model, we systematically investigate how RNA packaging signals—implemented as a heterogeneous distribution of specific and non-specific protein binding sites along the RNA—control assembly outcomes. By varying the spatial arrangement and strength of these binding sites, we quantify their effects on capsid nucleation rates, assembly pathways, and packaging efficiency. The results will establish a predictive framework for genome-guided viral assembly and provide design principles for synthetic polyelectrolytes relevant to biomedical and antiviral applications.

2026 College of Science Research Symposium

Physics and Astronomy

126. The Impact of Anisotropy on Dark Matter Halo Mass Estimates

Axis Fleischman, Advisor: Dr. Coral Wheeler

The Λ Cold Dark Matter Model (ΛCDM) is a widely accepted theory that describes the universe's evolution from the Big Bang to present. We analyze hydrodynamic ΛCDM simulations that include dark matter, gas and stars as particles, with the gas and star particles ~250M⊙ and the dark matter particles being around an order of magnitude larger. Within this research, we use the stellar kinematics of these Ultra-Faint galaxies to attempt to estimate the mass of the dark matter, gas and stars enclosed within the half-light radius– the radius at which half of the total luminosity of the galaxy is enclosed. This mass ($M_{1/2}$) can be approximated by the equation

$$M_{1/2}=4G^{-1} \langle \sigma_{los}^2 \rangle r_{1/2},$$

where $\langle \sigma_{los}^2 \rangle$ is the luminosity-weighted square of the line-of-sight velocity dispersion and $r_{1/2}$ is the half-light radius. We compare this to the M1/2 found within the simulation data to determine the accuracy of the $M_{1/2}$ estimator for Ultra-Faint galaxies.

We find that there are some stellar halos that deviate from the theoretical one-to-one relationship between the estimated half-mass and the true half-mass. These deviations may be related to the anisotropy, as those same halos have a relatively high positive anisotropy. However, that may be also due to the sample size, and definitive conclusions cannot be made until we have a greater sample size.

2026 College of Science Research Symposium

Physics and Astronomy

127. Computation of Kerr Black Hole's Spheroidal Harmonics

Noah Dobson, Emilio Galindo Mendez, Sujoy K. Modak, Advisor: Dr. Sujoy K. Modak

Black holes are one of the most important and common occurrences in nature. Stars running out of nuclear fuel will eventually undergo gravitational collapse and may form a black hole. Due to the initial rotations of gaseous matter, rotating black holes are the most likely outcome after gravitational collapse. Studying gravitational perturbations around a rotating Kerr black hole are a hot topic due to their ongoing detections in LIGO experiments. Such perturbations are governed by the Teukolsky equation, whose solutions provide quasi-normal modes and angular structure that are indirectly measured in LIGO. In this poster we present our work focusing on the angular structure where the main interest is spin-weighted spherical harmonics. In this poster we present our work to numerically solve the angular Teukolsky equation and plot these harmonics explicitly for the first time in literature.

2026 College of Science Research Symposium

Physics and Astronomy

128. Studying 47 Tuc Using Chandra and Rubin Observatories

Hermoine Hernandez, Advisor: Dr. Breanna Binder

47 Tuc is a globular cluster located in the constellation Tucana located about 4.45kpc from Earth and can be seen by the naked eye. It is a prime target for compact object research such as X-Ray Binaries (XRB) and Cataclysmic Variables (CVs) due to its immense density and high number of identified sources. It is also one of the first “deep drilling” targets for which public data is available from the Rubin Observatory. XRB are binary star systems consisting of a neutron star or black hole accreting material from a companion “donor” star, while CVs are analogous systems containing a white dwarf accretor. A lot is already known about the high energy properties of these sources from the Chandra X-Ray Observatory, but now we can cross match the locations of the known X-ray sources with preliminary Rubin optical information. The goal of this project is to match the locations of known XRBs and CVs from Chandra data with optical sources detected by Rubin and, if possible, characterize their multiwavelength variability properties. So far, using 8 Chandra observations, I have found approximately 257 X-ray point sources of 47 Tuc. Out of those sources, roughly 10% of them were currently in the non-saturated region of the cluster. I’m currently building a pipeline starting from Chandra positions (RA and Dec) to automate the process of querying Rubin data, identifying optical counterparts, and building optical light curves of these sources.

