18TH ANNUAL

2024 SURI RESEARCH SYMPOSIUM

SUMMER UNDERGRADUATE SURI RESEARCH INSTITUTE

UROC Undergraduate Research Opportunities Center UC MERCED

UCMERCED

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WELCOME MESSAGE
FROM THE UROC TEAM

UROC Staff: Valerie Anderson, Aliyah McGuire, Diana Hernandez Garcia, Hannah Escobar
UROC SURI Grad Mentors: Adityaa Bajpai, Alauna Wheeler, Peter Karabinis, Jose Millan Higuera, Jose Morales, Jaskanwaljeet Kaur, Alejandra Santoyo, Tony Hua, Shaira Vargas, Amish Patel

Welcome to the 18th annual Summer Undergraduate Research Symposium.

This symposium marks the end of SURI, The Summer Undergraduate Research Institute. It is a chance for our students to showcase all they have accomplished and how they have grown. We are so proud of them!

Thank you for supporting our students and team by attending the symposium. We hope you enjoy learning about all the questions that are being asked and answered by our SURI Scholars!

Best,
The Undergraduate Research Opportunities Center staff and Grad Mentors

Meet the UROC Team

Valerie Anderson

Interim Director

Throughout her career, Valerie has been dedicated to diversity, inclusion, and educational equity, and has a genuine passion for access and opportunity programming. Valerie is a first-generation Latina college graduate from Fresno, CA and she completed her BA in Community Studies at UC Santa Cruz where she conducted a field study in Nicaragua and completed a thesis on Educational Reform Pre and Post Revolution. Valerie also completed her Master's in Public Administration from the University of San Francisco, where she focused on Higher Education Administration, Organizational Change, and Social Justice.

Diana Hernandez Garcia

Coordinator

Diana Hernandez Garcia is a Coordinator for UCDC, UC LEADS, & SURF. She was born in Guadalajara, Mexico and raised in Hawthorne and then Bakersfield, CA. She earned a BS in Geology and an MPA at CSU Bakersfield. In her previous position, Diana was a Science Assistant at the National Science Foundation (NSF). Her favorite activity while at NSF was leading the Summer Scholars Internship Program of which she is an alumna. Diana is grateful to have joined UROC as she loves working to expand experiential learning opportunities for students through undergrad research and internships.

Meet the UROC Team

Aliyah McGuire

Coordinator

Aliyah McGuire is a Coordinator for UROC-H, SOAR, CAMP & UCCS. She completed her BA in International Studies – Linguistics at UC San Diego and more earned her Master's in International and Multicultural Education from the University of San Francisco. She is interested in the lived experiences of students of color, the knowledge gained and produced in those stories, and dedicated to access work in education. When not working, she can be found absorbing stories from books, video games and podcasts or spending time with her loved ones.

Hannah Escobar

Outreach Advisor

As the UROC Outreach Advisor, Hannah is thrilled to bring their experience to the table. With a BA in Criminal Justice Law Enforcement from Stanislaus State University and nearly five years in education, they've got a solid foundation in guiding students toward success. Recently receiving their MA in Higher Education from Grand Canyon University, their enthusiasm for learning and growth shines through. Growing up in the dynamic melting pot of Brooklyn, NY, they've developed a deep appreciation for diverse perspectives. When they're not at work, you might find them unwinding with a game on their PS5 or belting out their favorite Disney tunes!

SYMPOSIUM SCHEDULE

9:00am
Breakfast

9:30am
Symposium Welcome

10:00am
Presentations: Session A

11:00am
Presentations: Session B

12:00pm
Presentations: Session C

1:00pm
Presentations: Session D

2:00pm
Presentations: Session E

3:00pm
Closing Notes

Poster Presentations

SESSION A 10:00-10:45AM

#1 Holmi Calderon
#2 Brandon Castillo Flores
#3 Anthony Vazquez
#4 Felizardo Salazar
#5 Jaelynn Begay
#6 Surisaday Garcia
#7 Sarah Avina
#8 Abril Medina Landeros
#9 Ellen Escamilla
#10 Alan Barrios
#11 Melanie Lumus
#12 Brandon Barana
#13 Beatrice Olivier
#14 Elana Bodude
#15 Axel Muñiz Tello
#16 Mariah Benally
#17 Sarine Yeghiayan
#18 Jessica Pedroza
#19 Trizthan Jimenez Delgado
#20 Liani Angulo
#21 Katelyn Lunny
#22 Isaac Burge

SESSION B 11:00-11:45AM

#1 Yovanny Solorio
#2 Yamini Sirobushanam
#3 Regina Olalde Ruiz
#4 Jasmine Aguirre
#5 DaeVionn Chew
#6 Pamela Aguilar
#7 Isabel Delgado
#8 Omar Duenaz Ferreyra
#9 Cameron Hinson
#10 Joseph Kelleher
#11 Melisa Lovos Palacios
#12 Emmanuel Rabago Moreno
#13 Leonardo Salgado
#14 Ashley Gonzalez Perez
#15 Erin Luna
#16 Zachry Neighbors
#17 Austin Hernandez
#18 Roberto Marin Hernandez
#19 Breanna Remigio
#20 Lelah Munyer
#21 Amy Thiam
#22

Poster Presentations

SESSION C 12:00-12:45PM

#1 Haley G. Branley
#2 Rose Rudresh
#3 Luke Smithberg
#4 Alex Ragde
#5 Alfred Arellano Galvan
#6 Sakina A. Abedi
#7 Brandon Castaneda
#8 Joceline Navarro
#9 Kayla G. Kelly
#10 Ben Dong
#11 Matthew Munoz
#12 Anika Potu
#13 Sandra Hernandez
#14 Gagandeep Kaur
#15 Toxtli Huitzilopochtli
#16 Michelle Vadillo Cuevas
#17 Timothy Pourtarvirdi
#18 Oyinkansola Amao
#19 Ashley Liao
#20 Mark Julian
#21 Evan Lee
#22 Juan Hernandez

SESSION D 1:00-1:45PM

#1 Frances Cardinale
#2 Marie Cruz
#3 Kanly Thao
#4 Montserrat Mendoza
#5 Jada Mari Young
#6 Megha Sanghu
#7 Israel Galeana
#8 Camila Huitrón
#9 Allison Greer
#10 Karla Guadalupe Ramirez
#11 David Smythe
#12 Niove Aragon
#13 Maya Perez
#14 Michaela Cheechov
#15 Ellie Chew
#16 Alisa Ruiz Rios
#17 Emily Le
#18 Zulette Orduna
#19 Connie Chiang
#20 Juan Carlos Ruiz Orozco
#21 Crhsytian Marquez
#22 Victoria Elizabeth Zepeda

Poster Presentations

SESSION E 2:00-2:45PM

#1 Saray Maeda
#2 Ignacio Gutierrez Ramirez
#3 Sammie Bulaon
#4 Salma Arechiga Mendoza
#5 Alejandro Cos-Olivera
#6 Patrick Vazquez
#7 Rachel Kalthof
#8 Eghosa Isibor
#8 Jenny Situ
#9 Leena Sanchez
#10 Quenton Green
#11 Kanchana Khat
#12 Harini Muralidharan
#13 Stephanie Lin
#14 Ricardo Andres Quiroz Uribe
#15 Luis Onofre
#16 Lourdes Johnson
#17 Ronald Chestnut
#18 Jaxson Ramirez
#19 Kadisha Mitchell
#20

Oral Presentations

SESSION A1 10:00-10:15AM

205 Michael Ziegenfus
105 Avery Dolins
215 Alisa Loffe
225 Tyler Eckerman

SESSION A2 10:15-10:30AM

205 Mason Foster
105 Donte Wyatt Jr.
215 Adrian Magun
225 Kenziee Nguyn

SESSION A3 10:30-10:45AM

205 Eric Brooks
105 Gregory Kenning
215 Maria Paula Tapia Tolentini
225 Spencer Kirkman

Oral Presentations

SESSION B1 11:00-11:15AM

205 Jose Meza-Pantoja
105 Kendra Sesco
215 Marlen de Jesus
225 Estrella Zaragoza

SESSION B2 11:15-11:30AM

205 Sophia M. Martinez
105 Anaya Cambridge
215 Cassidy Liu
225 Edgar Moya

SESSION B3 11:30-11:45AM

205 Christopher Finley
105 Kahilan Skiba
215 Charles Jordan
225 Kyra Ruiz

Oral Presentations

SESSION C1 12:00-12:15PM

205 Viniccius Touma
105 Diego Cachón Blanch
215 Anthony Ramos
225 Luis Angel Acosta

SESSION C2 12:15-12:30PM

205 Katherine Herrera
105 Jenifer Hernandez Garcia
215 Ryan Schwerdtfeger
225 Peyton Pettyjohn

SESSION C3 12:30-12:45PM

205 Asher Skiles
105 Evelin Guardado Barron
215 Nathalia Gaytan

BRAAG

Geoscience is one of the least diverse fields in the United States, even within STEMM (Science, Technology, Engineering, Mathematics, and Medicine). The University of California (UC), Merced – Historically Black College and University (UCM-HBCU) partnership - “Boosting Representation of African-Americans in the Geosciences” (BRAAG) - aims to contribute to changing the trajectory of representation of African-Americans (AA) in the geosciences in the UC system and beyond.

The BRAAG partnership is a three-year program intended to improve the representation of Black people in the geosciences by recruiting students from three HBCUs - Kentucky State University, Tennessee State University, and Howard University. At UC Merced, we will provide HBCU students with an immersive and enriching research experience over eight weeks, along with multi-tiered mentoring and sponsoring of the students we recruit long after they complete their summer research at UC Merced.

Kadisha Mitchell
Howard University — Environmental Science
BRAAG

Using Convolutional Neural Networks for Food Classification

By: Kadisha Mitchell, Teamrat Ghezzehei PhD, Aaryn Wilson PhD candidate, Jennifer Alvarez PhD candidate, Rebecca Ryals PhD

Paradoxically, both extreme food waste and acute hunger coexist in our society. Globally over one-third of food produced for human consumption is lost or wasted, this totals about 1.3 billion tons of food per year. Conversely, nearly 282 million people experienced food insecurity in 2023 and 9 million people die of hunger and hunger-related diseases every year. Food waste is not limited to consumers, it occurs at varying steps during production. Eliminating food waste is therefore crucial to achieving zero hunger. Neural networks can be used to identify edible and inedible food, enhance food safety, for quality control and to reduce food waste. Convolutional Neural Networks (CNN), implemented via Python's TensorFlow or Mathematica are trained on large datasets of labeled images to accurately distinguish between safe and unsafe food items. The process includes preprocessing and augmenting images to ensure consistency and variety, encoding labels for classification, and designing a suitable neural network architecture. The model undergoes iterative training and validation to ensure accurate and reliable classification of food items. This technology presents a practical application of artificial intelligence that can be utilized to aid our sustainability efforts as we battle climate change and its effects on our food systems.

***1College of Arts and Sciences, Howard University; 2Life and Environmental Sciences, University of California, Merced**

Quenton Green
Kentucky State University — Business Administration
BRAAG

Impact of Biochar and Compost on Soil Organic Matter Stability: A Carbon and Nitrogen Isotopic Analysis in California's Winter Wheat Systems

By: Quenton Green, Melinda Gonzales, Ph.D Candidate, Rebecca Ryals Ph.D

This study aims to expound upon the influence of biochar and compost on soil organic matter (SOM) stability in California, driven by the increasing interest in biochar due to its potential to meet climate and waste management goals. Despite this growing interest, there remains a significant knowledge gap regarding the specific impacts of biochar on SOM stability in various soil depths and conditions. This research addresses this gap by analyzing soils collected from a winter wheat cropping system in Madera, California, sampled at depths ranging from 0 cm to 100 cm at two critical points in the growing season (early and late). The analysis will focus on carbon and nitrogen content and their isotopes 13C and 15N using the Costech ECS 4010 elemental analyzer. The information from these findings will contribute to a better understanding of soil carbon dynamics, potentially guiding sustainable agricultural practices and soil management strategies in California and similar regions.

Beatrice Olivier
Howard University — Environmental Science
BRAAG

Examining Extreme Smoke and Dust Pollution Cases in California's Central Valley

By: Beatrice Olivier, Md. Minhazul Kibria, Adeyemi Adebiyi

Air pollution in California's Central Valley remains one of the worst in the nation, with substantial impacts on people and the ecosystem in the region. Among the main pollutants in Central Valley air are smoke aerosols from wildfires and dust aerosols from agricultural activities. While surface instruments are crucial for monitoring air pollution, it is difficult to obtain accurate information in locations where instruments are not available. In these cases, satellite observation may be used to fill in the gap. A common variable often used in satellite observations is Aerosol Optical Depth (AOD), which measures the extinction of light by the aerosol components in the atmosphere. In this study, we use station and satellite information, including direct images and aerosol optical depth, to examine cases of extreme smoke and dust pollution over California Central Valley. Results suggest that both dust and smoke significantly impact atmospheric clarity and air quality, integrating station and satellite data will provide a more comprehensive understanding of aerosol distribution , concentration and the effects of air pollution.

Elana Bodude
Tennessee State University — Agricultural Science, Biotechnology Concentration
BRAAG

Soil Carbon and Nitrogen Nutrient Contents in Soil from the Kings River Experimental Watersheds (KREW) After Forest Management

By: Elana M. Bodude, Stephany Chacon, PhD, Asmerat A. Berhe, PhD

As the discussion on climate change evolves, it is important to understand the impact rapid changes in forestlands have on influencing soil carbon and nitrogen nutrients. Three different forest management strategies were implemented at the Kings River Experimental Watershed (KREW): uneven-aged group thinning, understory prescribed fire, and thinning with burn combination. Soil samples were collected across the watershed and each horizon until reaching saprolite. Total carbon and nitrogen in the soil were analyzed using a combustion-based elemental analyzer, oxidizing the soil samples with a catalyst through combustion in a high-temperature chamber. Subsequently, the combustion products were reduced to N2 and CO2 and detected using a thermal conductivity detector. Ammonia and nitrate were also extracted from each sample with 0.05 M potassium sulfate. Colorimetric reactions were used to determine precise NH_4^+ or NO_3^- concentrations. This soil nutrient analysis yields quantitative insights into how forestland modifications may affect specific nutrients, like carbon and nitrogen. This study aims to guide researchers and foresters in identifying the most effective forest management practices for nutrient retention in the Kings River Experimental Watershed.

*Elana M. Bodude, Stephany Chacon, PhD, Asmerat A. Berhe, PhD,
1College of Agriculture, Tennessee State University, Nashville, TN 37209
2Department of Life and Environmental Sciences, University of California-Merced, CA, 95343

Zachry Neighbors
Kentucky State University — Agricultural Systems
BRAAG

Soil Structure

By: Zach Neighbors

Soil structure is a critical indicator of soil health, influencing hydrology, carbon storage, and plant root establishment. This study investigates the long-term impacts of cover cropping and no-tillage practices on soil structure. Previous research has demonstrated that no-till practices can increase aggregate stability, while cover cropping enhances organic matter content. However, these studies have been limited by their short-term nature and the need for comprehensive analysis of these management practices' individual and synergistic effects over extended periods. To overcome these limitations, we embarked on a comprehensive long-term study spanning over 20 years. Our study, which involved the use of a wet sieving device that applies constant disruptive energy, allowed us to analyze intact soil bulk samples from different management combinations at two crucial time points: after 20 years of management and following a 3-year fallow period. This thorough approach ensured that we captured the full spectrum of effects of various combinations of tillage and cover cropping on soil structure. Our results show In the 'no-tillage' plots, a farming method where the soil is left undisturbed by plowing, it is more likely that the soil structure will withstand a certain amount of runoff water. The soil will keep a significant amount of carbon within. Still, on the downside, there are more than just crops competing for the carbon for them to use for photosynthesis. However, in samples from that field with 'tillage, 'farming method involving soil preparation for planting by plowing or harrowing, a small amount of carbon is lost because of this farming technique. These findings suggest that fewer plants use the carbon in the soil, which allows for higher yields because those crops do not have to compete with other plants trying to get carbon from within the soil in fields with tillage. The soil structure is also more compact and solid than fields with no tillage, making fields with tillage less likely to have any negative impact from runoff water

Cameron Hinson
Kentucky State University — Business Administration focus in Management
BRAAG

Rapid Soil Microbial Response to Wetting Events

By: Cameron Hinson, Simone J. Graham, Teamrat A. Ghezzehei

Recently, the interest in soil organic matter has increased because it is recognized that soil is the largest reserve of carbon. Therefore, it has the potential of slowing down climate change if loss of carbon from soil is slowed down. One of the unusual discoveries of soil respiration in the last half century is that the rate of CO2 loss from soil increases drastically immediately after wetting. The increased rate lasts only for a short time and decreases even if the water content does not go down. This research aims to answer whether the temporary increase of respiration can be explained by the fact that both water and oxygen are abundant for a short time immediately after wetting. In phase 1, soil samples were saturated with water at room temperature. The main treatment will receive water that has been deoxygenated. The control will be identical quantity water applied in the same manner, but with natural oxygen concentration. It is expected that the respiration of the samples wetted with tap water will be higher initially. Once the initial oxygen is depleted, the respiration in both treatments will be identical because the oxygen is supplied in both treatments by slow diffusion throughout the soil pore water. In other words, the more dissolved oxygen in water equates to a larger response in microbial activity (higher initial spike in CO2).

Ronald Chestnut
Kentucky State University — Business Administration
BRAAG

Testing storing and analysis of PAH

By: Ronald chestnut, Zeyi moo
Ronald T. Chestnut,
Mentor 1: Xuan Zhang, PhD, Assistant Professor, Life and Environmental Sciences, SE2

With the prevalence of fires around California, the air pollution from these fires can be monitored and measured through the concentration of PAH(Polycyclic aromatic hydrocarbons). These molecules have become a more prominent problem. The primary health issue that PAHs cause is their carcinogenic nature, which is due to their ability to bind together DNA, leading to tumor initialization. These molecules can be found in the air, water, and soil, persisting in the environment for months and even years. Human exposure to these molecules can occur through inhalation i.e. (the burning of oil, wood, tobacco, or garbage), primarily these molecules are found bound to PM(Particulate Matter), dermal exposure, and the ingestion of foods. Some of the ways you can be exposed to such things are the consumption of cigarette smoke, skincare products with coal tar, and barbecued and smoked foods. PAHs can also be swallowed and enter the gastrointestinal tract of cigarette and cigar smokers as well. PAH, once introduced into the lungs, becomes oxygenated, which then causes inflammation of the lungs (Pneumonitis), which occurs when an irritating substance, Ie. (PM) causes your lungs' tiny air sacs (alveoli) to become inflamed. This inflammation makes it difficult for oxygen to pass through the alveoli into the bloodstream. This can be a severe problem for adults ages 65 and older and children younger than 2.

CAMP

The following student scholars are participants in UC Merced's CAMP program. The Louis Stokes California Alliance for Minority Participation (CAMP) in Science, Technology, Engineering and Math, is a statewide initiative funded by the National Science Foundation (NSF) to strengthen the quality and quantity of underrepresented students receiving baccalaureate degrees in science, technology, engineering and mathematics studies at the University of California (UC). CAMP offers extensive resources and unique opportunities for students to excel in their respective fields of study. The CAMP program began at UC Irvine in 1991; currently, nine UC campuses participate in the program.

For more information, please visit
http://uroc.ucmerced.edu/camp

Saray Maeda
University of California, Merced —
Biological Sciences
CAMP

The Effects of High Temperatures on Prophages in Actinobacteria

By: Diane-Marie Brache-Smith, Maggie Sogin, Saray Maeda

Climate change plays a large role in how bacterium such as actinobacteria and their prophages interact at extreme temperatures. Actinobacteria are plant growth promoting bacteria that have a wide array of functions. Prophages, bacterial viruses, can be beneficial and/or pathogenic. Prophages can modify the bacterial phenotype by helping increase growth rates and withstand stressors such as oxidative stress. As temperatures rise, it is expected that prophages will die leading to the loss of their benefits. Here we heat stressed marine actinobacteria with and without Mitomycin C. Mitomycin C estimates the number of phage infected cells. These cultures were measured using a plate reader to observe OD 600 Growth Curves at 14°C (habitat temperature), 18°C, 20°C, 22°C, and 25°C. The growth curves will show that as temperatures elevate, the presence of phages will also increase. Future work involves isolating the actinobacteria prophage and attempting to introduce it to a new host. This is important because prophages can transfer genes that can help with plant growth. Understanding these dynamics is vital for comprehending how prophages and their associated microbial communities respond to climate change and its impact on plant growth promoting rhizobacteria.