2026 College of Science Research Symposium

Physics and Astronomy

129. Investigation of Structural and Dynamics of the SecA Protein using Atomic Force Microscopy

Ivyn Tran, Advisor: Dr. Krishna P. Sigdel

In bacteria, the Sec system transports nascent proteins from the cytoplasm to other areas of the cell like the outer membrane and periplasmic space.[1] This system consists of SecB, the protein targeting chaperone; SecA, the motor protein that helps translocate proteins across the protein channel; and SecYEG, which is a translocon allowing polypeptide transport between membranes.[2] Some studies suggest that the SecA protein and membrane's lipid bilayer have dynamic interactions during the translocation process. These processes correspond to structural details that appear on the protein.[3] By using atomic force microscopy (AFM), we performed high-resolution imaging of the interactions between SecA and the lipid bilayer in physiological buffer condition and at room temperature.

2026 College of Science Research Symposium

Physics and Astronomy

130. Examining Functional forms for Ultra Faint Dwarf Galaxy Surface Density Profiles

James Murphy, Advisor: Dr. Coral Wheeler

Ultra Faint Galaxies (UFD) are highly dark matter-dominated satellites orbiting larger host galaxies. UFDs sit in a range of 10^2-10^5 solar masses. They exhibit density profiles--the annular mass density measured from the center of the galaxy--which have similar traits and structural appearance as stellar clusters. The key difference is that UFDs have a far higher dark matter percentage, causing their structure to look more “puffy” than typical star clusters. This poster examines possible density profiles that can be fit to UFDs by analyzing FIRE (Feedback In Realistic Environments) simulations.

2026 College of Science Research Symposium

Physics and Astronomy

131. Using Transiting Exoplanet Host Stars to Refine Magnetic Field Proxy–Age Trends

Kaitlyn Torres, Kylee Sanchez, Advisor: Dr. Breanna Binder

We want to understand the correlation between the magnetic field proxy and the age of sunlike stars, and why there is much irregular scatter in the original plot. In doing so, we need to understand whether there is a problem with the data or if there is an element we are not aware of affecting the results, meaning there is a separate issue needing to be dealt with. The inclination of the stars used is not known, so the blueshift could be from the star at an angle anywhere from its equator to its poles, which means the documented rotational velocity may be incorrect, which affects the scatter plot. We know that if the star has a transiting exoplanet, we can be confident that we are seeing its full rotational velocity because most planets rotate around the equatorial plane of the star. To do this, we are selecting stars with known transiting exoplanets, using NASA's Exoplanet Archive. We use those stars that have x-ray observations through telescopes Chandra and XMM-Newton, and use the imaging software, SAOimage DS9, to analyze the x-ray images. This data is then used to find luminosity and plot Fxsini vs age. If the inclination angle is what caused the scatter, then we know that the outliers likely have high inclination angles, or we are looking at them pole-on. The Habitable World Organization (HWO) can use this information for imaging because their habitable zones are the most visible to us compared to other stars.

2026 College of Science Research Symposium

Physics and Astronomy

132. Exploring the Conditions Under Which a Dark Matter Halo Does or Does Not Form a Galaxy

Lauren Barkey, Advisor: Dr. Coral Wheeler

In the following work, we investigate FIRE-2 simulations of low mass galaxies to determine how gas mass and gas temperature affect star formation in dark matter halos at early redshifts. This work shows that while their halo mass range vary at z =15 and z =19, DM halos that have formed stars all lie in the same gas temperature range of 300 - 400K.