Brandon Barana
University of California, Merced —
Biological Sciences
CAMP

Distance-Based Phylogenomics of Eukaryotes using tRNA Functional Signatures

By: Brandon Barana, Francisco Gorrostieta Campos, BS, David H. Ardell, PhD

tRNAs play an essential role in protein synthesis through the base pairing of anticodons to mRNA codons in ribosomal A-sites. After tRNAs are accepted by ribosomes, they transfer their covalently linked amino acids to growing polypeptide chains. Therefore, the distribution of amino acids attached to tRNAs determines the accuracy of ribosomal protein synthesis. The recently published tRNA Structure-Function Mapper (tSFM) software facilitates bioinformatic prediction of features that determine amino acid distributions on tRNAs. These predictions identify genome-specific tRNA functional signatures shown to be phylogenetically informative and resistant to sources of phylogenetic bias. However, they have not yet been used directly to infer phylogeny. In this project, we investigate a new evolutionary distance based on tRNA functional signatures, implemented in tSFM. We applied it to tRNA genes predicted in unicellular and multicellular eukaryotic genomes from the UC Santa Cruz genomic tRNA database (GtRNAdb). Our method applies probabilistic covariance models to align tRNA data by their secondary structures and computes pairwise distances on genomes using tSFM. We will construct minimum evolution phylogenetic trees with FastMe 2.0 to evaluate our hypothesis. By employing sample-based inference and comparing alternative phylogenetic distance measures we can investigate any uncertainty. We hypothesize that the distance-based phylogenetic tree we obtain from tRNA signatures will be concordant with known phylogenetic relationships of these species, proposing an innovative method for phylogenetic inference from genome data. Ultimately the project aims to advance a novel approach to resolving deep relationships in the Tree of Life.

Patrick Vazquez
University of California, Merced — Mechanical Engineering
CAMP

Understanding the Effects of Relative Humidity and Operating Pressures on the Performance of Polymer Electrolyte Membrane Fuel Cells

By: Patrick Vazquez, Zabihollah Najafianashrafi, Po-Ya Abel Chuang

Fuel cells are energy conversion devices that convert chemical energy to electrical energy in large quantities, the most common of which are proton exchange membrane fuel cells (PEMFCs). Despite their potential for great marketability, obstacles are often associated with fuel cell operations, categorized through kinetic, ohmic, and mass transport losses. As methods incorporate the implementation of tailored material designs, improvements in PEMFC performance can become relatively high in cost. However, through modifying operating conditions such as pressure, temperature, relative humidity (RH), etc. each of the losses associated with fuel cells can be minimized for improved cost efficiency. In this study, the effects of varying pressure and inlet RH on low-temperature PEMFC performance were measured across a 4 cm2 straight parallel cell with a 2 cm2 active area. In addition to our current study, in situ measurements using electrochemical impedance spectroscopy (EIS) are also conducted to measure the humidification level of the cell. Our findings demonstrate that PEMFC performance increases with RH and cell operating pressure. However, at high current density regions operating under wet conditions (100% RH), the cell begins to flood, and losses, associated with mass transport, start to dominate. Under dry conditions (60% RH), performance is significantly improved by increasing pressure. By understanding the effect of these operating conditions on underlying transport phenomena, we can effectively contribute to further the development of fuel cell technologies.

Victoria Elizabeth Zepeda
University of California, Merced — Computer Science and Engineering
CAMP

PAVE: Pervasive Analysis of Vibration for Enhanced home care

By: Shijia Pan PhD, Dong Lee, Victoria Elizabeth Zepeda

The need for elderly care continues to grow as the world's older (people aged 65 and over) population is projected to double by the year 2050. Caretaking requires significant advancements to ensure the safety and well-being of senior residents, particularly when caregivers cannot be physically present. This study explores the potential of autonomous vibration sensors as a non-invasive alternative to traditional monitoring methods such as microphones and cameras, which may infringe on residents' privacy. By analyzing and grading various sensor models, our research aims to optimize the efficiency of these sensors when deployed in a network, thereby enhancing the accuracy of activity detection. A key focus of this investigation is the minimization of noise interference, allowing for the precise identification of relevant events and movements through vibration sensing. Our findings will contribute to the development of improved monitoring systems that safeguard both the safety and privacy of residents in assisted living environments .

Marlen de Jesus
University of California, Merced —
Physics
CAMP

Developing nanopyramid structures for 3-D calibration of the magneto optical response of Fluorescent Nanodiamonds

By: Marlen de Jesus and Jing Xu, PhD

Fluorescent Nanodiamonds are diamonds that have been engineered with specific defects to obtain the ability to have fluorescence. For nanodiamonds that contain a particular type of defect (Nitrogen-Vacancy centers), their fluorescence brightness can be strongly sensitive to external magnetic fields. Here we wish to leverage this magneto-optical response of fluorescent nanodiamonds to gain spatial information in microscopic samples. My project is to design an array of 3D-printed nanopyramid structures with well-defined spatial information. Software including the 3DPrinterOs, and Ultimaker Cura, was used to detail and design the nanopyramids whereas the Ender Creality 3D printer was used to print out the structures. The 3D printed nano pyramids will be used as the master mold which I will then cast them into Polydimethylsiloxane (PDMS), a material commonly used in microfluidics. The resulting PDMS nanopyramids will then be bonded to glass substrates for compatibility with established microscopic imaging. My future project goal is to distribute the fluorescent nanodiamonds at the surface top of the nano pyramids and measure their fluorescent brightness in the presence of external magnetic fields, to test the extent to which we can leverage the magneto-optical response of NV- centers recover the well-defined spatial positions encoded in the nanopyramid structures I have constructed.

Sammie Bulaon
University of California, Merced —
Biology, emphasis on Microbiology and Immunology
CAMP

Correlating Microbial Diversity and Community Composition Patterns with Shifting Chemodiversity Present in Oxygen Minimum Zones

By: By: Sammie Bulaon, Sonia Vargas, Michael J. Beman PhD, Irina Koester PhD, Margot E. White PhD

Microbial life depends on dissolved oxygen (DO) and other organic matter (OM) that contribute to biogeochemical cycling in the ocean. The anoxic waters introduced by oxygen minimum zones (OMZs) disrupt microbial diversity and community composition, therein affecting OM degradation and fostering selective preservation. Sampling deoxygenation gradients found in the eastern tropical North Pacific Ocean (ETNP) provide the assessment of DO trends and its significance to diversity and community composition. This is further supplemented with complementary OM data provided by our collaborators in Lihini Aluwihare's lab. We wish to investigate the correlation between microbial diversity and community composition patterns with the shifting chemodiversity present in OMZs. Previous research regarding bacterial diversity within the ETNP suggest strong, nonlinear joint correlations between temperature and DO concentrations, where bacterial abundances would increase in warmer temperatures found at the base of the euphotic zone or in decreasing DO concentrations found near the base of the OMZ. Profoundly, OTUs found in such abundances were able to adapt to changes in light sensitivity, salinity, or utilized anaerobic processes despite being phototrophic. Comparing these findings with complementary OM data will allow us to understand how such adaptations take place and contribute to selective competition. Additionally, we can learn more about the unique biogeochemistry found in OMZs and its implications for marine life on a larger scale.

Montserrat Mendoza
University of California, Merced —
Chemistry, Biological Chemistry Emphasis
CAMP

Selective Hydrogenation Reaction over Cu-based Nanocrystal Catalysts

By: Montserrat Mendoza, Jennifer D. Lee PhD

Catalysts are materials that facilitate chemical reactions and are the key component to developing efficient catalytic processes. Selective hydrogenation reactions are important for the chemical production industries, where Cu-based materials have been shown to be promising heterogeneous catalysts for this type of transformation. In this research, Cu nanocrystal catalysts added with a second metal were designed to improve the catalytic performance of hydrogenation reactions. The Cu-based catalysts were prepared by colloidal synthesis followed by deposition onto a support. The catalytic materials were tested for H2-D2 exchange reaction for evidence of hydrogenation. This was carried out by a continuous flow reactor at 1 bar over the temperature range 25-200 °C with products evaluated by online mass spectrometry. Compared to pure Cu catalysts, the addition of a second metal resulted in an increase in hydrogen-deuterium (HD) formation and served as an indicator of the increase in hydrogen dissociation activity. This study will give an insight into the behavior of the Cu-based nanocrystal catalysts to further explore the possibilities of using them as new materials for other hydrogenation reactions.

Maya Perez
University of California, Merced —
Biological Sciences
CAMP

Microbial composition in San Joaquin Valley airborne dust

By: Maya Perez, Adeola Fagbayibo, Estrella Herrera, Ph.D, Asa Bradman, Ph.D, Katrina K. Hoyer, Ph.D

Dust is a form of particulate matter (PMT), originating from various sources, including soil. The diverse organic materials found in soil include live and dead microbial components. Certain climates, weather conditions, and human influences induce the dispersion of dust. Climate change has elevated dust generation, increasing exposure to dust airborne microbes and thereby heightening the health risk to San Joaquin Valley residents. Microbes and microbial products within dust have the potential to transmit disease and impact health. The dust in this region potentially contains various biological agents that impact health and disease transmission. Respiratory diseases are on the rise in the California Central Valley. This research explores the relationship between climate conditions and airborne microbial communities in the San Joaquin Valley. We aim to understand this by sampling air and dust sedimentation across 12 San Joaquin Valley locations to assess the biological composition of these samples. Phylogenetic microbial data will be compared across seasons and related to soil composition, land cover types, and PMT2.5 data collected by Purple Air monitoring. This project will provide an in-depth analysis of the bacterial fungal composition of air and dust over the year. Enhancing our current knowledge of the bacterial and fungal species present in the dust and air will provide a foundation for developing strategies to reduce respiratory disease transmission across the San Joaquin Valley.

CCBM C-sip

The Center for Cellular and Biomolecular Machines (CCBM) is a National Science Foundation (NSF) Center of Research Excellence in Science and Technology (CREST) at the University of California, Merced. The NSF- CREST CCBM uses an interdisciplinary approach cutting across scientific and engineering methodologies to: 1) Pursue a fundamental understanding of the structure, dynamics and functioning of multi-scale biomolecular and cellular assemblies with the goal of enabling control of function in vivo; 2) Use these fundamental principles to design and develop novel bioinspired functioning machines ranging from designer cells and tissue to diagnostic and therapeutic devices, and 3) Host an integrated, interdisciplinary training program for graduate students that uniquely emphasizes both physical and biological components and provides research and training experiences for undergraduate and high school students that will enhance the recruitment of those traditionally underrepresented in STEM research.

Matthew Munoz
University of California, Merced — Chemical Sciences, Biological Emphasis.
CCBM C-Sip

Desiccant Tolerance Screening: A Sequencing Based Approached

By: Matthew Munoz

Intrinsically Disordered Proteins (IDP) are a unique class of proteins that lack an ordered three-dimensional structure. Unlike well-folded proteins, which have specific and stable conformations, IDPs are highly flexible and can adopt multiple shapes. Late Embryogenesis Abundant (LEA) proteins are a class of IDP that have been linked to desiccation tolerance. LEAs have been identified through weak homology of their amino acid sequence, but like other IDRs predicting function based on sequence alone is challenging. Our aim is to link the sequence of LEA proteins to their protective roles in a systematic, high-throughput way. To do this, we generated a library of LEA IDPs, both native and synthetic. The library is encoded in a plasmid, transformed into yeast, and the yeast can express these LEA constructs. We then subjected the pooled library of IDPs to subsequent rounds of desiccation/rehydration. Through next generation sequencing, we count the enrichment or depletion of specific IDRs, and identify key contributors to desiccation tolerance by analyzing abundance of IDPs. The results of this study contribute to our understanding of IDP functionality and reveal molecular strategies that organisms use to withstand desiccation. However, the next step is to increase the library's capability based on the proteins found in the enriched small library. These findings may provide a unique model for improving resilience in a variety of species and ecosystems.

Key Words: Desiccation Tolerance, Intestinally Disordered Proteins, Sequencing, Yeast. "

Alisa Ioffe
University of California, Merced — Molecular and Cell Biology
CCBM C-Sip

Determining the Degree of Bending that is Tolerated for De Novo Coiled Coil Peptide Heterodimers

By: Alisa Ioffe, Adekunle Adewole, Andrea D. Merg, Ph.D.

Coiled coils (CCs), which consist of two or more alpha helices that are supercoiled, are well-understood protein folds that have gained attention as supramolecular assembly motifs in the design and construction of bio-nanomaterials. The ability to program coiled coil formation via sequence engineering of the peptide has facilitated their exploration for building nanoscale architectures across dimensions (0D to 3D) for potential applications in drug delivery, sensing, and molecular/ion capture. Currently, there is limited information on the degree of bending that can be tolerated for de novo coiled coil heterodimers, as well as an investigation into coiled coil rigidity. Here, we investigate the bending tolerance of coiled coils by systematically adjusting the length of cyclic peptides (one half of a coiled coil heterodimer), thus controlling the degree of bending within the protein fold. In our analysis we compared our cyclic-linear CC assembly results with a predefined linear-linear control via circular dichroism spectroscopy. Insights into the degree of bending allowed by CCs will serve as a useful reference point in the future design of more intricate topologies of de novo CC peptide architectures.

Connie Chiang
University of California, Merced — Biological sciences - Human Biology
CCBM C-Sip

Protein-protein binding interaction of XCL1 chemokine mutants and vCCI chemokine inhibitor

By: Connie Y. Chiang, Katherina Martinez, School of Natural Sciences; Wenyan Guan, PhD, School of Engineering; Patricia J. LiWang, PhD, School of Natural Sciences

Chemokines play a vital role in inflammatory response by stimulating leukocyte chemotaxis. vCCI (viral CC chemokine inhibitor) binds many chemokines and blocks their ability to bind receptors and cause inflammation. Therefore, vCCI has potent anti-inflammatory properties. Lymphotactin (XCL1) is a subfamily of chemokines with the unusual property of having two different folded conformations; it has a dimeric structure that binds glycosaminoglycans and a monomeric structure that binds its receptor, XCR1. It has not been previously observed to bind with vCCI in either form. To obtain a better understanding of the molecular mechanisms of vCCI:chemokine interactions, it was hypothesized that particular mutations in XCL1 can potentially allow binding to vCCI. In addition to mutations that lead to a locked monomer-only form of XCL1, glutamine and isoleucine residues were mutated to lysines. XCL1 was mutated through an overlap extension polymerase chain reaction. After sequencing the DNA, the protein was produced via bacterial cell expression and purified through Ni-NTA columns and high-performance liquid chromatography. vCCI:XCL1 binding affinity was assessed with a bio-layer interferometry assay. An XCL1 double mutant was shown to bind more tightly to vCCI than the original XL1 monomer variant, indicating a higher binding affinity and the potential of this interaction. These findings provide insights into molecular interactions, which could inform therapeutic strategies and immune system regulation.

Alejandro Cos-Olivera
University of California, Merced — Bioengineering
CCBM C-Sip

Engineering a tighter XCL1-VCCI complex

By: Alejandro Cos-Olivera, Connie Chiang, Wenyan Guan, Patricia J. LiWang

Chemokines are notable for their ability to mediate the migration and activation of white blood cells (leukocytes) through endothelial cells via binding of leukocyte receptors, which is crucial for proper immune response. However, in some instances a disruption in the balance of immune response occurs and the heightened immune system mistakenly attacks healthy cells. The chemokine inhibitor vCCI is a protein used by viruses for immune evasion. This protein has anti-inflammatory properties due to its ability to bind and inhibit chemokines. However, this inhibitor generally only binds the CC subfamily of chemokines. Our lab is studying the binding capability of vCCI using Lymphotactin (also called XCL1), a chemokine that is not known to be bound by vCCI. Our hypothesis is that we can dictate the protein-protein interactions XCL1 makes, thereby mitigating the migration of leukocytes, by using vCCI to limit the traversal of leukocytes. XCL1, being metamorphic, can interchange between its Ltn10 and Ltn40 conformation; we therefore focused on the locked monomer of XCL1(Ltn10) as this conformation is responsible for the binding of leukocyte receptors. Moreover, we aimed to mutate XCL1 to understand the consequences of its binding affinity with vCCI with the goal of creating a better complementary binding partner. This work is important because as we raise the binding affinity XCL1 has with vCCI, we can control the anti-inflammatory response which can be useful in therapeutic

Jasmine Aguirre
Merced College — Molecular Cell Biology
CCBM C-Sip

Stem Cell Reprogramming from Oral Epithelial Cells

By: Jasmine Aguirre, Jose Zamora, Kara E. McCloskey, School of Natural Science, University of California, Merced, School of Engineering, University of California, Merced

Induced-pluripotent stem cells (iPSCs), with enormous self-renewal properties, are ideal cell sources for the generation of patient-specific disease models and therapeutic regenerative medicine. Current methods for generating iPSCs require blood donation or tissue biopsy. Here, we explore using oral epithelial cells called “buccal cells” acquired from tooth brushing to reprogram into stem cells. The CytoTune-iPS reprogramming system, with a replication-incompetent Sendai virus (SeV), is used to safely deliver and express the genetic factors required for reprogramming cells. Buccal cell isolation methods, without mouthwash, and matrix substrates such as fibronectin, collagen-type IV, and gelatin were explored for their ability to establish the buccal cells as a primary culture. Results suggest that more buccal cells are obtained using mouthwash and that collagen-type IV was the optimal cell culturing substrate. By developing a robust and non-invasive method for generating unlimited amounts of stem cells we may one day enable researchers and doctors to treat disease with a patient’s own derived stem cells.

Keywords: Stem cells, epithelial cells, IPSCs, cell reprogramming, cell adhesion.

BII INSITE

The INstitute for Symbiotic Interactions, Teaching, and Education in the Face of a Changing Climate (INSITE)

We are in an era of rapidly changing climate, threatening animal species that form complex relationships with microbes for essential benefits. To understand how these interactions will respond to certain climate futures from molecular to ecological scales, we have established the NSF Biological Integration Institute, INSITE — The INstitute for Symbiotic Interactions, Training, and Education in the Face of a Changing Climate. INSITE brings together a multi-disciplinary team at the University of California Merced and Michigan State Universit

Salma Arechiga Mendoza
University of California, Merced — Biological Sciences with an Emphasis in Molecular and Cellular Biology
BII INSITE

Symbiotic Responses of the Exaiptasia diaphana Microbiome to Temperature Variations

By: Salma Arechiga Mendoza, David M. Smythe, Kaden M. Muffet, PhD, and E. Maggie Sogin, PhD; Department of Molecular and Cell Biology, School of Natural Sciences, University of California, Merced

Corals are under threat from increased ocean temperatures. To advance conservation efforts, we must explore ways to modify their dependence on their symbiotic relationship with photosynthetic algae. Utilizing the sea anemone, Exaiptasia diaphana, offers a practical symbiosis model for corals in a laboratory setting. E. diaphana was sourced from Key West, Florida, and acclimated at 22.5°C for one month. These non-clonal specimens were then incubated at four different temperatures (22.5°C, 26.5°C, 31.5°C, and 34°C) to assess resiliency. Anemones were fed twice weekly, with water changes and photographs taken three times per week to track progeny growth and assess comparative population growth rates. Samples of anemone tentacles were obtained at the beginning and end of the experiment and stored for DNA extraction. Changes in the symbiotic relationships were monitored using PCR to analyze Symbiodinium across different temperature conditions. We hypothesize that higher temperatures (31.5°C and 34°C) will result in reduced progeny production and alterations in the symbiotic partnership. By understanding these dynamics, we aim to provide insights that can aid coral conservation efforts. These findings are crucial for developing strategies to help corals adapt to rising ocean temperatures.

David Smythe
Merced College — Biology
BII INSITE

Impact of Marine Heat Waves on Thermally Conditioned Anemones

By: David M. Smythe, Kaden Muffett, PhD, Maggie Sogin, PhD

Cnidarians, such as Exaiptasia diaphana (Aiptasia), are threatened by rising ocean temperatures. During marine heat events, the physiology and microbiome of an individual can be negatively affected. When Aiptasia have been conditioned in warmer water, they may have a higher fitness in extreme heat. This study aims to investigate how thermal conditioning can influence the reproductive fitness, physiological health, and microbiome of Aiptasia individuals. We assessed the population growth, community metabolism, and net respiration of heat-acclimatized and heat-naive individuals. Two clonal lines (CC7 and H2) have been grown for greater than 6 months in current baseline temperatures (26.5°C), and a current seasonal high (+5°C). Replicate populations of both the normal and elevated temperature groups were placed into an extreme temperature (+7.5°C). Additionally, highly heat-tolerant individuals (survived a 38°C heat shock as juveniles) served as a tertiary experimental group in 34°C to identify whether juvenile heat experiences convey any change in survivorship. Populations were assessed three times per week for four weeks. Host symbiosis and physiological health were assayed through oxygen exchange using a PreSens oxygen fluorometer. Using a Biolog EcoPlate, carbon source consumption by community members was assessed within the Exaiptasia microbiome. Despite our initial expectations, previous heat experiences were determined to not influence the reproductive fitness, physiological health, and microbiome of Exaiptasia individuals in any significant way.

Allison Greer
University of California, Merced — Environmental System Sciences
BII INSITE

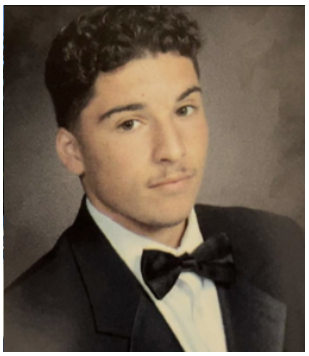
Developing A Method of Extracting DNA from Phyllosphere Viral Communities
By: Allison E. Greer, Shayna Bennett, Juris Grasis, PhD

DNA extraction is crucial for analyzing genetic material from various biological samples. Specifically, extracting DNA from phyllosphere viral communities can offer insights into how microbiomes support plant species in surviving environmental stressors. However, methods for extracting viral DNA from these communities are understudied, and obtaining viral DNA from this environment remains challenging. Viruses play an important role in regulating microbial communities on tree leaves. Being able to identify the viral genome can aid in understanding how it is regulated. Leaf surfaces pose an additional challenge to obtaining the viral DNA due to compounds such as polysaccharides which can interfere with the extraction process. To isolate the viral community, we immerse 50g of leaves in SM buffer and sonicate for 5 minutes. Volume is reduced with an overnight PEG precipitation and the remaining buffer is passed through a 0.2 micron filter to remove bacterial, fungal, and plant cells. These steps provide a foundation for improving the techniques of extracting and analyzing viral DNA on leaf surfaces. Ultimately, this will advance the understanding of phyllosphere viral ecology, and its role on plant health.

Toxtli Huitzilopochtli
University of California, Merced — Environmental System Science
BII INSITE

Heat Shock on Leafhopper symbionts – Predicting Climate Change
By: Toxtli Huitzilopochtli, Younghwan Kwak Ph.D. ,Gordon Bennett Ph.D.

Many animals such as aiptasia or insects use obligate symbionts that act as mutualists to aid them with nutritional functioning. Plant-sap feeding bugs, such as leafhoppers (Hemiptera), have long had relationships with bacterial symbionts going back as far as 300 million years. In Deltocpehalinae leafhoppers, host insects depend on two ancient bacterial symbionts, Sulcia and Nasuia, for essential amino acids along and vitamins that are lacking in their diet of phloem and xylem and that animals are unable to make. In return, the host in this case leafhoppers provide the bacteria with genomic resources needed to complete basic cell processes and metabolisms. These bacteria live their entire life-cycles inside the leafhopper in special organs called bacteriomes and cells called bacteriocytes. The relationship of the host and symbiont are dependent on each other to the point that one cannot live without the other. To understand how environmental stress influences the relationships between host and symbionts, we simulated a climate change scenario that involved shocking the leafhopper host with higher temperature (25°C) living conditions. We will test the ability of the host to regulate symbiont populations under stress using quantitative molecular tools. This work is important because understanding how insects and their microbes perform under climate stress implications for conservation and pest species control in managed ecosystems (e.g., agriculture).



Timothy Pourtarvirdi
Merced College — Bioengineering
BII INSITE

Antimicrobial Effectiveness of Copper and Zinc

By: Juris Grasis Ph. D, Ching Lee, Timothy Pourtarvirdi

The antiviral and antimicrobial traits in which both copper and zinc alloys possess has given way for potential pharmaceutical breakthroughs in finally having a resource which can fight and inactivate viruses. Though scientifically proven that metal ions can terminate viral pathogens, the reason behind this phenomena is still unknown. We hypothesize that is due to the ionic charge of these metals disallowing viruses from binding onto the cell membrane of hosts for long enough, which in turn disables the viruses from also binding onto cell DNA. In view of this, we worked with stocks of the T7 and M13 viruses, in which we initially conducted a plaque assay process in order to get a count of the viruses. After obtaining an appropriate viral count, the viruses were ready to be introduced to a copper sulfate solution which possessed the metallic charge of 2+. The plaque assay process was embedded once more with the viruses, but now through ten-fold serial dilutions with the copper sulfate solution. Plates holding the T7 and M13 phages in addition to the metal solutions were then incubated at 37 degrees Celsius for one day. Results showed a decrease in plaques upon the plates for the copper (II) solutions, suggesting the inactivation of phages' due to exposure to the metallic +2 charge. Metallic ions can serve as revolutionary breakthroughs in fighting viruses of all sorts.

NASA Kelpfire

Wildfire Impacts on Watershed Transport of Carbon to Coasts

This project aims to quantify how wildfires alter particulate organic carbon and sediment fluxes to the California coast, and how these fluxes impact coastal kelp forest distributions and productivity along the California Current system for the 2000-2020 study period.

NASA's Minority University Research and Education Project (MUREP) Ocean Biology and Biogeochemistry, or OCEAN, has awarded grants to 10 universities for projects that will support NASA's Science Mission Directorate in seeking a better understanding of the ocean's role in the Earth system.

Jenny Situ
University of California, Merced — Civil Engineering
NASA Kelpfire

KelpFire: Wildfire Impacts on Watershed Transport of Sediment to Coasts

By: Jenny Situ, Erin Hestir PhD, Tesfa Meshesha PhD.
Department of Civil and Environmental Engineering, University of California, Merced

Wildfires within coastal watersheds cause excessive sediment delivery into coastal waters, adversely affecting water quality and marine wildlife. As climate change exacerbates wildfire activity in intensity and magnitude, exploring sediment load changes within coastal waters is crucial to assess the hazards associated with wildfires. Through hydrological modeling, this study investigates the impacts of the 2017 Thomas Fire on the Ventura River in California, USA. Utilizing the Soil and Water Assessment Tool (SWAT), four models were developed to investigate discharge flow and sediment load pre-fire and post-fire. One baseline model simulates watershed discharge flow and sediment load as if a fire had never occurred. Three burned models use different data points from Monitoring Trends in Burn Severity (MTBS), Wildfire Burn Severity and Emissions Inventory (WBSE), and the United States Geological Survey (USGS) to simulate the effects of the wildfire. Findings showed a significant post-fire increase in discharge (1.5 - 3.8 times greater) and sediment loads (0.6 - 12.9 times greater), consistent across all burned models. Hydrological modeling has allowed us to simulate wildfire impacts on sediment delivery to coastal waters, advancing our understanding of wildfire-related changes in marine ecosystems.

Eghosa Isibor
University of California, Merced — Civil Engineering
NASA Kelpfire

KelpFire: Wildfire Impacts on Watershed Transport of Sediment to Coasts

By: Eghosa H. Isibor, Erin Hestir PhD, School of Engineering; Tesfa Meshesha PhD, School of Engineering

The KelpFire Project investigates the climate change-driven impacts of wildfires on watershed sediment transports along the coast. This study examines how increased wildfires lead to water-repellant soils and altered coastal water environments. We utilize the Soil and Water Assessment Tool (SWAT) model to determine the discharge and sediment loads affecting the watersheds. Four SWAT models were run: a Baseline (no fire), Burned - Monitoring Trends in Burn Severity (MTBS), Burned - Wildfire Burn Severity and Emissions Inventory (WBSE), and Observed (using USGS data). Results indicated a significant post-fire increase in discharge (1.5 - 3.8 times greater) and sediment loads (0.6 - 12.9 times greater), consistent across all burned models. By comparing model data with pre-fire data, we gained insights into the timing and magnitude of post-fire fluxes. Our findings reveal that wildfires significantly impact the turbidity of coastal waters, altering watershed attributes such as soil properties, soil-water interactions, and vegetation abundance, as well as increasing erosion. Understanding how wildfires affect our coastal ecosystem is crucial for coastal resilience as these regions boast high ecosystem productivity and are essential for the environment.

Physics REU

NSF funds a large number of research opportunities for undergraduate students through its REU Sites program. An REU Site consists of a group of ten or so undergraduates who work in the research programs of the host institution. Each student is associated with a specific research project, where he/she works closely with the faculty and other researchers.

The UC Merced Physics REU supports student in research projects at the forefront in the sub-fields of biophysics; condensed matter and solar science; atomic, molecular, and optical physics and quantum optics; nonlinear dynamics; soft condensed matter; and astrophysics.

Mason Foster
University of California, Merced — Applied Mathematics with a Physics emphasis
Physics REU

Stability and reproducibility of MAPI thin films integrated with quantum dots
By: Mason J. Foster, Asmitha Mekala, M.Tech School of Natural Science University of California, Merced, CA, US

Perovskites are a promising material for photovoltaic applications due to their ease of synthesis and bandgap tunability. However, the stability and reproducibility of these materials remains a challenge. Methyl ammonium lead iodide (MAPI) is widely used in the study of perovskite films as a photon absorber layer in photovoltaic devices. Methyl ammonium lead bromide quantum dots are integrated into MAPI thin films to address the challenges of stability. The light-induced degradation of the MAPI material is assessed via outdoor testing. The changes in structural properties before and after degradation are investigated with x-ray diffraction and confocal microscopy, while the optical properties are analyzed with photoluminescence measurements. These evaluations are done on a batch of samples to test for reproducibility. Understanding the degradation mechanisms of perovskites and the performance of multiple samples will help improve the encapsulation techniques to enhance stability and create reproducible procedures to promote the commercialization of perovskite photovoltaics.

Gregory Kenning
Indiana University of Pennsylvania/ University of Pittsburgh — Physics & Materials Science Engineering
Physics REU

Analyzing Semiconductor Band Gaps in Ensemble Density Functional Theory using Thermodynamic Limits of Finite One-Dimensional Model Systems
By: Gregory G.V. Kenning, Remi J. Leano, David A. Strubbe

Ensemble Density Functional Theory (EDFT) is one of the most promising extentions to Density Functional Theory (DFT) for analyzing energy levels and excitation energies. So far in EDFT's history, it has been shown to improve the accuracy of energy level differences in multiple models including atoms, molecules and isolated model systems. However, as of now, it is uncertain as to whether or not EDFT is capable of calculating the band gaps within periodic systems. We believe that EDFT could be used to calculate band gaps by estimating the thermodynamic limit with increasingly wide finite one-dimensional “particle in a box” systems, which approach the Kronig-Penney (KP) periodic model, which is a model of a finite box and a finite well within a lattice constant repeating in periodicity. To do this estimation, ensemble-generalized Hartree as well as Local Spin Density Approximation (LSDA) exchange-correlation functionals are used. To do this we use Octopus, an open source software. This method has been used before for analyzing metallic materials with no band gaps from this paper, https://iopscience.iop.org/article/10.1088/2516-1075/ad610e. In this paper we will be analyzing finite KP models using the same methodology. We expect to find that corrections tend to go to specific band gaps as the infinite limit is approached, which is similar to that of a semiconductor system.

Luke Smithberg
Haverford College — Astrophysics
Physics REU

Creating Mock Telescope Observations of FIRE-2 Galaxy Simulations
By: Luke S. Smithberg, Sarah R. Loebman"

Recent observations from the SPITZER telescope (Gordon et al., 2006) have shown a hole within the disk of the M31 (Andromeda) galaxy, believed to be a consequence of interactions with its satellite galaxy, M32. However, determining whether M32 has interacted with the disk of M31 is complicated by Andromeda's significant inclination, approximately 75 degrees relative to our line of sight. Several mechanisms could have formed the hole in the disk due to internal and external processes. In this project, I explore whether we find a simulated galaxy with a satellite and a hole in its disk similar to Andromeda. With this, we hope to understand the causes of the hole in Andromeda's disk. To accomplish this, I employ Feedback in Realistic Environments (FIRE-2) galaxies selected from the Latte suite of cosmological simulations of Milky Way and Andromeda-mass galaxies, executed on the Stampede3 supercomputer. Utilizing SKIRT, a radiative transfer code, I generate synthetic observations in the 24, 70, and 160 μm bands to ensure direct comparability with observational data from the Andromeda galaxy. I will present initial findings from the Latte simulations, focusing on the impact of satellite interactions on disk morphology. This study aims to provide crucial insights for astronomers like Gordon et al. in interpreting observational data.
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Cassidy Liu
University of California, Merced — Physics
Physics REU

Optical response of fluorescent nanodiamonds to magnetic field
By: Cassidy D. Liu, Jing Xu, PhD, Physics, University of California, Merced

A magnetic field is a region around a magnet that induces a magnetic force on charged objects. One well-established method to measure magnetic field strength is using a Hall probe, which uses the deflection of electron paths to produce voltage readouts in the presence of a magnetic field. However, Hall probes are macroscopic and not readily suitable for probing magnetic fields in microscopic samples. It has been shown that the fluorescent brightness of a certain type of nanodiamonds can decrease as the magnetic field increases, making them appropriate for magnetic field sensing on the nano-scale. This research will characterize the optical response of such fluorescent nanodiamonds. Specifically, a method will be presented utilizing single-particle tracking methods to quantify the fluorescent brightness of nanodiamonds over a range of applied magnetic fields. Findings will help establish the feasibility of using the optical response of fluorescent nanodiamonds for precision position sensing at the nano-scale.

Spencer Kirkman
San Francisco State University — Physics
Physics REU

Phase Engineering of Tin Chalcogenides in SACVD

By: Spencer Kirkman, Bamidele Onipede, Hui Cai PhD

The recent interest in SnTe as a topological insulator has resulted in many investigations of the material and its properties, necessitating effective and reproducible methods for crystal production. The crystalline structure of the material and its growth usually results in standard {111}, {110}, and {001} crystal planes. However, while these planes typically present as triangles and squares on the surface, a new shape has occurred during growth in our lab, that of a hexagon. The new shape presents some interesting properties, such as room temperature Raman and Infrared activity, properties not present in the aforementioned crystal planes. The aim of this work is to probe and analyze this new crystal shape/new material as such fully obtain reproducible, high quality, large growths of this phase and then characterize its properties. The method of Salt assisted chemical vapor deposition was used for crystal growth at atmospheric pressure. We optimize the size, quality, and reproducibility of growth of these crystals and characterize them via Raman spectroscopy and X-ray Photoelectron spectroscopy. Our results show precise control in the growth of this new phase of the tin chalcogenide with Raman active modes as evident in the spectra.

Alfred Arellano Galvan
California State University San Bernardino — Physics/ Materials Science Engineering
Physics REU

Entangled photon generation for switching applications

By: Alfred J. Arellano, Albert DiBenedetto, Jay E. Sharping, PhD

We aimed to build a source of entangled photons for the purpose of testing an entanglement preserving switch, as has been shown by previous research efforts in birefringent fibers. A major bottleneck in quantum information technology is the speed of high-fidelity, entanglement-preserving switches. Low-speed switching limits our ability to route entangled photons through the nodes of the network. The best state-of-the-art off-the-shelf devices are 10 ns, −1dB-loss components, but the MHz operation provided is still sub-optimal. Our research objective is to remove the switching speed bottleneck in entanglement-preserving switching and to enable loophole-free testing of entanglement within a 19-inch rack mount footprint. In our experiment we launch 2-picosecond pulses of 800 nm light into a birefringent optical fiber. We expected birefringent phase matching to produce idler pairs or four-wave mixing, but no evidence of the entangled photons has been detected. We contrasted the differences between the setup of our beamline and previous efforts. We modified our setup to produce photon pairs as expected. Within the modifications we have identified that the fiber length, pulse bandwidth, polarization control, and detection sensitivity may limit our ability to see the photon pairs.

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Michaela Cheechov
University of Oregon — Physics
Physics REU

Utilizing the Fast Inertial Relaxation Engine (FIRE) algorithm to simulate random elastic networks

By: Michaela M. Cheechov, Kinjal Dasbiswas, PhD, Arnab Roy, School of Natural Sciences, University of California Merced

Studying the energy minima of systems has long been a goal of computer simulation. A handful of methods exist for this task, such as Steepest Descent and Microconvergence. The Fast Inertial Relaxation Engine is a molecular dynamics scheme used to find stable structural equilibrium configurations. The advantages of FIRE as opposed to other methods include its simplicity and speed, allowing for use in systems with many degrees of freedom. The goal of this project is to use established literature on FIRE to write simulation code of random elastic networks, often seen in biological systems, and further study their behaviors under varied conditions. The primary network studied is an interconnected network with many nodes built using Delaunay Triangulation. The simulation code is written in Python, and due to its small size and simple algorithms can be run with minimal computing resources. The algorithm has shown promising results for random networks and hopefully will continue to provide new insights. Simulations using this algorithm are a powerful and efficient tool for discovering new mechanical behaviors, and in the future will hopefully be applied to more complex systems.

Alan Barrios
California State University, Fresno — Physics/ Materials Mathematics
Physics REU

A comparative cost analysis of implementing an AI-based grading tool for efficient feedback and assessment in engineering classrooms

By: Alan R. Barrios, Ayush Pandey, PhD, School of Electrical Engineering, UC Merced

An auto-grader is software that automatically grades a student's work based on a rubric provided by the instructor. Current auto-grading software lacks the flexibility to enable students to become independent learners and often requires strict adherence to predefined prompts. In this project, we aim to build an AI-based auto-grader that not only allows students to freely develop their own creative projects but also provides personalized feedback. This benefits instructors by saving them time, allowing them to focus on other important tasks such as direct interaction with students, planning engaging class activities, and providing additional mentorship to students who may be struggling in the class. Clearly, auto-graders carry great importance in classrooms. However, it is not clear whether such an endeavor would be cost-effective compared to human graders given that AI models often incur high costs. Thus, it is in our interest to conduct a cost analysis to test the economic feasibility of our auto-grader. Specifically, we consider computational resources and the Low-Rank Adaptation (LoRA) methods as two main factors in our cost analysis. With our cost analysis, we also explore alternative cost-cutting measures in training the large language models. Finally, we will compare these costs with those associated with traditional face-to-face instruction and grading by human Tas and discuss our findings.

Ellie Chew
University of Washington — Astrophysics
Physics REU

Qiskit Modeling of the 1-D Transverse-Field Ising Model

By: Ellie N. Chew
Advisors: Lin Tian PhD, Kelvin Yip, School of Natural Sciences University of California Merced

Quantum computing is an intriguing area of research due to the potential advantages that quantum computers have over classical computers in certain tasks such as prime factorization, unstructured search, and the simulation of quantum many-body systems. In this project, we perform quantum simulation of the transverse-field Ising model (TFIM) using IBM's cloud quantum computers. The TFIM is a prototype for studying quantum phase transitions in spin chains, which can provide insight into ferromagnetic materials and quantum critical behavior. We develop a protocol to digitally simulate the many-body Hamiltonian of a 1-dimensional TFIM chain using quantum logic gates in the IBM Qiskit and cloud platforms. By simulating the time evolution and characterizing the quantum states of this system at different TFIM parameters, we demonstrate the change in the many-body phase of the TFIM model.

Charles Jordan
University of California, Davis — Physics
Physics REU

Theoretical examination of 3-D imaging using NV-Centers in Fluorescent Nanodiamonds

By: Charles M. Jordan, Jing Xu, PhD, School of Natural Sciences

The nitrogen-vacancy (NV) center is a point defect in a diamond lattice where two adjacent carbon atoms are substituted by a nitrogen atom and a vacancy. In the presence of a negative charge, the spin configuration of this defect results in magnetic-field-dependent photoluminescence, turning the NV- defect into an optical magnetic imager. The excellent imaging contrast of methods utilizing these NV-centers, even in the presence of strong background autofluorescence, makes them strong candidates for biological imaging. This work examines the theoretical limitations in leveraging the magneto-optical response of NV-centers for depth-resolution, which is a key step in performing 3-dimensional imaging. Findings will place upper-bounds on depth-resolution in both the static and dynamic imaging applications.

Israel Galeana
University of California, Merced — Chemistry (emphasis in materials)
Physics REU

Quantifying and Characterizing Mesogenic Ligands Seven Through Eleven with Quantum Dots

By: Israel Galeana, Linda Hirst PhD., Joceyln Ochoa M.A.

As the work of soft condensed matter advances, different mesogenic ligands are being attached to quantum dots to better understand the surface treatment between liquid to solid phases. Since not all ligand exchanges are successful, work needs to be done to quantify and characterize the different modified ligand better comprehend their microstructures. To characterize these structures, we do dynamic light scattering measurements, transmission electron microscopy imaging, and H1 NMR spectroscopy while also using python programming language to quantify our data. Unfortunately, while doing dynamic light scattering measurements our quantum dot ligands were contaminated due to a broken cuvette. Because of this were not able to come up with a conclusion. We hope that by quantifying our quantum dots ligands can help characterize them for potential uses such as nanoparticles or medical transportation.