2026 College of Science Research Symposium

Physics and Astronomy

133. Investigating undergraduate students' use of spontaneously generated representations in Physics problem solving (mechanics) using eye-tracking

Lee Deng, Colton Pfann, Advisor: Dr. Qing Ryan

Representations such as diagrams, equations, and graphs play a central role in physics problem solving. While prior research has examined students' ability to interpret or construct representations when prompted, less is known about how students generate and use representations spontaneously during problem solving.

This study investigates how undergraduate students create and use their own diagrams while solving physics problems. We conducted problem-solving interviews with 5 physics undergraduate students from Cal Poly Pomona. During each session, students solved five introductory-level problems—three in mechanics and two in electricity and magnetism—while wearing mobile eye-tracking glasses that recorded their gaze behavior as they worked through the Mechanics problems.

We analyze when diagrams are produced and how students visually coordinate these diagrams with other elements of the solution process, including equations and the problem statement. Using the ACER framework (Activation–Construction–Execution–Reflection), we examine gaze transitions among different representations to better understand how diagrams support reasoning. The results provide insight into the role of spontaneously generated representations in physics problem solving and illustrate the usefulness of mobile eye-tracking methods for studying students' representational practices.

2026 College of Science Research Symposium

Physics and Astronomy

134. Investigating undergraduate students' use of spontaneously generated representations in Physics problem solving (E&M problem) using eye-tracking

Marcus Orozco Elias, James Murphy, Dr. Qing X. Ryan, Advisor: Dr. Qing X. Ryan

Representations such as diagrams, equations, and graphs play a central role in physics problem-solving. While prior research has examined students' ability to interpret or construct representations when prompted, less is known about how students generate and use representations spontaneously during problem solving.

This study investigates how undergraduate students create and use their own diagrams while solving physics problems. We conducted problem-solving interviews with 5 physics undergraduate students from Cal Poly Pomona. During each session, students solved five introductory-level problems—three in mechanics and two in electricity and magnetism—while wearing mobile eye-tracking glasses that recorded their gaze behavior as they worked through an Electricity and Magnetism problem.

We analyze when diagrams are produced and how students visually coordinate these diagrams with other elements of the solution process, including equations and the problem statement. Using the ACER framework (Activation–Construction–Execution–Reflection), we examine gaze transitions among different representations to better understand how diagrams support reasoning. The results provide insight into the role of spontaneously generated representations in physics problem solving and illustrate the usefulness of mobile eye-tracking methods for studying students' representational practices.

2026 College of Science Research Symposium

Physics and Astronomy

135. Exploring alternative interferometer geometries for gravitational wave detection using CubeSats

Miguel Angel Cai Lane, Advisor: Dr. Shohreh Abdolrahimi

Many gravitational wave detection methods have been extensively studied, ranging from pulsar timing arrays to space-based detectors. For space-based detectors, there are particular detector geometries where it is not possible to detect certain gravitational wave polarizations from specific regions in the sky. In our project, we aim to determine whether or not we can utilize cheaper CubeSats to lessen the blind spots of different detector geometries. To explore this concept, we have developed a Python library built on SymPy and Matplotlib that allows us to explore the visibility of these detectors. Given a detector configuration, our library yields the basis tensors for each corresponding polarization, and the antenna pattern coefficients, expressed in the same basis. Our library also allows us to visualize the antenna pattern coefficients and gives us the functional form. We are now attempting to utilize this library to optimize configurations with more than one detector.

2026 College of Science Research Symposium

Physics and Astronomy

136. Analysis of Student Self-Generated Representations in Interdisciplinary Physics Problem Solving Using Eye-Tracking Glasses

Nguyen Ho, Advisor: Dr. Qing Ryan

As science curricula become increasingly interdisciplinary, understanding how students apply physical principles across contexts is essential for effective instruction. This study investigates how undergraduate students approach mechanics problems involving elastic systems that require application of Hooke's Law. Using Tobii Eye Tracking Glasses, we record students' gaze patterns and fixations in a naturalistic problem-solving environment, allowing participants to work as they would in a typical classroom setting. This mobile eye-tracking approach captures how students visually attend to problem information while also generating written or graphical representations during the solution process.

The study examines how students allocate visual attention to key quantities and conceptual cues, whether they spontaneously generate external representations such as diagrams or equations, and how these representations relate to successful problem solving. By linking eye-movement data with students' written work and solution outcomes, this research aims to identify visual attention patterns associated with productive reasoning about stiffness and force–extension relationships.

Findings from this work will inform the design of interdisciplinary learning environments, particularly in Introductory Physics for Life Sciences and related courses, by highlighting strategies that support students in connecting physical principles with applications in diverse scientific contexts. Ultimately, this research contributes to improving how physics concepts are taught to students in interdisciplinary STEM programs.

2026 College of Science Research Symposium

Physics and Astronomy

137. Exploring Student Perspective and Interest in Quantum Mechanics Across Majors

Osheen Gupta, Ibrahim Elsousi, Advisor: Dr. Homerya Sadaghiani

Quantum mechanics is a specialized area within physics that is typically introduced only at the upper-division undergraduate level or during the first year of graduate study, resulting in limited early exposure for many students. At the same time, there is a growing need to diversify the quantum workforce by engaging students from disciplines beyond physics. This study investigates student interest in learning quantum mechanics across physics and engineering majors at multiple academic levels. Using survey-based data, the research examines students' curiosity, prior exposure, and willingness to pursue further learning in quantum-related topics. By analyzing patterns of interest across majors and grade levels, this study seeks to identify untapped interest in quantum education and assess whether expanding access to quantum coursework beyond traditional boundaries is both feasible and beneficial. The findings aim to inform efforts to broaden participation and strengthen the future quantum workforce.

2026 College of Science Research Symposium

Physics and Astronomy

138. Stability of Fe-Ba Structures at Earth's Core Pressures

Owen W. Lugo, Advisor: Dr. Jorge Botana Alcalde

The composition of Earth's core is not fully understood, particularly whether iron structures can incorporate barium at extreme pressures. In our project, we are investigating the stability of iron structures of differing geometries with barium impurities at a range of pressures found in the Earth's core. Specifically, we are applying software, VASP, to perform relaxation calculations in which the geometries are slightly changed, and the total enthalpy of the system is calculated using Density Functional Theory (DFT). The focus will be on the mantle-core boundary (MCB) pressure, approx. 150 GPa, and the Inner Core Boundary (ICB) pressure, approximately 350 GPa. We will learn at what pressures the Fe–Ba structures become stable.

2026 College of Science Research Symposium

Physics and Astronomy

139. Tuning CeO2 Optical Properties via Os Doping

Rae Carterette, Ozgur Polat, Dinara Sobola, Yasemin Caglar, Mujdat Caglar, Advisor: Dr. Ozgur Polat

Undoped and Os-doped CeO2 thin films (0–5% Os) with a thickness of ~40 nm were prepared on glass via spin coating and systematically investigated to elucidate the effect of Os incorporation on the structural, chemical, and optical properties. X-ray diffraction (XRD) confirms that all films crystallize in the fluorite-type cubic CeO2 structure with reflections indexed to the (111), (200), (220), and (311) planes, and no secondary crystalline phases are detected, indicating successful Os incorporation without altering the parent phase. X-ray Photoelectron Spectroscopy (XPS) demonstrates progressive modification of the near-surface defect chemistry with Os doping: deconvolution of Ce 3d spectra shows an increase of Ce3+ fraction from 23.68% (undoped) to 42.97% (5% Os), accompanied by a corresponding decrease in Ce4+, evidencing dopant-assisted reduction and oxygen-vacancy formation. The Os 4f region indicates Os is predominantly present as oxidized Os(IV), supporting substitutional/oxidized incorporation rather than metallic Os. Optical measurements show strong UV absorption and high visible transparency, while Tauc analysis reveals systematic bandgap narrowing from 3.42 eV (undoped) to 3.22, 3.15, and 3.12 eV for 1%, 3%, and 5% Os, respectively, consistent with dopant/defect-induced near-gap states. Optical-constant analysis further shows that Os incorporation increases the real part of the optical dielectric constant (□1) across the visible range, indicating enhanced electronic polarizability, while the real optical conductivity (□1) is markedly modified, showing higher values for doped films through much of the visible region and a pronounced long-wavelength upturn. These findings demonstrate that Os-doping is an effective strategy for engineering the defect density and optoelectronic response of CeO2 for advanced functional applications.