Sasha Pisarchik Shketav
University of California, Merced — NA
Physics REU

Beads Coated with a Functionalized Synthetic Lipid Bilayer as Promising Biosensors

By: David H. Amezcua, Christopher J. Randolph, Eva de Alba, PhD

Functionalized beads are used in a broad range of biotechnological applications, including separation, detection, and immobilization. However, the functional moieties cannot move across the bead surface, which is a desirable property as dynamics are key for many biological processes. For example, the oligomerization of surface receptors in the cell membrane controls the detection of extracellular stimuli and the transmission of amplified signals across the membrane. Here, we aim to add dynamic properties by coating beads in a functionalized synthetic lipid bilayer containing fragments of a cell surface receptor. The bilayer fluidity should allow receptor oligomerization and thus signal amplification. As proof of concept, we are using several domains of the cell surface Receptor for Advanced Glycation End-products (RAGE). This protein prompts an inflammatory signaling pathway upon the detection of a variety of cellular insults. RAGE's function strongly depends on its oligomerization; thus, we aim at showing RAGE oligomerization in the synthetic membrane-coated beads upon ligand binding. These "fluid mosaic-coated beads" can be used as biosensors for signal amplification and for biophysical studies of membrane receptor oligomerization and its effect on signaling.

IoT4AG

Our Mission is to create and translate to practice Internet of Thing (IoT) technologies for precision agriculture and to train and educate a diverse workforce that will address the societal grand challenge of food, energy, and water security for decades to come. Monitoring of agricultural crops is still accomplished primarily through the expensive, labor-intensive, and time-consuming process of crop scouting, by manual sampling and documenting the state of the field. Precision agriculture involves the use of technology to acquire and analyze data from the field. While the concept of precision agriculture has existed for 30 years, the exponential growth in information technology and data science and the reduction in their cost is setting the stage for the next revolution in agricultural practices.

Interns in this program worked on agricultural robotics projects in the lab of Professor Reza Ehsani .The internship program was coordinated by the Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS) in partnership with IoT4Ag.

Liani Angulo
Merced College — Mechanical Engineering
IoT4AG

Optimizing Agricultural Efficiency: Integrating Machine Learning and Robotics for Targeted Leaf Detection and Analysis

By: Liani M. Angulo, Mehrad Mortazavi, MS, Reza Ehsani, PhD

This project aims to integrate machine learning and robotics to improve agricultural efficiency. The project focuses on developing instance segmentation models to identify leaves suitable for robotic manipulation. The RGBD camera used is an Intel RealSense D435i, and our dataset, labeled "good-leaf," trains these models. The models are deployed on a robotic arm equipped with advanced vision systems, programmed using ROS2 to perform tasks such as selective harvesting and health assessment. The model was trained using a supervised learning approach, achieving an initial accuracy of 68%. Challenges included data variability and occlusion, which we addressed with data augmentation and advanced preprocessing techniques. Preliminary results indicate that our model can accurately segment target leaves, and we are working to improve the accuracy to exceed 80% which will further enhance the robot's ability to target fully visible and minimally occluded leaves. This project enhances agricultural robots' capacity to assess crop health, inform farmers about crop quality, and perform precise agricultural interventions. By addressing labor shortages and environmental challenges, this research aims to significantly improve agricultural productivity and sustainability. Demonstrating the potential of combining machine learning with robotics, this project paves the way for more efficient, effective, and intelligent farming practices, ultimately contributing to a more sustainable agricultural future.

Austin Hernandez
Merced College — Mechanical Engineering
IoT4AG

Object Detection in Agriculture

By: Austin Hernandez, Reza Ehsani PH. D

In the realm of agricultural robotics, the precise identification and classification of plant components such as leaves and fruits are critical for tasks ranging from harvesting to plant health monitoring. Object detection, a key technology in computer vision, offers significant potential in enhancing the capabilities of agricultural robots. This study explores the application of advanced object detection algorithms to enable robots to differentiate between leaves and fruits, and to identify optimal leaf samples for analysis. By integrating state-of-the-art deep learning models, such as Convolutional Neural Networks (CNNs) and Region-based CNNs (R-CNNs), we develop a robust system capable of real-time detection and classification of plant parts in various environmental conditions. The proposed approach not only improves the accuracy of robotic perception but also enhances the efficiency of agricultural operations by ensuring precise identification of target objects. Experimental results demonstrate high detection accuracy and classification performance, underscoring the potential of object detection technologies in advancing agricultural robotics. This research paves the way for more intelligent and autonomous agricultural systems, contributing to increased productivity and sustainable farming practices.

SOAR

The following student scholars are participants in UC Merced's SOAR program. The Summer Opportunity for Advanced Research provides funding for UC Merced Undergraduates with prior research experience to continue their projects and research development at UC Merced. Qualified students with interest in pursuing graduate school are especially encouraged to apply. This program is funded directly through the Division of Undergraduate Education.

For more information, please visit
https://uroc.ucmerced.edu/soar

Kahilan Skiba
University of California, Merced — Cognitive Science
SOAR

Human Perceptions of Robotic Agents with Conversational Capabilities
By: Kahilan M. Skiba, Colin Holbrook PhD

With the development of Large Language Models, people are beginning to trust conversational AI to be integrated into everyday life. This trust can cause potentially dangerous developments as people begin to over-rely on this technology. This worry becomes even more prominent with highly anthropomorphic robots that are being programmed with conversational skills that are strikingly equivalent to a human's. To test how anthropomorphism may be affecting an individual's perception, three levels of anthropomorphic to non anthropomorphic robots will be observed having a conversation with their coworker in an educational environment where the robot utilizes language that suggests it's capable of Theory of Mind, or the ability to understand others emotional state or goals, which is a distinctly human quality. Participants will then react to these videos and rate the robot on how human-like their qualities appear to be based on these five human traits: thinking, feeling, perceiving, desiring, and choosing. Prior research suggests that robotic agents that appear to utilize Theory of Mind are perceived as having more human-like qualities, so it is expected that the addition of physically human attributes will increase the human perception of the robot. Understanding what may play into how our perception of robotic agents will play a critical role in how we develop robots and LLM's in the coming future.

Anaya Cambridge
University of California, Merced — Anthropology
SOAR

Native Americans in the University of California System
By: Anaya N. Cambridge, Robin M. DeLugan, PhD, Anthropology & Heritage Studies, University of California, Merced

Do Native American students, faculty, and staff at select University of California (UC) campuses perceive that their interests are recognized and represented within the UC system? In the United States, Native Americans have the lowest enrollment and graduation rates of all racial and ethnic minority groups that seek out higher education and are the only group to have not experienced a consistent rise in attendance. If the UC system wants to improve the experience of the Native American demographic at UC campuses, then understanding the importance of having a Native American support community on campus is crucial. This research analyzes the opportunities and barriers Native Americans face in higher education within the United States. The research methodology includes a review of published academic work, interviews with the Native American community at select UC campuses (UC Santa Cruz, UC Berkeley, UC Davis, and UC Merced), and ethnographic participant-observation amongst Native American students, faculty, and staff members. Additionally, Native American community events, both campus-based and campus-related, were attended for a first-hand experience of the festivities the event curated. Statistical and secondary data provided by the UC websites and other information sources were also utilized. The results of the research provide information about what is working, what can be improved, and potential solutions to enhance the academic experience of Native Americans in higher education.

Karla Guadalupe Ramirez

University of California, Merced — Management & Business Economics and Political Science

SOAR

Pandemic Politics and the Tradeoff of Unemployment and Mortality: A County Level Study in California

By: Karla G Ramirez

The COVID-19 pandemic has had important yet varied impacts in various counties in California, and certainly the rest of the world. As COVID-19 rapidly spread it spurred political reactions and widely varied policies related to mandated testing and business closures. Political parties converged as being either for mandatory testing and widespread business closures with the intent to halt the spread of the disease, or for much less stringent mandates with the intent to keep the economy healthy. My analysis focuses on key metrics at the county level by month from 2020 through 2023, including COVID-19 testing rates, COVID-19 positivity rates, COVID-19 mortality rates, unemployment rates, and unemployment claim rates. The polarization of politics during the pandemic seemingly created a set of polarized policies, which I study in this analysis. By combining data from local, state, and federal sources, my study aims to evaluate the performance of counties using daily, monthly, and yearly data. My analysis shows significant differences in the patterns of the impact of COVID-19 when separating counties by their dominant political party and the key metrics previously mentioned. My study highlights which counties are better positioned to effectively respond to future pandemics depending upon the voter intentions, providing valuable insights for improving preparedness and resilience, whether that be health or economic.

Kanchana Khat

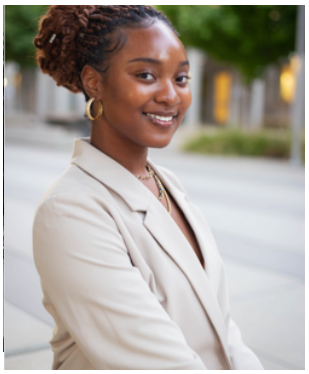
University of California, Merced — Economics with an emphasis in policy and analysis

SOAR

Beyond Wages: Investigating Occupational Segregation and Labor Market Discrimination

By: Kanchana Khat, Crhystian Marquez, Evan S. Lee, Todd Sorensen PhD

Researching the fundamentals of discrimination in the job market helps us better understand injustices in the workplace. We build on Foote, Whatley, and Wright's (2003) work, which highlighted Ford Motor Company's exploitation of labor market inequality by concentrating black workers in unpleasant foundry jobs in the 1920s-1940s. This indicated that wage alone is not a conclusive indicator of labor market discrimination. We expand this analysis to a broader set of jobs across three firms. Our study measures occupational segregation using Stata to examine archived employee records from Ford, A.M. Byers, and Pullman, classifying workers by occupation and measuring the degree of segregation.



Oyinkansola Amao
University of California, Merced — Bioengineering with an emphasis in Biotechnology
SOAR

Using Griffithsin as an Anti-Fungal Agent Against Candida albicans

By: Oyinkansola V. Amao, Zahra Alitaneh, School of Natural Sciences; Patricia J. LiWang, PhD, School of Natural Sciences, University of California Merced

Griffithsin (GRFT), a lectin renowned for its antiviral efficacy against HIV, shows potential as an antifungal agent against Candida albicans. Given the escalating resistance to current antifungal treatments, there is a pressing need for novel therapeutic agents. The primary objectives include purifying wild-type Griffithsin, assessing its inhibitory effects on C. albicans through in vitro assays, and enhancing its antifungal properties by conjugation with a known antifungal peptide. The project aims to determine the minimum inhibitory concentration (MIC) of wild-type Griffithsin, which is the lowest concentration of the drug, analyze the growth patterns of C. albicans, and compare the efficacy of wild-type Griffithsin with its peptide conjugate. Expected outcomes include confirming the antifungal properties of Griffithsin, developing a more potent antifungal agent, and interpreting the mechanisms by which Griffithsin and its conjugates inhibit C. albicans growth. This research endeavors to expand the therapeutic applications of Griffithsin, offering new strategies to combat fungal infections and addressing the critical issue of antifungal resistance. By achieving these goals, the project will significantly contribute to infectious disease research and pave the way for innovative therapeutic interventions.

Melisa Lovos Palacios
University of California, Merced — Psychology & Spanish
SOAR

Recognition of loanwords by native Spanish speakers

By: Melisa Lovos Palacios, Rachel Casper, Zenaida Aguirre- Muñoz, Ph.D.

Spanish has borrowed words from other languages that mostly preserve their native spelling and pronunciation, known as loanwords. Spanish is mainly derived from Latin and indigenous languages, including Nahuatl, which share phonological features. There is conflicting information on how bilingual individuals can process loanwords. Previous findings show that, while loanwords might be easier to learn, bilinguals find them more difficult to use due to the different meanings in each language. Others suggest that bilinguals have a hard time recognizing loanwords altogether. It is argued that bilinguals have one integrated lexicon, where lexical access is not selective to one language. Not many studies have examined whether native Spanish speakers recognize loanwords in their language and if that is influenced by the acquisition of an indigenous language. The present study aims to assess loanword identification within the Mexican population. We examined participants' (n =27) identification accuracy of Nahuatl/ Latin origin words. Behavioral data was collected asking participants whether the word was of indigenous origin or not. Participants completed a questionnaire about their language and socio-economic backgrounds. Results show that participants were more likely than chance to accurately identify words as Nahuatl or Latin origin, but there was no significant difference in accuracy between the stimuli groups. The findings of this study contribute to our understanding of word recognition amongst adults with diverse Spanish/ Nahuatl language experiences.

Jenifer Hernandez Garcia
University of California, Merced — Bioengineering
SOAR

Exogenous Thyroxine increases Cardiac NOX4 and TRX in Insulin Resistant Rats
By: Jenifer Hernandez Garcia, Dora A. Mendez, Rudy M. Ortiz Ph.D.

Impaired redox homeostasis and increased oxidative injury contributes to diabetic cardiomyopathy due to a shift towards fatty acid metabolism over glucose. Thyroid hormones (THs) mitigate oxidative injury and enhance antioxidant defense systems by regulating substrate utilization. However, conflicting data suggests that THs dysregulation may contribute to oxidative stress, indicating the need for further investigation into their effects on redox biology. Therefore, we hypothesized that exogenous thyroxine (exoT4) upregulates the expression of mitofusion 2 (Mfn2), thioredoxin (Trx), and NADPH oxidase 4 (NOX4) in the heart of insulin resistant rats. Insulin resistant, Otsuka Long Evans Tokushima Fatty (OLETF) rats were used to assess the effects of exoT4 on heart. Rats were assigned to four groups: (1) lean, control Long Evans Tokushima Otsuka (LETO; n=6), (2) LETO + T4 (8 µg/100g BM/d × 5 wks; n=7), (3) untreated, insulin resistant OLETF (n=6), and (4) OLETF + T4 (n=7). Our findings demonstrated that exoT4 increased Trx protein expression by 88% in OLTEF compared to untreated OLETF. OLETF group presented a 31% decrease in Trx compared to LETO. Mfn2 protein expression increased by 49% and increased NOX4 by 56% in OLETF compared to LETO. This data suggests that exoT4 has the potential to improve cardiac antioxidant potential and mitochondrial function in insulin resistant OLETF rats.

SURF

The following student fellows are part of UC Merced's Summer Undergraduate Research Fellowship (SURF) Program. SURF is a fellowship that is offered to all undergraduate students in any discipline. This 9-week summer fellowship offers our students the opportunity to work alongside faculty and graduate student mentors and provides graduate school preparation. This program is directly supported by the Division of Undergraduate Education.

For more information, please visit http://uroc.ucmerced.edu/surf

Kanly Thao
University of California, Merced — Cognitive Science & Computer Science and Engineering
SURF SSHA

Evolving Neural Networks for Efficient Resource Pursuit

By: Kanly Thao, Jeffrey Yoshimi, PhD

We study an evolutionary algorithm designed to control an agent in a virtual environment using a neural network. While the study of evolutionary and genetic algorithms is extensive (Mitchell, 1988; Luke, 2016) and there is some study of evolving neural networks (Jones, 1993), there has been relatively little study of evolving neural networks to control agents (exceptions include Cangelosi et al., 1994 and Beer, 1992). One novel feature of this genetic algorithm is that it incorporates genes coding for abstract phenotypes such as the layout of neurons, connectivity patterns, and local learning rules. Using Simbrain (Tosi and Yoshimi, 2016) in conjunction with the local Pinnacles cluster, we developed a model of resource pursuit, in which fitness was defined by their efficiency in finding randomly changing food sources. Optimal agents should be able to develop circuits for finding food sources while minimizing energy expenditure. Our goal was to classify the main strategies evolved pursuers utilize and to assess what kinds of neural circuits they developed. We examined evolutionary simulations in which various genes are manipulated to see how they impact the strategies agents follow. Specifically, we examined the impact of the layout rules, connectivity rules, activation functions, and local learning rules. The resulting findings will be presented in a poster.

Ignacio Gutierrez Ramirez
University of California, Merced — Psychology
SURF SSHA

A Comparative Analysis of Autonomy Granting and Supportive Parenting in Single, Dual Parent, and Stepparent Households

By: Ignacio Gutierrez Ramirez, Elisa Gomez, Emely Covarrubias, MEd Mayra Bamaca, PhD

Over the past 50 years, there has been an increase in varying family structures. For example, single-mother households have increased from 11% in 1968 to 21% in 2020 and there were approximately 3.8 million stepchildren under 18 in 2020 (U.S. Census Bureau, n.d.). Parental support may help reduce problem behaviors while autonomy granting may help satisfy an adolescent's need for autonomy, and promote the development of intrinsic motivation, relatedness, and competence (Neubauer, 2021; Savell et al, 2023). Therefore, it is necessary to understand the impact of family structure on parenting as it is thought that fewer emotional resources may be used on an adolescent in single-parent and stepparent households, (Waldfogel et al, 2010). The current study examines the differences between autonomy-granting and supportive parenting between single-parent, stepparent, and dual-parent households in a sample of 7th-grade and 10th-grade Latinx girls (n=338). Parental support was measured using the Inventory of Parent and Peer Attachment (Armsden & Greenberg, 1987). Autonomy granting was assessed by the Behavioral Autonomy Scale (Peterson, Bush, & Supple, 1999). The results indicate no significant differences between single-parent, stepparent, and dual-parent households concerning supportive parenting and autonomy granting. This may be explained by the fact that contextual factors may matter more than family structure (Murry & Lippold, 2018). Consistency in these two parenting practices across family composition may inform future intervention strategies.

Haley G. Branley
University of California, Merced — Psychology
SURF SSHA

Parent-Child Talk Regarding Social Emotions: An Analysis of Parent Emotion Label Usage
By: Haley G. Branley, Manasa Ganesh Kumar, Eric A. Walle PhD

Parent-child conversations about emotions play an integral role in children's emotional development. Previous literature has examined how parents talk to their children about emotions such as joy, sadness, anger, disgust and fear, when these emotions are displayed in non-social situations. The current investigation aimed to extend previous work through exploration of parent-child talk regarding social emotions; Emotions exhibited within specific social contexts involving relationships in one's social environment. Our study recruited 7-year-old children (N = 43, female = 20) and their parents and asked them to talk to each other about 5 images representing Schadenfreude, Jealousy, Empathy, Pride and Envy. Parent-child conversations were then transcribed and coded (using MAXQDA). Our research questions were twofold: (1) Whether the frequency of parents' usage of emotion labels (examples: sad, happy, mad, jealous, etc.) varied depending on valence of emotion context (positive versus negative) and (2) Whether the frequency of parents' usage of social (examples: jealous, envious, schadenfreude, empathy, sympathy, love, pride, etc.) and nonsocial (examples: happy, sad, mad, angry, disgusted, etc.) emotion labels differed across the discrete emotion conditions. Our work has implications for the everyday lives of humans. Since human interactions are predominantly social, and that emotions are often expressed in social, multi-person plots (rather than in non-social situations), the current work will add to the ecological validity of literature investigating parents' communication and socialization of emotions.

Jessica Pedroza
University of California, Merced — Psychology
SURF SSHA

Supportive Parenting, Autonomy Granting, and Self-Esteem in Latina Adolescents
By: Jessica Pedroza, Mayra Y. Bamaca PhD,

Symbolic interactionists' theory emphasizes the importance of parental warmth on youth's self-esteem because youth have an innate need to form emotional bonds with attachment figures (Quintana et al., 2023). Additionally, societal norms may make women feel inferior (Rosenberg & Simmons, 1975) however, support from family may enhance self-esteem. For example, Bamaca-Colbert et al. (2015) found that females in a supportive family reported higher self-esteem. Moreover, Brenning et al. (2015) found that parental autonomy was associated with self-esteem. Given previous research, the present study examines the link between supportive parenting and parent autonomy granting to Latina adolescents' self-esteem. Data was collected Spring 2007 on 7th (n=170) and 10th (n=171) graders in a large Southwestern, metropolitan area in the U.S. Results showed that supportive parenting and autonomy granting were positively associated with 7th graders self-esteem. Similar results were found for 10 graders; however, there was no association between mother's autonomy granting and self-esteem. Like previous research, supporting parenting and autonomy granting are important to understand because it may influence development and prevent psychological distress (Bámaca-Colbert et al., 2011). Furthermore, when females have more freedom and acknowledgement on their own decisions making, they have more confidence (Sher-Censor et al., 2011). Future research should consider investigating different parenting practices contrary to the positive effect supportive parenting has on adolescent self-esteem such as psychological control.

Viniccius Touma
University of California, Merced — Cognitive Science
SURF SSHA

Exploring Theory of Mind in Large Language Models

By: Christopher Kello PhD, Rachel Ryskin PhD, Viniccius Pailo, Vanshika Rathi

As Artificial Intelligence (AI) continues to be implemented further into the operations of our society, it becomes increasingly important to define the limits of AI and how similar its capabilities are to human cognition. A benchmark for testing human cognitive development is used in this study to verify whether AI is capable of comprehending Theory of Mind (ToM)- the ability to attribute mental states to oneself and others. By tasking Chat GPT with describing images of notable landmarks to two hypothetical users with novice or expert-level knowledge of the subjects, we can extrapolate from the differences in the AI's responses how Chat GPT comprehends the difference in expertise between the two users. Results show that Chat GPT does, in fact, produce differences between responses, demonstrating that it understands the differing mental states of the users. Chat GPT is a powerful AI tool that is capable of seemingly human-like levels of understanding and intelligence and seemingly is able to understand the concept of other entity's conscious states and alter its behavior to better respond to an individual's knowledge and mentality.

Yamini Sirobushanam
University of California, Merced — Economics: Economic Policy and Analysis
SURF SSHA

Birth Equity: Evaluating the Effect of Various Insurance Systems on Maternal and Neonatal Health

By: Yamini Sirobushanam

Varying economic factors play a large role in inequity in all sorts of ways. This research investigates the influence of diverse insurance systems on birthing equity and outcomes in the United States. The study examines how varying types of health insurance – public, private, and uninsured status – affect maternal outcomes amongst different demographic groups. Utilizing a mixed-methods approach, the research combines quantitative data from state health records and insurance claims with qualitative insights from healthcare documents. The research hypothesizes that there is a correlation between the type of insurance an individual has and resulting maternal mortality rates and neonatal birth weights. The results demonstrate a statistically significant relationship between insurance types and health outcomes along with fixed variables including income, race, age and marital status. Using a difference-in-differences method, the analysis reveals how shifts in insurance coverage, particularly during economic downturns such as the Great Recession, impact maternal and neonatal health. These findings highlight the critical role of health insurance in mitigating disparities in birth outcomes and underscore the importance of policy interventions to promote equitable healthcare access for all demographic groups.

Estrella Zaragoza
University of California, Merced — Psychology
SURF SSHA

"My Parents Wanted Me To, So They Made Me": The Impact of Familial and Financial Pressures on the Sense of Belonging Among First-Generation University Students

By: Estrella R. Zaragoza, Lindsay K. Crawford, PhD

This study aimed to identify factors that influence the sense of belonging (SB) among underrepresented university students in California's Central Valley. Previous research has shown that a higher sense of belonging positively correlates with academic performance and overall well-being. We aimed to identify strategies universities can take to enhance SB, with a particular focus on first generation students. We interviewed a representative sample of 20 students, who were an average age of 20 years old, from a Hispanic-Serving institute in rural California. The semi-structured interviews sought to reveal factors that strengthen or weaken a SB on campus. Interviews were transcribed and coded for themes using Atlas.ti. The results demonstrated that family, academic, and financial pressure greatly influenced students' SB. 12 of the 20 participants were first-generation college students, which prompted a deep sense of pride but also sizable pressure from their families. Conversely, students acknowledged the campus's resources for the abundant 'first-gen' community. Half of the students worked a part-time job while the other half were looking for work, adding to their academic burden. These pressures often brought feelings of isolation and stress within the students. With these results, we strive to inform more pipeline programs that support first generation college students and enhance their SB.

Brandon Castaneda
University of California, Merced — Management and Business Economics
SURF SSHA

Economic Growth and Immigration: A county-level study in the U.S.

By: Brandon Castaneda

My analysis of immigration's economic impact in the United States cuts through the noise to examine its effects on counties. Employing quantitative research methods, I analyzed various economic indicators such as employment rates, income levels, and GDP growth rates to explore the enduring correlations between immigration levels and economic performance at the county level. By considering both immediate and delayed effects and exploring regional variation, I offer a comprehensive understanding of the economic contributions made by immigrant communities. My analysis reveals how immigration influences economic growth and labor market participation. My findings contribute to the ongoing discourse on immigration policy by providing evidence of immigrants' role in driving economic development and prosperity in U.S. counties and offer valuable insights to policymakers, economists, and stakeholders about immigrants' critical role in local economies.

Ellen Escamilla
University of California, Merced — Management and Business Economics, Political Science
SURF SSHA

Effects of Missionary Proselytization on Literacy Rates in South India

By: Ellen Escamilla, Hasslyn Sanabria, Omar D. Ferreyra, Anil R. Menon, PhD
School of Social Sciences, Humanities, and Arts, University of California, Merced

Today in South India there is a great disparity in literacy rates between genders, castes, and religious groups across different states. What caused this disparity? We argue that the disparity stemmed from differences in British colonial rule, the British directly controlled some governments, while others were ruled by their native government, but indirectly by the British. The indirect rule of states allowed Missionaries to freely spread Christianity through any means possible; we hypothesize these actions by Missionaries expedited the development of literacy rates in indirectly ruled states. To examine this, we analyzed census data, scholarly readings, and historical administrative reports in Travancore, an indirectly ruled, princely state, and Madras, a directly ruled state. We find that the presence of Missionaries in Travancore caused the government to implement policies that improved and modernized the educational system. Actions of Missionaries caused conflicting ideals among Hindus, creating educational institutions with goals of proselytization. However, this threatened one of the core values and foundations of Travancore, Hinduism. In contrast, Madras aimed to modernize their educational system, but received backlash due to the poor relationship between the British and native residents. As a result, access to education was limited, causing lower literacy rates. This highlights the significance of religion and differences in British colonial rule that can impact a state's development today.

Omar Duenaz Ferreyra
University of California, Merced — Management and Business Economics
SURF SSHA

Effects of Missionary Proselytization on Literacy Rates in South India

By: Ellen Escamilla, Hasslyn Sanabria, Omar D. Ferreyra, Anil R. Menon, PhD
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Crhsytian Marquez
University of California, Merced — Management and Business Economics / Sociology
SURF SSHA

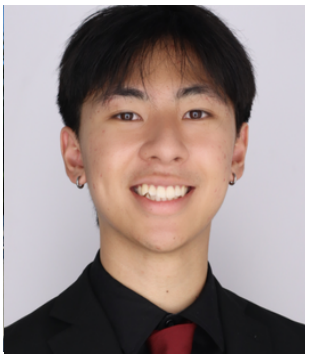
Beyond Wages: Investigating Occupational Segregation and Labor Market Discrimination
By: Crhystian Marquez, Evan Lee, Kanchana Khat, Todd Sorensen PhD School of Social Sciences, Humanities and Arts, University of California Merced

Researching the fundamentals of discrimination in the job market helps us better understand injustices in the workplace. We build on Foote, Whatley, and Wright's (2003) work, which highlighted Ford Motor Company's exploitation of labor market inequality by concentrating black workers in unpleasant foundry jobs in the 1920s-1940s. This indicated that wage alone is not a conclusive indicator of labor market discrimination. We expand this analysis to a broader set of jobs across three firms. Our study measures occupational segregation using Stata to examine archived employee records from Ford, A.M. Byers, and Pullman, classifying workers by occupation and measuring the degree of segregation.

Edgar Moya
University of California, Merced — Computer Science and Engineering
SURF SSHA

Exploring Sense of Belonging: Factors Influencing Well-being of Underrepresented Students in California's Central Valley
By: Edgar S. Moya, Lindsay K. Crawford, PhD, School of Social Science, University of California, Merced

The transition to college significantly impacts the well-being of marginalized students. Sense of belonging (SB), an essential aspect of well-being, encompasses feelings of embracement, respect, and support within a community. This study aims to explore the factors influencing SB among underrepresented students in California's Central Valley. Twenty students from UC Merced participated in Zoom interviews to investigate this topic. The findings revealed that students often perceive themselves as excluded from their community, citing their personal background, identity, and past experiences as contributing factors. Moreover, students reported feeling anxious, fearful, and lacking confidence when accessing campus resources. Based on these results, our goal is to identify strategies to enhance SB and increase students' confidence in utilizing available resources.



Evan Lee
University of California, Merced — Management and Business Economics
SURF SSHA

Beyond Wages: Investigating Occupational Segregation and Labor Market Discrimination
By: Evan Lee, Crhystian Marquez, Kanchana Khat, Todd Sorensen PhD, School of Social Sciences & Humanities, University of California, Merced

Researching the fundamentals of discrimination in the job market helps us better understand injustices in the workplace. We build on Foote, Whatley, and Wright's (2003) work, which highlighted Ford Motor Company's exploitation of labor market inequality by concentrating black workers in unpleasant foundry jobs in the 1920s-1940s. This indicated that wage alone is not a conclusive indicator of labor market discrimination. We expand this analysis to a broader set of jobs across three firms. Our study measures occupational segregation using Stata to examine archived employee records from Ford, A.M. Byers, and Pullman, classifying workers by occupation and measuring the degree of segregation.

Alex Ragde
University of California, Merced — Psychology
SURF SSHA

Bilingualism and Statistical Learning: A Secondary Analysis
By: Alex M. Ragde, Heather Bortfeld, PhD, Cerena Lee PhD Candidate

There is limited research on how bilingualism impacts statistical learning (SL) (Bulgarelli, 2018), particularly in underrepresented groups. Traditional assessment methods inadequately capture the full range of proficiency in bilingual populations (Backer & Bortfeld, 2021). Lee et al. (2024) assessed 216 heritage Spanish speakers in the US using a standard novel word learning task and the Bilingual Language Profile (BLP) (Birdsong et al., 2012), which assesses language dominance. They found that more English-dominant participants outperformed the balanced-dominance participants in learning novel words when there was no prior-known word embedded in the training stream; however, when a prior-known word was embedded, performance of balanced-dominant participants improved, matching that of English-dominant participants. The basis for this effect is unclear. Because BLP score alone does not account for all aspects of language use (i.e., language switching), I analyzed performance in the same task when participants completed both the BLP and the Bilingual Switching Questionnaire (BSWQ) (Rodríguez-Fornells et al., 2012). If switching between two languages more often is associated with better auditory attentional control (Bialystok, 2017), then high-switch bilinguals should outperform low-switch bilinguals when there is inclusion of a known word. Understanding the influence of language use on individual differences is critical in a diverse society. Our focus on auditory attention stands to inform clinicians and educators alike.

Brandon Castillo Flores
University of California, Merced — Psychology
SURF SSHA

Cannabis-related Health Risk Perceptions among Mexican American Young Adult Users
By: Brandon Castillo Flores, Selina Espinoza, M.A., Luis Solorio, B.A., Mary Garcia, B.A., & Anna E. Epperson, Ph.D.

Cannabis is the most commonly used substance the U.S., with young adults reporting the highest use. Racial/ethnic minority groups may be more at risk for use and misperceptions about the health risks of cannabis. As part of the largest and fastest-growing racial/ethnic minority group in the U.S., Latinx young adults have had cannabis use rates double over the last decade. However, less research has focused this important community's perceptions of health risk about cannabis use. The current study examined the relationship between social (having an immigrant parent, socioeconomic status) and cultural (ethnic identity) factors on cannabis health risk perceptions among Latinx young adults (ages 19-26 years old; n=397) identifying as Mexican American. Participants were recruited from two sources: 1) an online research platform, and 2) a university research pool. Young adult participants were asked questions about their demographics (age, gender identity, family socioeconomic status, primary language spoken at home), whether they had an immigrant parent, how much they identified with their Mexican ethnicity, and about health risk (self and others) and addiction of cannabis. Regression analyses indicated that perceptions of health risk and addictiveness of cannabis were not associated with having an immigrant parent or ethnic identification. More research is needed to further determine which factors impact perceptions of health risk and use of cannabis use among Mexican American young adults.

Leonardo Salgado
University of California, Merced — Public Health
SURF SSHA

Comparing Health Insurance Rates in the Central Valley to the Rest of California
By: Leonardo Salgado, Advisor: Alexandra Rivera-González, PhD, MPH "

The Central Valley, which is home to a large number of immigrants in California, faces several disparities involving health insurance coverage. Evidence from regional health reports suggests that statewide improvements through initiatives such as the Affordable Care Act and Medi-Cal eligibility expansions to all residents regardless of documentation status have provided some sense of relief. This study hypothesizes that, despite these policy shifts, the Central Valley likely has lower rates of health insurance coverage among immigrants compared to other counties in California due to its unique socioeconomic and environmental challenges. To measure this, annual data from the Census will be exported from data.census.gov for the 2022 California population (n= 38,548,670). Tables will be merged and cleaned in Microsoft Excel to create descriptive summaries for health insurance by county and plot trends by year using graphs. We expect to find that the Central Valley has consistently lower rates of health insurance coverage compared to other counties in California, particularly those in more urban and affluent regions. These results help highlight the importance of tailored policy interventions and resource allocation to address the unique health insurance coverage challenges faced by immigrants in the Central Valley. Furthermore, the findings underscore the necessity of ongoing support and monitoring to ensure that statewide health initiatives are effectively reaching and benefiting all communities, particularly those that are most vulnerable and underserved. Additionally, it can help investigate the long-term impacts of health initiatives throughout different counties in California or statewide.

Melanie Lemus
University of California, Merced — Cognitive Science
SURF SSHA

Human milk and its implication on child development and helath

By: Melanie Lemus, Jennifer Hahn-Holbrook, Kavya Swaminathan

The circadian variation in human milk cortisol plays a significant role in an infant's development by influencing various physiological processes and behaviors. Healthy circadian rhythms establish regular sleep patterns, optimal digestion, and proper neurocognitive function. The LATCH Lab aims to understand the circadian variation of cortisol in milk as it changes throughout the day and its implications on infant health. To understand how maternal and environmental factors influence the natural circadian rhythms in milk cortisol, we investigate factors such as light exposure, sleep disturbance, and daily stress. We recruit breastfeeding mothers and infants less than 5 months old. Participants are given the same instructions of collecting 1 ml of milk sample 8x a day and 1 ml of infant saliva samples 5x a day for one week, participants wear a watch that measures sleep and light exposure at all times, and complete two mood surveys daily. By understanding how maternal and environmental factors influence the circadian variation in human milk cortisol, we can create a clear concept on how human milk may serve as "chrononutrition" for infants, impacting their sleep-wake cycles.

Sakina A. Abedi
University of California, Merced — Molecular and Cell Biological Sciences
SURF STEM

The Effect of Physiological and Psychological Stress on Milk Transfer in Humans
By: Sakina A. Abedi, Jasmine Dias Joaquin, Jennifer Hahn-Holbrook PhD., Department of Psychology, University of California, Merced

This scientific literature review looks at how stress affects breastfeeding in new mothers, focusing on a hormone called cortisol. Cortisol is produced when we're stressed and plays a complex role in milk production. Short-term increases in cortisol can boost milk production. However, long-term high cortisol levels, often linked to prolonged stress or depression, can negatively impact breastfeeding success and milk supply. The review found that high cortisol during pregnancy and childbirth can delay when a mother's milk comes in and reduce early milk volumes. Mothers experiencing depression around birth, which is associated with higher cortisol, generally have more difficulty breastfeeding. Interestingly, breastfeeding itself appears to lower cortisol levels in mothers. This creates a positive cycle: breastfeeding reduces stress, which can then support continued milk production. The relationship between cortisol and breastfeeding goes both ways. While some cortisol is necessary to start milk production, too much due to stress can hinder effective breastfeeding. This is further complicated by a mother's mental state, as psychological distress can disrupt hormones and impair milk release. The review concludes by suggesting that stress management and mental health support could help counteract cortisol's negative effects on breastfeeding. It emphasizes the need for more research to better understand how cortisol and breastfeeding are linked, highlighting the importance of supporting new mothers in multiple ways.

Isabel Delgado
University of California, Merced — Mechanical Engineering
SURF STEM

Acoustic behavior of the adult soybean weevil, Rhyssomatus nigerrimus (Coleoptera: Curculionidae)
By : Isabel Delgado, Andrea Joyce, PhD, Guillermo Lopez-Guillen, PhD, Engineering and Public Health, University of California, Merced

The soybean weevil, Rhyssomatus nigerrimus (Fahraeus) (Coleoptera: Curculionidae), is an economically important pest of soybean in Mexico. This insect is generally controlled using insecticides, which can have collateral effects on health, the environment, and non-target organisms. Therefore, alternative monitoring and control methods, such as acoustic traps, are needed. The airborne sound and substrate vibration signals produced by insects play vital roles in pair formation and species recognition. These acoustic signals produced by insects can potentially be used in acoustic traps or pheromone-baited traps to improve captures. This study investigated the acoustic signals produced by groups of male and female R. nigerrimus. Adult males and females were collected in the field during the month of October 2023, while weevils were aggregating on soybean plants. The weevils were separated by sex and kept in plastic jars with food in the laboratory. The airborne stridulations of groups of 10, 5, and 3 adults of males and females were recorded using a microphone. Adobe Audition software was used to visualize and measure acoustic parameters. Groups of males produced two characteristic sounds, which were pairs of chirps, or long pulse trains. Female groups similarly produced paired chirps and pulse trains. The chirp and pulse durations and frequency were measured and compared between males and females, and among the different group sizes. The morphological structures on the abdomen associated with sound production were also investigated and are described. The results will be discussed in the context of pest management.

Nathalia Gaytan
University of California, Merced — Biology with an Emphasis in Microbiology and Immunology
SURF STEM

The Role of Enhancer-like Transcriptional Regulatory Complexes in Controlling White-Opaque Phenotypic Switching in Candida albicans

By: Nathalia Gaytan, Namkha Nguyen, Aaron Hernday

The opportunistic human pathogen Candida albicans has evolved the ability to epigenetically switch between two cell types, named 'white' and 'opaque', that aid in adaptation to distinct host niches. This cell-fate decision-making is controlled by transcriptional regulatory networks in which transcription factors (TFs) can assemble into condensates that resemble super-enhancers that regulate mammalian cell identity. Super-enhancer-like complexes have been found upstream of many key regulatory targets in opaque cells, suggesting that cell-type-specific enhancers may play a critical role in the establishment and maintenance of the opaque state. However, the functional significance of these opaque-specific enhancers has yet to be tested. One such enhancer, which forms upstream of a gene named ORF19.6805, is believed to be necessary for the opaque-specific expression pattern of ORF19.6805. We aim to elucidate this relationship by using CRISPR-mediated genome editing to disrupt the enhancer element upstream of ORF19.6805. We will replace the ORF19.6805 open reading frame with the fluorescent reporter protein, mNeonGreen, we will then use fluorescence flow cytometry to evaluate how these enhancer perturbations impact mNeonGreen expression and therefore, the opaque-specific expression of ORF19.6805. If the TF condensate is indeed critical for ORF19.6805 expression, then we expect to see decreased mNeonGreen fluorescence in strains without the super-enhancer-like region compared to wild-type.

Luis Onofre
University of California, Merced — Materials Sciences and Engineering
SURF STEM

Polymerization of Novel Impact Adaptive Conducting Polymers

By: Luis Onofre, Di Wu, Yue Wang

Conductive polymers (CPs) possess various advantages such as good conductivity and light weight. However, CPs are vulnerable to rapid deformation due to intrinsic viscoelasticity. This behavior severely restricts the applications of CPs specially in wearable electronics. Our lab has developed a novel poly(2-acrylamido-2-methyl-1-propanesulfonic acid) (PAMPSA):polyaniline (PANI) and PEDOT (Poly (3,4-ethylenedioxythiophene):PSS (poly (styrene sulfonic acid)) hybrid that shows deformation rate adaptive behavior which allows higher toughness, strength, and elongation at break for the CP under fast stretching, which is the opposite to the intrinsic behavior of conventional CPs. This study aims to explore the underly mechanism of adaptive behavior by focusing on the molecular weight effect on the mechanical response of PAMPSA under different strain rates. PAMPSA with different molecular weights are synthesized via free radical polymerization. The molecular weights are determined by rheology. The tensile behavior of solution-casted PAMPSA films is investigated using Instron under different strain rates. The relation between tensile properties and molecular weight of PAMPSA will be discussed.

Emmanuel Rabago Moreno
University of California, Merced — Physics and Mechanical Engineering
SURF STEM

Combining JWST and Keck OSIRIS to Improve Strong Lensing Dark Matter Measurements

By : Emmanuel Rabago Moreno, Anna M Nierenberg, PhD, Ryan Keeley, PhD

The dark matter model determines the abundance of substructure on sub-galactic scales. Strong lensing provides a way to test the properties of dark matter by probing dark matter structure at these scales. Flux ratios in quasar images denote the varying brightness levels among multiple images created by strong gravitational lensing. Traditionally studies have used the image fluxes of either the narrow-line region measured with Keck OSIRIS, or of the warm dust region measured with JWST. Here we present a new method of measuring the properties of dark matter using simultaneous flux ratio measurements from both sources for the same lens. The framework uses simultaneous flux ratios from these two sources, to measure the shape and amplitude of the halo mass function, including line-of-sight (LOS) haloes and main deflector subhaloes. We show that combining the constraints yields an improved constraint on the properties of dark matter.