2026 College of Science Research Symposium

Physics and Astronomy

140. SMS Fiber Sensor Probe with Reflective Gold Coating

Shawn Chen, David Gonzalez, Advisor: Dr. Ertan Salik

Single-mode-multimode-single-mode (SMS) fiber optic sensors are Mach-Zehnder interferometers that are sensitive to both mechanical stress and temperature. Traditionally, SMS fiber sensors are fabricated through an inline method, where a short length of multimode fiber is spliced between two single-mode fibers. However, in applications with spatial constraints, such as one-way access environments, in-line sensors may be impractical. We propose and experimentally demonstrate a probe-based sensor that allows the light source and detector to be on the same end. This is achieved by a reflective coating at the tip of the multimode fiber and by using a fiber coupler.

2026 College of Science Research Symposium

Physics and Astronomy

141. Cold Plasma Treatment of Metal Organic Frameworks for Carbon Capture Applications

Silvi Petrosyan, Lee Deng, Sophia Coronel, Ian Maglinte, Grace Harrison, Advisor: Dr. Nina Abramzon

Metal-organic framework (MOF), crystalline structures shown to be highly active catalysts for carbon dioxide cyclic reactions, are currently under exploration for use in Carbon Capture and Utilization (CCU). Plasma has been shown to induce missing linker defects, increasing adsorption abilities and active sites, without affecting the MOF's overall structure or stability. Here, we investigate the effects of atmospheric plasma surface treatment on the MOFs UiO-66 and UiO-67. The MOF is characterized before and after plasma treatment to observe changes in chemical composition, structure, and properties of the substance. In the project's second phase, the use of a laboratory-made atmospheric plasma reactor will be investigated as well. The experimental results will add to the communal understanding of the effects of cold plasma treatment on MOFs relating to carbon capture and, furthermore, may suggest a more cost effective and feasible method of modification/utilization of MOF.

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142. Direct visualization of Melittin-induced defects on the POPC-supported lipid bilayer

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Antimicrobial peptides (AMPs) cause a wide range of effects when interacting with cell membranes, depending on the AMP's properties. Melittin, a linear antimicrobial peptide consisting of 26 amino acid residues, is a major toxic component in the venom of the European bee Apis mellifera. The interactions between melittin and cell membranes have been studied extensively through various biochemical assays. However, the mechanistic details behind the effect of melittin on membrane destabilization are still elusive. In this study, we used atomic force microscopy (AFM) to explore the effects of melittin on a supported lipid bilayer formed by phosphatidylcholine (POPC) lipids (a model Eukaryotic cell membrane). We tested various concentrations to gain insight into the resulting patterns of pore formation or membrane lysis. Our study sheds light on how melittin interacts with a supported lipid bilayer that mimics a eukaryotic cell membrane.

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143. Measuring Thermal Expansion Coefficients of Solids with Single-Mode-Multimode-Single-Mode Fiber Optic Sensor

Yulin Cong, Thong D. Ho, Advisor: Dr. Ertan Salik

We experimentally demonstrated the measurement of a solid's coefficient of thermal expansion (CTE) using a single-mode-multimode-single-mode (SMS) fiber sensor, leveraging its sensitivity to both temperature and strain.