Joseph Kelleher
University of California, Merced — Chemistry
SURF STEM

The Effect of Molecular Dynamics Thermostat on Simulated Ensemble Absorption Spectra: Cresyl Violet in Methanol

By : Joseph Kelleher, Arthur Pyuskulyan, Christine Isborn

In order to produce accurate simulations of absorption spectra for molecules in solution there is a need for accurate sampling of chromophore-solvent configurations; these can be generated from molecular dynamics trajectories. A key factor in controlling the sampled chromophore solvent configurations is the temperature of the trajectory. The temperature is controlled by the model of the thermostats. Three common varieties of thermostat are Berendsen, Langevin, and Nose Hoover. Nose Hoover is regarded as being more accurate in the reproduction of ensemble results, Langevin is often used where solvent interactions are of key importance, and Berendsen is typically used for quick equilibration. In a prior study performed in the Isborn group, a molecular dynamics trajectory using the Berendsen thermostat resulted in a simulated absorption spectrum for the cresyl violet chromophore in a methanol solution that was too narrow when compared to experimental results. We then hypothesized that a potential cause of the narrow spectrum was due in part to the poor description of the chromophore's temperature when using the Berendsen thermostat. In this study, we tested Nose Hoover, Berendsen, and Langevin thermostats when applied to the molecular dynamics trajectories of solvated cresyl violet. We here analyze the chromophore temperature, dynamics of hydrogen bonds, and simulated absorption spectrum.

Roberto Marin Hernandez
University of California, Merced — Computer Science & Engineering
SURF STEM

Battery Management System For The Characterization Of Rechargeable Lithium-Ion Batteries For The Battery Workforce Challenge

By: Roberto Marin Hernandez, Justin Arroyo, Ricardo Pinto de Castro, PhD

Electric vehicles are a promising technology to reduce greenhouse gas emission and address climate change. For all the benefits that this technology has, Lithium batteries still have a lot of room for improvement in terms of efficiency, capacity, and degradation. To address these issues, a battery management system (BMS) is vital for monitoring voltage, temperature, and current to prevent damage to the battery. We use Simulink and MATLAB to simulate the sensing circuit. Then we use a Digital to Analog Converter (DAC) to convert the digital Simulink code into an analog signal that the circuit can work with. Next, we measure voltage, current, ambient temperature, and battery surface temperature to calibrate the BMS. We perform two kinds of tests on the battery cell. The first is the static capacity test. We discharge the battery at different currents; either at 4.9 Amps or 0.98 Amps at a constant rate until the battery reaches 2.4 Volts. The second is the Hybrid Power Pulse Power Characterization (HPPC) test. This test discharges for some time, recharges for some time, rests, and then repeats. These tests are performed at 0, 10, and 30 degrees Celsius. As the future heads further towards electric vehicles, it is imperative that future generations have an understanding and training in this field.

Pamela Aguilar
University of California, Merced — Human Biology
SURF STEM

Physician Availability and Social Vulnerability to Disasters in Puerto Rico using the US Census Bureau Community Resilience Estimates (CRE)

By : Pamela Aguilar, Alexandra Rivera-González, PhD, MPH, Department of Public Health, School of Social Sciences, Humanities, and Arts, University of California, Merced

Puerto Rico, a U.S. territory susceptible to natural disasters, has been in a crisis due to hurricanes, infectious disease outbreaks, a prolonged economic recession, and more. The situation has contributed to severe shortages of medical professionals, worsening health conditions on the island, and leading to socioeconomic instability. A new measure created by the US Census Bureau, the Community Resilience Estimates (CRE), captures social vulnerability to disasters throughout Puerto Rico. This study aimed to explore how the availability of physicians is associated with this CRE measure by county. We conducted different data analyses using R, including descriptive statistics and simple linear regressions, to reveal if there was a significant correlation between physician availability and community resilience in Puerto Rico. Our results showed that municipal areas of Puerto Rico with fewer physicians exhibited lower levels of resilience, which could worsen the impact of disasters. The findings of this study underscore the crucial role of physician availability since medical professionals are essential for improving health outcomes and enhancing the resilience of the island to respond to natural disasters. To protect the well-being of its residents and mitigate the impacts of future crises, the Puerto Rico health system should prioritize improving physician availability, especially among municipalities with more socially vulnerable populations.

Gagandeep Kaur
University of California, Merced — Human Biology & Psychology
SURF STEM

Unexpected Sexual Dimorphism in Thirsty Water Seeking through Peptidergic Signaling in Drosophila melanogaster

By: Gagandeep Kaur, Brian P. Wang, Fred W. Wolf, PhD

Thirst is a highly motivated state that drives a sequence of behaviors to ensure proper balance of water to meet the body's needs. We quantify water intake, water seeking, and feeding behavior to assess thirst levels and discover the thirst circuitry in fruit flies. We primarily assess water seeking behavior to reveal the fly's motivation to find water, reflecting the want for water. Both sexes need water and express the same thirst-related behaviors for water homeostasis. However, we discovered AstAergic (Allatostatin A; homologous to kisspeptin/spexin/galanin) thirst neurons called Janu-AstA in fruit flies that promote water seeking in males only. Janu-AstA also inhibit feeding behavior and encode for reward suggesting Janu-AstA encode for the rewarding anticipation of water when thirsty. We expanded the sexually dimorphic water seeking circuit by discovering male-specific NPF (Neuropeptide F; homologous to NPY) neurons, the NPF-Ms, are downstream of Janu-AstA. NPF-Ms inhibit water seeking and courtship behavior in males. My research aims to test the involvement of NPF-Ms in water intake and feeding behavior to uncover the complete role of the sexually dimorphic NPF-Ms in the thirst circuitry. Since NPF-Ms are downstream of Janu-AstA, we hypothesize NPF-Ms inhibit feeding behavior without affecting water intake behavior like Janu-AstA. Our findings lay the foundation of sexual dimorphism in thirst that allows us to further test the circuitry underlying differences in motivational states between males and females.

Ashley Gonzalez Perez
University of California, Merced — Computer Science & Engineering
SURF STEM

Exploring the Functionality and UI/UX requirements for data visualization for drone detection systems using Remote ID

By: Ashley Gonzalez Perez, Brandon Stark PhD

Remote ID holds significant importance in airspace and local authority security. The FAA has mandated that all small unmanned aircraft systems (sUAS) require remote ID to ensure all sUAS operations follow regulatory standards and hold sUAS pilots accountable in case of accidents. To address this requirement, this research will examine the functional requirements and UI/UX design of a drone detection system capable of receiving remote ID identifiers from sUASs. A prototype system will be implemented using a DroneScout 230 for broad evaluation of different UI/UX implementations to support reserve management security needs. We will deploy the prototype system over the Merced Vernal Pools and Grassland Reserves as a testbed.

Ben Dong
University of California, Merced — Computer Science and Engineering
SURF STEM

Profiling Post-quantum Crypto Algorithms for QUIC Protocol on Embedded System
By: Ben Dong, Dr. Qian Wang, PhD, Department of Electrical Engineering and Computer Science, School of Engineering

Abstract: Advances in quantum computing present a significant threat to cryptographic algorithms and in response, the National Institute of Standards and Technology (NIST) has recently finalized the selection of post-quantum cryptographic (PQC) algorithms for standardization. While there have been some studies of integrating PQC into the TLS protocol for key establishment and signature generation, limited research exists on profiling these newly standardized algorithms in resource-constrained embedded systems for IoT usage. In this work, we first integrate NIST's recently standardized PQC algorithms into both TLS servers and clients built upon embedded systems. e.g., Raspberry Pi system with Arm Cortex-A72 64-bit SoC). Our experimental results show the performance comparison of PQC algorithms with the currently used schemes, demonstrating a 3.12x to 7.18x performance boost for key generation compared to the traditional algorithm (ECDH) for Key Encapsulation Mechanism (KEM) algorithms and 2.8% to 128% of the performance of the traditional signature algorithm (RSA2048) while using PQC signature algorithms. Additionally, we evaluate the PQC-TLS performance on the embedded SOC and reveal that the handshake latency ranges (5-90%) compared to the non-PQC schemes. Furthermore, we are the first to evaluate the PQC-enabled QUIC protocol on an embedded system, aiming to optimize the performance overhead by leveraging QUIC's quick connection establishment trait as a UDP-only protocol.

Mark Julian
University of California, Merced — Civil Engineering
SURF STEM

Assessing stakeholder perspectives and their influence on the success or failure of carbon dioxide removal projects in the San Joaquin Valley
By: Mark I. Julian, Samuel A. Markolf, PhD, Caspar L. Donnison, PhD, Minerva Uribe-Robles, PhD

As the San Joaquin Valley looks to address extreme heat and other climate change impacts, carbon dioxide removal (CDR) technologies have been proposed to combat this issue. CDR projects work to remove carbon dioxide from the air and transfer it into a form of durable storage, some also generating cleaner forms of energy, these projects often face public opposition from local communities. Through a literature review of digital newspaper articles and other news media, and by using a discourse analysis framework we explored narratives and the way information has been communicated to the public which may influence public opinion. A discourse analysis focuses on the tone and language used within an article and its overall message, categorizing coalition, frame, actors, storyline, and the language used. Furthermore, we conduct a statewide search for CDR projects in California using online resources, focusing on specific CDR technologies. Then we spatially analyze these projects across the state map using ArcGIS. Early results indicate that the success of a CDR project depends on support or opposition from the local community, and is affected by the community's understanding of the project. Efforts must be taken to inform the local population and engage with their concerns about emerging technologies to help determine the best role for CDR in their community.

Evelin Guardado Barron

University of California, Merced — Biological Sciences, Human Biology

SURF STEM

Audiovisual Speech Perception in Heritage Spanish Speakers

By: Evelin Guardado Barron, Kristina C. Backer, PhD

Audiovisual speech perception involves integrating auditory and visual cues during speech comprehension. When visual and auditory information diverge, individuals often report hearing the visually-conveyed phoneme—a phenomenon known as the visual dominance illusion. Despite being a significant portion of the US population, Heritage Spanish speakers (i.e., individuals who learned Spanish at home although English is the primary language in the region) have received minimal attention in the realm of audiovisual speech perception. To address this gap, we propose a two-part experiment. Participants will be presented with /ba/ or /va/ audiovisual stimuli at varying degrees of blurriness; while the phoneme /b/ is shared across Spanish and English, the /v/ phoneme is English-specific. These stimuli will be either congruent (e.g. auditory /ba/ + visual /ba/) or incongruently paired (e.g. auditory /ba/ + visual /va/). Participants will report what they heard to determine the presence of the visual dominance illusion at varying levels of visual blurriness. Subsequently, we shall assess each participant's English and Spanish proficiency to account for the wide variation in Spanish proficiency. We propose an inverse relationship between English language dominance and reliance on visual context: as English dominance decreases, individuals should become more tolerant of blurriness whilst still experiencing the visual dominance illusion, particularly for visual /ba/ + auditory /va/ pairings. The results of this study will provide insight into how one's language experience as a Heritage Spanish speaker may modulate audiovisual speech perception.

TUSCEB

The goal of the UC Merced COMPASS: Training Undergraduates in Stem Cell Engineering and Biology (TUSCEB) program is to provide training to UC Merced students in stem cells, regenerative medicine, and related areas in biotechnology to provide them with the knowledge, skills and abilities needed to support the industry's hiring needs for the growing field. The training program is a collaboration across the Schools of Natural Science and School of Engineering targeted to serve undergraduate majors in Biological Sciences and Engineering. The core of the pilot program focuses on inquiry and research-based activities that are scaffolded through three academic semesters and two summer sessions. Along with the core classes and a Capstone project, students participate in undergraduate research, external industry internship, professional development, one-on-one faculty, peer, and industry mentoring, patient and healthcare engagement activities, and community outreach.

The training program launched October 2022 and funded from CIRM'S program on Creating Opportunities through Mentorship and Partnership Across Stem Cell Science (COMPASS).

For more information, please visit https://tusceb.com/

Does pesticide exposure lead to bone marrow failure in mice?

By: Megha Sanghu, Jennifer O. Manilay, Ph.D

Megha Sanghu

University of California, Merced — Bachelors of Science, Human Biology & Bachelors of Arts, Psychology

TUSCEB

Bone marrow failure (BMF) is a critical condition where damaged blood cells cannot regenerate, resulting in reduced production of white and red blood cell production, essential for immune defense properties and oxygen transport to the body. In the Central Valley of California, extensive use of pesticides in agriculture and domestic practices has raised serious concern regarding the potential role of BMF. Evidence in the literature suggests a link between chemical exposure from a pesticide now banned in California, chlorpyrifos, and BMF, with chlorpyrifos causing defects in bone stromal cells and altering immune cell populations characteristic of BMF diseases. Our current study aims to broaden animal models to two other pesticides, abamectin and pyraclostrobin. Eight-week-old C57BL/6 mice were exposed to pesticides via intraperitoneal injections over 14 days. Multiparameter flow cytometry was employed to assess changes in hematopoietic stem cells/progenitor cells, mature blood cell levels, and anemia was evaluated using complete blood counts. Thin bone sections were prepared for histological examination to observe changes in the bone marrow niche. Our flow cytometry results showed that long-term hematopoietic stem cells were significantly reduced in pyraclostrobin-treated mice compared to vehicle-only controls. Analysis of abamectin-treated mice are in progress. Future studies will elucidate the molecular mechanisms behind pesticide-induced changes in bone marrow and the immune system and determine if those changes lead to BMF.

Exploring Pesticide Effects on Hematopoiesis and the Thymus

By: Jada Mari C. Young and Jennifer O. Manilay, PhD

Jada Mari Young

University of California, Merced — Biological Sciences, Microbiology & Immunology emphasis

TUSCEB

Hematopoiesis in the bone marrow (BM) produces red blood cells, platelets, or various white blood cells. Common lymphocyte progenitors in the BM can migrate to the thymus to form T lymphocytes, a type of immune cell. In some cases, bone marrow failure (BMF) arises from impairments in hematopoiesis and results in the inability to produce necessary blood cells. California's Central Valley has a high exposure to pesticides due to agriculture. Past research shows correlations between leukemia and high pesticide exposure, but surprisingly, there has been little published research regarding the direct effects of pesticides on BMF. This study aims to use mouse models to aid our understanding of the molecular effects of two pesticides, abamectin and pyraclostrobin, on hematopoiesis. In previous studies, abamectin led to weight loss while pyraclostrobin led to weight gain. We hypothesize that changes in the BM due to pesticide exposure may result in lower numbers of T lymphocytes. We exposed 8-week-old C57BL/6 mice to pyraclostrobin or abamectin for 14 days via intraperitoneal injections and monitored their health with routine weighing and complete blood cell analysis using a Hemavet cell counter. After 14 days, we collected BM and spleen cells for flow cytometric analysis on a ZE5 Cell Analyzer and the thymus for histology. We expect to see a decrease in T lymphocytes in the periphery and impairments in the thymus structure. For future work, this study hopes to uncover underlying mechanisms of BMF, possible disease mitigation strategies, and encourage safer policies for pesticide use.

Rachel Kalthof
University of California, Merced — Molecular and Cell Biology
TUSCEB

Characterization of Mutant Zebrafish: syne1b Knockouts

By: Rachel C. Kalthof, Emma H. Gerlt, Stefan C. Materna

This study investigates the role of the syne1b gene which encodes the Nesprin-1 protein. Nesprin-1 links actin filaments to the cell nucleus, this is crucial for many cellular processes such as maintaining nuclear integrity, positioning, and communicating cell polarity. During early development Nesprin-1 is highly expressed in dorsal forerunner cells (DFCs) which are precursors to Kupffer's vesicle, the zebrafish left/right organizer (LRO). Considering Nesprin-1's prolific expression in progeny cells to the LRO we hypothesize that a loss of function (LOF) of syne1b may result in laterality defects. CRISPR-Cas 9 gene editing was employed to create two heterozygous knockout mutants of syne1b: ucm122, the result of a 7bp deletion, and ucm129, the result of 3.7kb deletion in the coding regions of syne1b. Both versions of the heterozygous mutants were then crossed to yield F3 generations to observe the heart laterality phenotypes of homozygous mutants. Additionally, we cloned mRNA constructs which will allow us to visualize the cell membrane, nuclei, and cilia of Kupffer's vesicle. Single-embryo genotyping of F3 offspring suggests homozygous syne1b mutants may be embryonically lethal. This study aims to characterize the impact of syne1b's LOF both in its effect on the morphology of Kupffer's vesicle and to determine at what time point (in hpf) homozygous syne1b mutants perish during development.

Ryan Schwerdtfeger
University of California, Merced — Biology
TUSCEB

Differentiation of Mouse Embryonic Stem Cells into Tip-Specific Endothelial Cells

By: Ryan P. Schwerdtfeger, Jose Zamora Alvarado, Kara E. McCloskey
University of California Merced School of Engineering
University of California Merced School of Natural Sciences

Cardiovascular diseases are the leading cause of death worldwide, responsible for an estimated 17.9 million deaths annually. Within the body, vasculature is responsible for delivering nutrients and oxygen and removing waste products; however, under diseased conditions, these tissues and vasculatures become damaged and unable to perform their function properly. The discovery of the tip cell, a type of angiogenic endothelial cell, shows promise as a possible solution for this issue. It allows for rapid repair of damaged vasculature by inducing angiogenesis and therefore forming new blood vessels. Unfortunately, the exact culture conditions for maintaining these tip-specific endothelial cells remains a challenge. This project sets out to differentiate a commercially available mouse embryonic stem cell line (R1s), mESC-R1s, into tip-specific endothelial cells using our lab's two step serum free induction protocol. We then varied the concentrations of vascular endothelial growth factor (VEGF), between 10ng/mL and 50ng/mL, and fluorescently stained cell cultures for the tip-cell specific marker delta like ligan 4 (DLL4) using flow cytometry. This study is focused on developing a robust protocol for the direct differentiation of tip-endothelial cell in vitro.

Eric Brooks
University of California, Merced — Bioengineering
TUSCEB

Modelling Thymus Hemodynamics and Structure Using Skeletonized Network of Blood Vasculature

By: Eric G. Brooks, Bioengineering; Kai S. Hu, Bioengineering; Joel A. Spencer PhD, Bioengineering

The thymus is a lymphoid organ that facilitates the differentiation and maturation of T cells. Progenitor lymphoid cells migrate from the bone marrow to the thymus via the circulatory system, making the thymus blood vasculature vital to its function. When recovering from cytotoxic conditions, such as chemotherapy or radiotherapy, the thymus undergoes structural remodeling, leading to altered hemodynamics and vasculature. Quantifying these changes is therefore important for understanding the impacts of cytotoxic conditioning on thymic cell trafficking. Currently, intravital imaging techniques of the thymus are limited to a depth of ~150 microns. Ex vivo imaging can capture the entire vessel architecture with sub-micron resolution but lacks significant dynamic parameters such as blood flow distribution and oxygen profile. Our group seeks to develop methods to create an in silico model for examining thymic blood flow and vascular changes using tissue-cleared, ex vivo images. We tested our methods on a toy model blood vessel network, where we calculated volumetric flow rates of blood under Hagen-Poiseuille assumptions and accounted for blood's dynamic viscosity by modeling it as a power law fluid. Network centrality was measured to identify key vessel junctions. These key vessel junctions correlate to high blood flow regions, suggesting that our methods could be valuable in analyzing changes in thymic cell trafficking following the structural remodeling that occurs in response to damage.

Leena Sanchez
University of California, Merced — Molecular and Cell Biology
TUSCEB

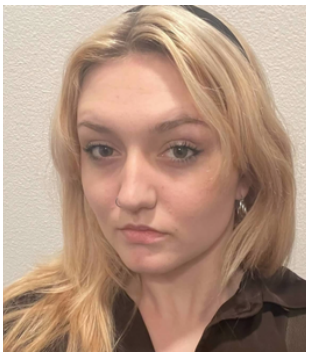
The role of intrinsically disordered regions in synapse-nuclear signaling

By: Leena Sanchez, Andie Venegas, Ramendra Saha PhD

During brain development, neuronal connections strengthen and weaken in response to environmental cues. This is our understanding of synaptic plasticity and its importance in learning and memory. Neuronal activity triggered by environmental cues leads to changes in nuclear gene transcription at the post-synaptic end, also known as excitation-transcription coupling (ET-C). Previous studies have shown the importance of ET-C in long term potentiation (LTP) and memory. However, how a stimulus received at the synapse is relayed to the nucleus for transcription remains unclear. We hypothesize that intrinsically disordered regions (IDRs) of post-synaptic channels play a role in driving phase separation in the post-synaptic density (PSD). These phase-separated biocondensates mediate signaling to the nucleus and regulate synapse-nuclear signaling. To investigate this hypothesis, we will examine the role of IDRs in the MAPK-ERK signaling, a pathway necessary for the transcription of rapid immediate early genes, such as Arc. Further understanding how IDRs play a role in synapse-nuclear signaling through phase separation will help provide deeper insights of synaptic mechanisms and potential new therapeutic interventions for synapse-related diseases like neurodevelopmental disorders.

Altered Cell Contractility of Aerosol Exposed Epithelium Cells

By: Peyton K Pettyjohn



Peyton Pettyohn
University of California, Merced — Molecular and Cell Biology
TUSCEB

Aerosols such as combustion cigarette (CCA) have been linked to diseases, such as chronic obstructive pulmonary disease (COPD). One of the mechanical characteristics of COPD is altered levels of epithelial cell contractility. This study aims to quantify differences in epithelial cell contractility after exposure to different aerosol conditioned media (CCA). We quantified epithelial cell contractility via traction force microscopy (TFM). TFM consists of seeding cells onto a polyacrylamide hydrogel (PAH) that contains fluorescent beads, taking a phase contrast image of the cell boundary, and then taking a fluorescent image of the beads surrounding the cell during and after cell attachment. TFM generates quantitative heat maps of cellular generated stresses. To model the alveolar epithelium, we used adenocarcinoma human alveolar basal epithelial cells (A549s), which we seeded onto collagen-1 coated elastic polyacrylamide hydrogels. The A549s were exposed to different concentrations of CCA conditioned media prepared with a cigarette smoking machine, for 18 hrs. Our preliminary results suggest that with increased concentrations of CCA conditioned media, epithelial cell contractility increases.

Investigation of Bone Marrow Changes in Mice due to Short-Term Pesticide Exposure

By: Joceline Navarro and Jennifer O. Manilay, PhD; School of Natural Sciences, University of California, Merced

Joceline Navarro
University of California, Merced — Biological Sciences
TUSCEB

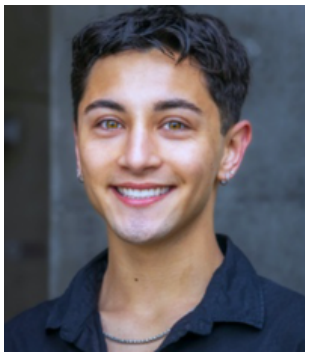
Bone Marrow Failure (BMF) is a disease that hinders the body's ability to produce red blood cells, white blood cells, or platelets in the immune system. Chronic BMF can be genetically inherited or developed through chemical exposure, like pesticides. Due to insufficient experimentation, our laboratory aims to confirm and extend pesticide findings to reveal connections to pyraclostrobin (fungicide) and abamectin (insecticide) exposure in BMF development of mice. Previous studies revealed slight anemia in rats ingesting feed with pyraclostrobin at 500 mg/kg and a 52% body weight reduction in rats ingesting 40 ppm of abamectin in their feed. In our laboratory, both pyraclostrobin (10 mg/kg) and abamectin (3.8 mg/kg) or vehicle (peanut oil or corn oil) were administered in C57BL/6 mice through intraperitoneal (IP) injection for 14 days. We collected complete blood cell (CBC) count data on day 0, day 7, and day 14. We also used flow cytometry to analyze cell characteristics and specific cell populations in the bone marrow on day 14. In parallel, we stained tissue sections and viewed them under a microscope for histological analysis of their anatomy. Although our data analysis is still in progress, we believe these pilot studies could lead to future work in understanding the longer-term effects of pesticide exposure on the bone marrow, the immune system, and other organ systems.

Erin Luna
University of California, Merced — Molecular and Cell Biology
TUSCEB

Characterization of TurboID expression in the adult brain of Cilium-TurboID transgenic mice

By: Erin C. Luna, Eva Cai, Xuecai Ge, PhD

Our lab studies the cilium proteome in the brain using cilium directed TurboID under the BLBP promotor. Brain lipid-binding protein (BLBP) is a signal molecule-carrying protein that is characteristically found in radial glia of the developing brain in mammals. This protein has previously been associated with the cerebral cortex of embryonic brains, as well as the cerebellum, hippocampus, and cortical astrocytes in the adult brain. In this project, we aim to confirm the localization of BLBP in the adult brain. We used transgenic mice with Arl13b-TurboID-GFP under the control of the BLBP promotor to characterize BLBP activity in the adult mouse brain. We used several different antibodies to stain the primary cilia in astrocytes of the cortex, dentate gyrus neurons in the hippocampus, and purkinje neurons in the cerebellum. In the future, we can pursue further studies on cilium proteomics in the different brain regions of adult mice.



Jaxson Ramirez
University of California, Merced — Biological Sciences with an concentration in Molecular and Cell Biology
TUSCEB

Zebrafish endodermal cells utilize the epha2a gene to optimize cellular migration during gastrulation

By: Jaxson T. Ramirez, Jesselynn LaBelle, Stephanie Woo, PhD

Molecular Cell Biology, University of California, Merced

I am currently conducting fluorescent in situ hybridization (FISH) to detect mRNA for the gene epha2a in both endogenous endodermal zebrafish cells and cells with a deletion of the epha2a gene. This is part of a larger project investigating endodermal migration, where Epha2A receptors may play a significant role. I will observe fluorescence to indicate the presence of Epha2A mRNA in wild-type endodermal cells, alongside the corresponding ligand EphrinA5a, which should be visible in the cytoplasm of these specific cells. In the deletion mutants, the absence of fluorescence will indicate no mRNA within those cells, although they should still fluoresce with EphrinA5a. Wild-type embryos fixed in paraformaldehyde are then hybridized with a highly specific fluorescent probe targeting epha2a mRNA. These samples are imaged using a spinning disc confocal microscope to produce fluorescent images. These images will be analyzed using bioimaging techniques and image analysis to quantify fluorescence intensity within the cells. Analysis of the results will verify that the deletion mutants show no transcription of the mRNA. Fluorescent in situ hybridization will confirm the CRISPR deletion of epha2a in the mutant cells and the presence of Epha2A in the endogenous wild-type cells.

UC LEADS

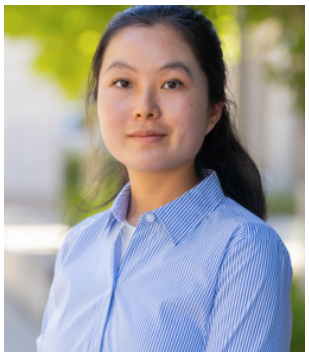
The following student scholars are part of the University of California Leadership Excellence through Advanced Degrees (UC LEADS) Program. The goal of the UC LEADS research and graduate preparation program is to educate California's future leaders by preparing promising students for advanced education in science, technology, engineering and math (STEM) fields. The program is designed to identify upper-division undergraduate students with the potential to succeed in these disciplines, but who have experienced situations or conditions that have adversely affected advancement in their fields of study. This program is funded by the University of California Office of the President.

For more information, please visit
http://uroc.merced.edu/uc-leads

Trizthan Jimenez Delgado
University of California, Merced — Environmental Systems Science
UC LEADS

Assessing Soil Organic Amendments for Improved Climate Resilience in Rangelands
By: Trizthan Jimenez Delgado, Shrijana Duwadi PhD; Rebecca Ryals PhD

Rangeland ecosystems are vulnerable to the impacts of climate change, including altered precipitation patterns, that can have consequences for plant growth, soil carbon stability, and greenhouse gas emissions. The addition of organic matter amendments, such as compost, may help buffer climate extremes and increase the resiliency of rangeland ecosystems. We aim to explore the potential of organic amendments to minimize greenhouse gas emissions, stabilize soil organic matter pools, and enhance plant growth under varying moisture and temperature conditions in California's rangelands. Our research will focus on the use of distinct soil types -coastal and central valley- along with varying organic amendments, such as biochar and manure, under different temperature and moisture levels. The results of this research will enhance our insights of sustainable land management practices, offering strategies to mitigate climate change impacts and improve the ecological resilience of rangeland ecosystems, contributing to broader efforts in environmental conservation and climate adaptation.



Stephanie Lin
University of California, Merced — Computer Science Engineering
UC LEADS

Transformer Based Agricultural Digital Twin Fine-tuned Using LoRA on Geospatial Data
By: Xiaoyi Lu, Adam Weingram, Carolyn Cui, Stephanie Lin, Samuel Munoz

Artificial intelligence (AI) is revolutionizing the way data is processed, allowing people to work more efficiently through improved data visualization and interpretation. One technology that builds upon data processing is digital twinning (DT), a method in which real-world physical objects are simulated by computers. Despite recent interests in DTs, the integration of AI techniques into DT has not been well explored in spite of the natural synergies between the two technologies. In order to apply AI to DTs, two prerequisites must be fulfilled: an AI model for the foundation of the DT, and a real-time connection to update the DT. Both of these prerequisites are costly in terms of computation. To fulfill these prerequisites, we explore the use of transformers, a type of architectural framework for AI, and fine-tuning techniques that allow for low-cost processing of new data to update existing models. This article provides a survey on the state-of-the-art techniques for transformers and fine-tuning methods. In particular, we weigh the pros and cons, and we provide a taxonomy of the evolution and variations of fine-tuning methods. From our review, we identify LoRA (Low Rank Adaptation) as a potential fine-tuning method. Furthermore, we explore several potential transformer architectures and foundation models. Lastly, as a testbed, we apply LoRA on a transformer to create a DT of a Smart Farm to predict factors affecting plant health using geospatial and meteorological data.

Emily Le
University of California, Merced — Biological Sciences
UC LEADS

Exploring the Role of Ammonia-Oxidizing Bacterial Strains in Aiptasia

By: Emily M. Le, Sophia MacVittie, E. Maggie Sogin, PhD
Department of Molecular and Cellular Biology, University of California, Merced

The sea anemone Aiptasia (Exaiptasia diaphana) is a popular model system to study coral-algal symbiosis because they harbor the same algal symbionts (Symbiodiniaceae) and are easier to work with in the laboratory. One of the key mechanisms that regulates the symbiosis is host control of ammonia availability. Under temperature stress, the symbiosis breaks down, resulting in algal expulsion (bleaching). While this has been well-studied, little is known about the role of ammonia-oxidizing bacteria (AOB) within the Aiptasia microbiome and its role in coral bleaching. Our objective is to culture novel AOB and identify their functional niche. To maximize diversity, we enriched Aiptasia homogenate in Marine Nitrifier Medium (MNM) under aerobic and anaerobic conditions and grew our colonies on MNM and marine broth plates treated with two antibiotics: chloramphenicol and penicillin. We screened isolate identity using 16S sequencing and sent isolates of interest for whole genome sequencing. We created a pipeline to assemble and annotate a whole genome to identify genes, including those involved in ammonia oxidation. Future work includes applying our pipeline to other isolates of interest and using metabolomics to study nutrient exchange and provide insight into the functional roles of these microbes within the host. Additionally, we will investigate how the presence and abundance of AOB changes host resilience under temperature stresses through inoculation experiments.

Kyra Ruiz
University of California, Merced — Mechanical Engineering
UC LEADS

Simulating the Fluid Dynamics of Establishing Symbiosis in the Bobtail Squid

By: Kyra Alexa M. Ruiz, Stephen Williams PhD, Applied Mathematics; Shilpa Khatri PhD, Applied Mathematics

Beneficial symbiosis, the partnering between organisms, is often vital for survival of organisms. These types of relationships are often necessary for nutritional needs, environmental regulations, defensive mechanisms and much more. There is a growing interest in the study of these relationships and how they are established between different organisms and the impact rising temperatures and climate change will have on these relationships. One example is the relationship between the bobtail squid, Euprymna scolopes (ES), and the bioluminescent bacteria, Aliivibrio fischeri (AVF). The establishment of the bacterial colonies within the squid allows the squid to have bioluminescent properties which allow it to camouflage itself in the dark. While there are already a large number of existing studies pertaining to this biological model system for symbiosis, many aspects of this colonization process have yet to be well-understood. Here, we are studying the fluid dynamics within the squid which allows for the colonization of the bacteria. We use the Method of Regularized Stokeslets to develop a mathematical model and computational simulations to explore the fluid dynamics and the resulting colonization of the bacteria within the squid. In addition, by varying squid and flow parameters, based on experimental data, within the ES, we begin to understand the impact of external forces. With this information, we have begun to evaluate the impact of varying temperatures within the symbiotic relationship of the ES and AVF.

Breanna Remigio
University of California, Los Angeles — Computational and Systems Biology
UC LEADS

Using Computational Methods to Compare Bioadhesin Peptide Chains
By: Breanna Remigio, Roberto Andresen Eguiluz, PhD

There has been an increasing interest in understanding the mechanisms of natural adhesion in biological systems, particularly in aquatic environments, for the development of aqueous adhesion technologies. Mussel foot protein 5 (mfp-5) is an amino acid chain found on the plaque surface of marine mussels, enabling them to attach to various surfaces in aquatic environments. Mfp-5 is known for its strong adhesive ability and surface versatility. This has sparked interest in investigating its similarities to biofilm-specific adhesin protein 1 (bap1), an amino acid chain crucial for forming and maintaining bacterial biofilms. Bap1 is of interest because of its recently reported strong adhesion to various abiotic surfaces. To understand the multiple characteristics of these amino acid peptide chains, we used computational tools to analyze and compare the physical properties of mfp-5 and bap1. Specifically, using LocalCIDER, we calculated the fraction of negatively and positively charged residues and determined the grouping of positively and negatively charged residues for mfp-5 and bap1 determined by the parameter κ. We find that mfp-5 behaves as a Janus sequence that can be collapsed or expanded, based on environmental factors, while bap1 behaves as a weak polyelectrolyte. Furthermore, mfp-5 demonstrates a preference for grouping similarly charged amino acids compared to bap1, as indicated by κ. By further understanding these amino acid peptide chains, researchers will better understand the amino acid synergies of biomimetic adhesion-promoting peptides in aqueous environments.

Sarine Yeghiayan
University of California, Merced — Astrophysics
UC LEADS

Attempting to Observe the Aharonov-Bohm Effect in a Rubidium Spectroscopy Apparatus
By: Sarine N. Yeghiayan, Jay E. Sharping PhD

Sarine N. Yeghiayan, Jay E. Sharping PhD, School of Natural Sciences (Physics), University of California, Merced

We aim to experimentally observe the Aharonov-Bohm effect (AB effect) in a Rubidium spectroscopy apparatus. The AB effect is a phenomenon in which an electrically charged particle inside a confined space, where both the electric and magnetic fields are zero, is affected by an electromagnetic potential. The AB effect will produce variations in the absorption spectrum in a Rb vapor subjected to a time-varying voltage. The AB experiments prior to my arrival were unsuccessful and we are verifying each component in the apparatus. First, we recorded the spectra as a function of temperature over range 27 - 45 C to verify that the Rubidium atoms go into a vapor phase and as the temperature of the Rubidium cell is increased. This is due to heat being added to the system, the Rubidium atoms desorb from the walls of the cell and interact with the light. Finally, we propose a two pass measurement that may enhance measurement sensitivity thus enabling us to observe the AB effect. This project is important, because the AB effect is a purely quantum mechanical effect. If successful it provides a new tool for preparing and measuring quantum mechanical systems for quantum computing and communication.

Katherine Herrera
University of California, Merced — Cognitive Science
UC LEADS

Eliciting Moral Elevation Through a Humanoid Robot

By: Katherine M. Herrera, Colin Holbrook, PhD, Cognitive Science, UC Merced

Elevation is an emotion hypothesized to be elicited when a person witnesses prosociality and to trigger increased motivation to act prosocially. While studies have shown that prosocial acts by humans can increase feelings of elevation, none to date have examined whether highly altruistic robots can evoke elevation. This paper investigates whether Engineered Arts' Ameca, an advanced humanoid robot, can elicit moral elevation by recounting a story in which it saves a little girl from a fire at a substantial cost to itself. This online study randomly assigns participants to either the highly altruistic first responder Ameca condition or to a control condition in which Ameca presents as an amused restaurant server. Both conditions include a video in which the robot discusses its job experiences. We predict that participants will report higher levels of elevation in the experimental condition compared to the control condition. Potential moderators include idealism, the attitude that humans are generally cooperative, and attitudes towards robots, as measured by Sparks et al.'s Idealism-Cynicism Scale and Koverola et al.'s General Attitudes Towards Robots Scale, respectively. As robots become more integrated into society, it is important to understand whether people are susceptible to mistaking them for moral agents and being influenced by their prosocial behavior.

Kenziee Nguyn
University of California, Merced — Cognitive Science, BS and Psychology, BA
UC LEADS

Would you take the lead? Exploring initial romantic preferences for dominant or submissive personalities in anthropomorphic robot partners

By: Kenzie H. Nguyen, Colin Holbrook, PhD

Robots and artificial intelligence (AI) are tools, creating an inherent power dynamic between the user and the machine. For this reason, users have been hypothesized to prefer virtual assistants that utilize a subservient personality.

Engineered Arts and similar companies have developed highly anthropomorphic robots such as Ameca, which are capable of complex movements, gestures, and facial expressions. The advent of large-language model AIs have also allowed for more fluid human-robot interaction (HRI) in casual conversation, advice, and romance.

The present study explores preferences for dominant or submissive personalities in the decision to pursue romantic HRI. Participants provide demographic information and romantic tastes, and then are randomly assigned to a dominant or submissive personality. Participants view a mock dating-profile and introduction video of the robot. Robot gender presentations are matched according to participant preference. After viewing the profile and video, participants give their impressions of and feelings for the robot.

The researchers predict that, relative to dominant personalities, robots with a submissive personality will be rated as more physically attractive and desirable as a potential date, perceived as having less personal power than the dominant robot. Additionally, participants with a higher self-rated personal power will rate the submissive personality as more physically attractive and desirable as a potential date.

There are troubling implications for the development of romantic HRI. While beneficial in providing companionship for those that struggle with social interaction, socially anxious/isolated people are at risk of devoting their time to a machine rather than meaningful human connection. "

Harini Muralidharan
University of California, Merced — Cognitive Science
UC LEADS

Does Co-speech Gesture Influence the Adoption of Spatial Frames of Reference?
By: Shervin Nosrati, Harini Muralidharan, Tyler Marghetis, PhD

People use different frames of reference to conceptualize space in memory and reasoning. In Western industrialized cultures, people typically rely on a body-based "egocentric" frame of reference for small-scale space (e.g., "the fork is left of the plate"), but people in many other cultures rely instead on environment-based "allocentric" frames of reference (e.g., "the fork is north of the plate"). The origins of this cross-cultural variation remain unclear. One proposed explanation is "linguistic relativity," the idea that habitual patterns in language are responsible for associated regularities in non-linguistic thought. Here, we investigate whether co-speech gestures may also play a role in transmitting spatial frames of reference, a kind of "gestural relativity." Participants (N = 18) completed a spatial search task where the location of a target was described in speech and gesture by the experimenter. In a between-subjects experiment, we manipulated whether the experimenter's gestures adopted an egocentric or allocentric frame of reference, which would imply different locations for the hidden target. We predict that egocentric gestures will prompt participants to adopt an egocentric frame of reference when subsequently searching, while allocentric gestures will prompt them to adopt an allocentric frame of reference. If co-speech gesture can shape the frame of reference used subsequently by listeners, it may play a role in transmitting culture-specific differences in spatial cognition. In short, cross-cultural variation in gesture may explain cross-cultural variation in cognition.

Anika Potu
University of California, Merced — Computer science and engineering
UC LEADS

Visualizing Agricultural Output Using Digital Twins
By: Anika Potu, Adam Weingram, Xiaoyi Lu PhD, School of Engineering

Digital twins, virtual representation of physical objects, offer significant benefits for visualizing agricultural output. By integrating real-time data from sensors and drones with advanced modeling techniques, digital twins enable farmers and agronomists to monitor and accurately predict crop growth, soil health, and environmental conditions. The use of digital twins also aids in identifying inefficiencies in farming operations and equipment usage, leading to cost savings and improved productivity. For this, we are designing a front end, in JavaScript, and a back end, in Rust programming, of a website to make all the data from Smart Farm accessible. All the primitives displayed on the front end are various models that contain the farm data which is queried through the back end. These simulations facilitate proactive decision-making, allowing for timely interventions to optimize yield and resource use. As a result, agricultural workers can easily visualize the impact of different variables, such as weather patterns, irrigation schedules, and pest infestations, on crop performance. This enhances their ability to implement precision agriculture practices, reducing waste and improving sustainability. In essence, digital twins represent a transformative tool for modern agriculture, driving innovation and efficiency in the pursuit of optimal agricultural output.

Frances Cardinale
University of California, Merced — Mechanical Engineering
UC LEADS

Technology for Entanglement Preserving Switches

By: Frances Cardinale, Harry Hart-Alesch, & Jay Sharping

The long-term goal of my project is to enable experimental research in quantum physics. One specific project is an entanglement-preserving optical switch that directs photons between various channels while maintaining entanglement between the photons. A key part of evaluating such a switch will be detecting single photons on each port of the switch. We are installing and testing a set of superconducting nanowire single-photon detectors (SNSPDs), which use the superconducting-to-normal transition in a nanowire to count photons. Here, we report the general operation, dark count rate, and quantum efficiency of four SNSPDs operating at cryogenic temperatures. Our next steps are to use these SNSPDs to evaluate an entangled photon source and finally to evaluate switched photons from that source.

UCM Mexico Climate Research

The UC Merced-Mexico Undergraduate Climate Research Program is part of a Chancellor's initiative to increase exchange and collaboration between UC Merced and Mexican higher education institutions. This year, UC Merced invited students from Mexican partner universities who are interested in climate-related research and considering graduate study to apply for the nine-week program. The participating twelve students, from Instituto Politécnico Nacional, Universidad Autónoma de Baja California, Universidad de las Américas Puebla, and Universidad Nacional Autónoma de México, conduct directed research on climate-related topics with faculty mentors and graduate students from engineering and natural and social science disciplines. The students also participate in activities to prepare them for graduate school. It is anticipated that this year's program is only the first instance of an annual program to bring Mexican undergraduates to UC Merced during the summer to research a variety of issues affecting both the US and Mexico.

Diego Cachón Blanch
Universidad De Las Américas Puebla — Environmental Engineering
UCM Mexico

H4-CBD effect on the development of zebrafish embryos

By: Diego Cachón Blanch, Rudy M. Ortiz PhD, Yuki Yang; School of Natural Sciences, Molecular & Cell Biology, UC Merced

Cannabis sativa is a plant known for its many therapeutic and psychoactive properties. Cannabidiol (CBD) is an abundant non-intoxicating, constituent of Cannabis sativa, with no psychoactive effects that has gain popularity due to its potential therapeutic effects. Cannabinoids can be found in freshwater systems in measurable amounts; however, its effects on naturally breeding fish inhabiting these systems have not been extensively examined. Zebrafish are ideal models for scientific research as they develop similar human diseases, and possess translucent characteristics, allowing scientists to observe their development from fertilization to adulthood. H4-CBD, a compound with stronger biological interactions and molecular stability, was used. Fertilized eggs were exposed to different concentrations in ranges between 0.25 and 10 mg/L of H4-CBD diluted with 0.01% of DMSO. The eggs were treated at 4 hours post fertilization and observed daily for 5 days, before they develop into fry. The hypothesis is that exposure of fish embryos to H4-CBD will impair their development, causing phenotypic alterations that can be observed. Results show that zebrafish can grow without alterations at the tested concentrations, which are higher than the ones present in the environment. The goal of this study is to contribute to the study of CBD and its effects, so its benefits and impacts on wildlife can be well understood.

Regina Olalde Ruiz
Universidad De Las Américas Puebla — Civil Engineering
UCM Mexico

Visualization of projected climate change in Mexican hydrological regions in 2061-2090

By: Regina Olalde Ruiz, John Abatzoglou, Josue Medellin-Azuara

Temperature and precipitation data are critical to predict and mitigate the effects of extreme events, such as floods and droughts, ensuring the safety, economic prosperity, and well-being of communities. Monitoring temperature and precipitation over time facilitates better planning and management of water resources. However, projected changes in temperature and precipitation at actionable scales for planning in Mexico are not accessible, visible, or understandable to the population. This study aims to address this gap by creating comprehensive maps that illustrate these changes. The maps will show the projected temperature and precipitation for the future years, specifically from 2061 to 2090, for each season. They will be developed with the Climate Mapper module of Climate Toolbox and the QGIS platform, a robust Geographic Information System software that allows for detailed spatial analysis and visualization. By featuring the projected temperature and precipitation change under climate change, these maps will highlight changes across the different regions in Mexico. Further, synopses at the hydrologic region level narrating potential climate change effects will be developed to provide context of potential impacts and adaptation efforts. By making the data accessible, the project aims to raise awareness about the impacts of climate change and encourage proactive measures to mitigate its effects. This initiative seeks to empower stakeholders with the information needed to address climate change challenges effectively, contributing to the overall resilience of communities in Mexico.

Juan Carlos Ruiz Orozco
Universidad de Guadalajara — Chemistry
UCM Mexico

Design, Synthesis and Characterization of Air Stable Ligand-Metal Complexes For CO2 Reduction Catalysis

By: Juan C.R. Orozco, Harleen Kaur, Rebeca Arevalo

The increasing levels of atmospheric CO_2 necessitate efficient and sustainable reduction methods. This study focuses on the synthesis and characterization of novel, air- and moisture-stable sustainable transition-metal complexes and the assessment of their efficiency as catalysts for CO2 reduction with mild reducing agents. The synthesized ligands were bidentate diimines and pyridylimines (N-N), which were prepared by condensation reactions of the appropriate ketones and anilines. The resulting ligands were characterized by 1H and 13C NMR spectroscopy. The reactions of the N-N ligands with the appropriate amount of the metal sources MX2 (M = Fe or Mn, X = Cl, CF3SO3 or OAc) afforded complexes of the type [M(N-N)X2] and [M(N-N)2X2] which air- and moisture-stability was evaluated in solution and in the solid state. The efficiency of the synthesized metal complexes as catalysts for CO_2 reduction was assessed employing HBPin (Pin = pinacol), HSi(OEt)3 and NH3BH3 as reducing agents. This research presents a promising approach to CO_2 reduction, leveraging the tailored design of ligands and their coordination chemistry to enhance catalytic activity. These findings contribute to the broader effort of developing practical solutions for mitigating CO_2 emissions and advancing green chemistry.

Ricardo Andres Quiroz Uribe
Universidad De Las Américas Puebla — Civil Engineer
UCM Mexico

Solutions for Methane Detection: Ensuring Safety and Sustainability

By: Ricardo A. Quiroz Uribe, Yangquan Chen, PhD

Methane concentration in the atmosphere has increased significantly, contributing to 20% of anthropogenic radiation, just after carbon dioxide at 60%. Methane is 25 times more potent in trapping atmospheric heat than carbon dioxide and has 86 times more global warming potential over 20 years, with an atmospheric persistence of about 10 years. The challenges in managing methane start with accurate detection and monitoring, given its significant contribution to global warming and the difficulties in detecting and quantifying leaks. To address these challenges, the paper examines the necessity of sensors for methane detection. It reviews different types of methane sensors, including infrared, catalytic bead, and semiconductor sensors, detailing their mechanisms, advantages, and limitations. The methodology involves comparing these sensors' performance, including sensitivity, accuracy, and reliability under various environmental conditions. The study begins with a comprehensive overview of methane's properties and environmental impact, followed by a discussion on the critical need for effective monitoring systems. The research then compares the types of sensors, providing a complete overview of methane detection. The conclusions emphasize the advancements in sensor technology that enable more accurate and reliable methane detection, highlighting the critical role of advanced sensors in mitigating methane emissions, enhancing environmental protection, and supporting regulatory compliance. These advancements bring hope for a more sustainable future where we can effectively manage methane emissions and protect our environment.

Abril Medina Landeros
Universidad de Guadalajara — Biology
UCM Mexico

Fluorescence detection of Wolbachia (Rickettsiales: Anaplasmataceae) in mosquito (Diptera: Culicidae) embryos from California

By: Abril Medina Landeros, Sadiq Khan; Sandro Jovany Barajas, MS, Department of Environmental Systems; Andrea Joyce, PhD, Department of Public Health

Wolbachia is a common and widely distributed endosymbiont bacterium found in many arthropods, known for significantly impacting the ecology, evolution, and reproductive biology of its hosts through various interactions. Insect-borne diseases, particularly those transmitted by mosquitoes, are among the leading causes of mortality and morbidity in humans, making it crucial to continually gain understanding of the role of *Wolbachia* in these vectors. Previous investigations have pointed to the natural occurrence of *Wolbachia* in mosquito species commonly found in the study area. Therefore, this study focuses on the localization of *Wolbachia* within mosquito embryos using immunofluorescence techniques. Traps were set near bodies of water to lure female mosquitoes, and a portion of the collected eggs was preserved in alcohol while the remaining eggs were incubated until adulthood. Adult mosquitoes were preserved, and species were determined using taxonomic keys. Preserved eggs underwent dechorionation, fixation, and endochorion disruption. The embryos were then subjected to Fluorescent In *Situ* Hybridization (FISH) and DAPI staining techniques, with image analysis performed using a confocal microscope. Our findings revealed that the collected mosquitoes corresponded to the species expected in the area. Additionally, we successfully standardized the hybridization protocol, and molecular techniques confirmed the presence of *Wolbachia* within the embryos. These findings contribute valuable information for future vector control programs integrating *Wolbachia* into mosquito management strategies.

Camila Huitrón
Universidad De Las Américas Puebla — Environmental Engineering
UCM Mexico

Use of Activated Carbon Particulate Sorbents to Treat Mercury-Contaminated Sediments

By: Camila Huitrón García, Marc Beutel, Ph.D., UC Merced Environmental Science School

Mercury (Hg) is a major environmental contaminant in aquatic ecosystems. Guadalupe Reservoir in San Jose, California suffered mercury contamination from the historic gold mining in the area. Previous successful attempts to remediate the contamination were made using sorbents, such as activated carbon and Mersorb. This project used thiol extraction, with the addition of glutathione which acts as an analog for a moderately weak organic ligand for Hg (II), to assess the release of sorbed Hg (II) loaded onto activated carbon and Mersorb. The extraction was performed in duplicate after the incubation process of the sorbents and was collected on days 5, 15, 25, and 35 after the start of the incubation. Additional knowledge on Hg release on sorbents is needed to inform future mercury management and strategies in Guadalupe Reservoir and other bodies of water that suffer from mercury contamination.

Luis Angel Acosta
Universidad Michoacana de San Nicolas de Hidalgo — Civil Engineering
UCM Mexico

Measurement Diagnosis in Irrigation District 075 Río Fuerte

By: Luis A. Acosta Chávez, Josué Medellín Azuara, PhD School of Engineering, UC Merced

Irrigation District 075 Río Fuerte Sinaloa is one of the three most important irrigation districts in Mexico, covering an area of approximately 235,000 hectares and serving as one of the country's most significant agricultural producers. Consequently, it is crucial to review its infrastructure and ensure compliance with Mexican regulations. The district currently faces deficiencies in its infrastructure, notably the lack of an updated record or inventory of existing measuring devices, with data dating back to 2007-2010. These devices may now be obsolete, hindering efficient water management and affecting its distribution for irrigation purposes. To address this issue, a freely available Geographic Information System (GIS) will be utilized. Specifically, QGIS software will be employed to analyze and manage data, facilitating the review and characterization of the area. This process includes identifying existing infrastructure, creating an inventory of available resources, and pinpointing areas in need of improvement. Based on these findings, the district's operation will be evaluated, focusing on the distribution and delivery of water to users and analyzing water management practices. Finally, a proposal will be developed for the necessary control points and the selection of appropriate equipment, focusing on the main channels of the district, in accordance with the Mexican standard "NMX-AA-179-SCFI-20," to ensure proper monitoring, control, and evaluation of the water distribution for the irrigation plans implemented each year.

Maria Paula Tapia Tolentini
Universidad De Las Américas Puebla — Civil engineering
UCM Mexico

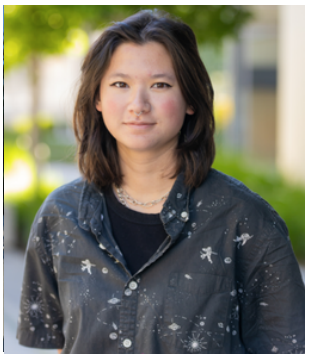
Comparing Remote Sensing application on water sector in Central Valley U.S.A. and Puebla Mexico

By: Kamila Dilmurat, Benjamin J. Lewis, Senior Adepoju, Erin L. Hestir, PhD

Water is the most important resource on Earth; it gives life being possible the development and continuation of it. Earth is about 71% water, mostly saltwater, only about 2.5% being freshwater. Globally, around 70% of that 2.5% freshwater is used for agricultural purposes. Agriculture involves many factors more than just the final product such as soil and water components. This can be observed in Central Valley, a vast, elongated, and flat valley that dominates the interior of California, United States. It is one of the world's most productive agricultural regions, producing more than half of the fruits, vegetables, and nuts grown in the United States. Otherwise, Puebla is a city and state in Mexico where agriculture is a significant economic activity, particularly with high corn production. In recent years, both countries have suffered droughts and climate alterations due to global warming. Water sustains the world. Remote Sensing is a technology that helps us observe Earth and specific details such as ground health and water concentration, helping on predict and understand Earth. In this study management irrigation to understand how much water is needed to avoid wasteful. Remote sensing enables the assessment of water distribution in specific areas by generating data through colors that indicate water concentration consecutively ground health. The study aim is effectively utilizing irrigation water resources in agriculture by using remote sensing methods. Having the opportunity to apply remote sensing in other countries, making a difference globally by focusing on effective water management in agriculture to prevent droughts.

U-RISE

The goal of the Undergraduate Research Training Initiative for Student Enhancement (U-RISE) program is to develop a diverse pool of undergraduates who complete their baccalaureate degree, and transition into and complete biomedical, research-focused higher degree programs (e.g., Ph.D. or M.D./Ph.D.).



Kayla G. Kelly
University of California, Merced — Molecular and Cell Biology
URISE

Any Cut, Anywhere – Programmable Synthetic Restriction Enzymes
By: Kayla G. Kelly, Brian L. Pipes, PhD, and Michele K. Nishiguchi, PhD.

Research in basic and applied biology makes extensive use of plasmids as vectors for genetic modification. However, the design and construction of plasmid vectors is a time-consuming and intensive process that can be rate-limiting for areas of research that are rapidly advancing. Therefore, to resolve issues in slower methodologies, we report on the development and application of a novel plasmid construction methodology that utilizes programable synthetic restriction enzymes, based on the Pyrococcus furiosus Argonaute (pFAgo) enzyme. pFAgo can introduce staggered double strand cuts at any location on a plasmid by binding to target plasmid DNA sequences with the aid of complementary16bp ssDNA guide sequences. To demonstrate proof-of-principle of pFAgo cloning, we constructed plasmids designed with artificial restriction sites in place of natural restriction sites. The ability of our pFAgo cloning methodology to construct plasmids without the limitations of traditional restriction enzyme cloning should greatly expand the potential of synthetic biology and be a novel and quick method for advancing molecular genetic capabilities.

Felizardo Salazar
University of California, Merced — Biological sciences
URISE

Optimizing the aster leafhopper CLK recombinant protein expression protocols
By: Felizardo Salazar Jr, Luisa Garcia Michel, Michael C Thompson

To study this project we research leafhoppers from two regions of Hawaii which are the subalpine area and the coastal area. Hawaii was chosen as the temperatures range from 4 to 8 celsius while the coastal area has a range of 20 to 24 celsius. In this project we focus on cdc2-like-kinase(CLK) protein in the leafhoppers(Nesophrosyne sp.) to see if the CLK senses the physiological temperature of the leafhopper. We hypothesize that the structure of the CLK should change with different physiological temperatures that the protein will experience. To produce the CLK protein I use the recombinant protein expression. I do these experiments to make inferences on how temperature will affect organisms that can't stabilize physiological temperature.

Axel Muñiz Tello
University of California, Merced — Applied Mathematics & Physics
URISE

Modeling Disease Spread Using SIR Agent Framework: A Kinetic Monte Carlo Approach

By: Axel Muñiz Tello, Changho Kim, PhD, Applied Mathematics

Using pre-existing computational methods such as Kinetic Monte Carlo (KMC) simulations, this research study intends to investigate the dynamics of disease transmission using the Susceptible-Infected-Recovered (SIR) with an agent-based modeling framework (ABM) on lattice-like structures for a controlled movement population vs an unrestricted movement population; through simulations to analyze the relationships between susceptible(S), infected(I), recovered(R) populations in an environment in these circumstances. Using these methods, we simulate the stochastic processes that govern disease transmission and recovery on the lattice grid, providing a comprehensive analysis of the evolution of the disease spread. We anticipate that the overall findings will uncover iterative patterns in disease transmission, highlighting the critical importance of spatial structure and stochastic effects on population dynamics. Furthermore, we expect these results to offer deeper insights into epidemic dynamics, thereby enhancing the effectiveness of disease control strategies for future outbreaks. However, future work is needed to address two unknown areas. First, the impact of different lattice configurations on disease dynamics should be investigated to comprehend how spatial structures influence disease spread. This should include exploring various spatial configurations. Second, further investigation is required into how different temperatures affect disease transmission within restricted populations in lattice-like structures compared to populations not restricted by these physical conditions.

Zulette Orduna
University of California, Merced — Human Biology
URISE

Assessing Changes in Vibrio fischeri Biofilms Evolved by Protozoan Predation

By: Zulette Orduna, Daravuth Cheam, and Michele K. Nishiguchi, PhD.

The symbiotic relationship between Vibrio fischeri and bobtail squid is a model for studying host-microbe interactions. We focused on how different symbiotic strains respond to biotic pressures (protozoan predation) and their adaptability for grazing resistance. We examined two strains of V. fischeri: ES114, isolated from the Hawaiian bobtail squid (Euprymna scolopes), and ETBB1-C, isolated from the Australian bobtail squid (Euprymna tasmanica). These strains were subjected to grazing by two protists (Acanthamoeba castellanii, a surface-feeding amoeba and Tetrahymena pyriformis, a suspension-feeding ciliate) to understand how predation pressure influences key symbiotic traits over evolutionary time. Growth rate, bioluminescence, and motility assays were conducted on these strains at 0, 25, 50, 75, and 100 generations of grazing. Results indicate that grazing pressure induces significant changes in growth rate (biofilm proliferation), bioluminescence (light production for counterillumination in squid hosts), and motility (colonizing the squid's light organ) for both strains. These traits also varied across generations, suggesting the adaptive potential of V. fischeri to environmental pressures and the importance of biofilm growth rates, bioluminescence, and motility in the symbiotic relationship. Future research will focus on the genetic mechanisms underlying these traits to further explain the complexities of host-microbe interactions.

UROC-H

The following students scholars are part of UC Merced's Undergraduate Research in the Humanities (UROC-H) Program. The goal of the UROC-H program is to engage promising UC Merced undergraduate students each year in faculty-mentored research during the summer and prepare them for advanced education in the humanities and humanistic social sciences.

This collaborative program led by UROC, the Graduate Division, and the School of Social Sciences, Humanities, and Arts is made possible through a grant from the Mellon Foundation. Learn more at mellon.org

For more information, please visit
http://uroc.ucmerced.edu/uroc-h

Surisaday Garcia
University of California, Merced — Public Health
UROC-H

Linking ICD-10 codes to the most prevalent diseases, conditions, and injuries in the California Central Valley

By: Surisaday N. Garcia Ruiz, Alexandra Rivera-González, PhD, MPH, Department of Public Health, School of Social Sciences, Humanities, and Arts, University of California, Merced

The International Classification of Diseases (ICD) codes, created by the World Health Organization, allow systematic documentation of morbidity and mortality data globally. This organization ensures consistency in recording clinical diagnoses, allowing accurate assessments of health trends and outcomes across different regions and periods. This study aims to predict which ICD-10 codes, numbered after the 10th version, will be the most common in the Central Valley counties. An extensive search of prevalent conditions, diseases, and injuries in each county in the Central Valley and California overall, was conducted using roughly 30 health department websites and other sources. Using the ICD-10 dictionary, the corresponding codes were linked to each condition to analyze and compare epidemiological trends and healthcare burdens across regions. Results revealed varying prevalence rates for the Central Valley and California. The more common ICD-10 codes in the Central Valley include B38 (valley fever) and J45 (asthma). In California, the more common codes include I00-I99 (heart disease), D05 (breast cancer), and V00-V89 (car accidents). Variations within Central Valley were noted; Fresno County had a higher incidence of lung cancer compared to Madera County and the state average. These results provide a foundation for future research using ICD codes in health insurance claims data in the Central Valley. In conclusion, our study highlights significant differences in diagnosis prevalence across the Central Valley counties compared to California overall, emphasizing the need for specialized healthcare solutions.

Alisa Ruiz Rios
University of California, Merced — Public Health and Spanish
UROC-H

'It's a Slap in the Face': Exploring Sense of Belonging and Challenges Among Undocumented Students in Higher Education

By: Alisa Ruiz Rios, Lindsay K. Crawford, PhD

Sense of belonging (SB) is a basic human need which describes the extent to which people feel personally accepted, respected, and involved in their respective communities. Research has consistently demonstrated the positive implications of a heightened SB, including improved academic performance, engagement, motivation, and mental and emotional well-being. Although its importance is well established, many underrepresented students suffer from lowered SB compared to their White peers. SB is consistently shown to be lower for women, minorities, and underrepresented populations. Therefore, the aim of this study was to describe the factors that influenced undocumented students' SB at a University of California. Twenty semi-structured interviews were conducted to explore this research question. Results demonstrated that these students face additional barriers, compared to their documented peers, due to their legal status. They are frequently unable to participate in internships or research opportunities that require citizenship. Additionally, undocumented students face increased financial challenges because they are unable to obtain on-campus employment. This lack of experiential learning opportunities led to feelings of invalidation, isolation, and a decreased sense of belonging. From these results, we aim to produce an actionable set of recommendations to enhance SB among undocumented students.

Kendra Sesco
University of California, Merced — History
UROC-H

Invisible Genocide: Oral Histories of the Anti-Trans Onslaught

By: Kendra R. Sesco, Sean L. Malloy, History/Critical Race and Ethnic Studies

In 2013, Arizona proposed the first anti-transgender "bathroom bill", inaugurating a firestorm of dehumanizing and deadly legislation that has burned across 41 states as of the time of this writing. In my research, I contend that this nationwide swath constitutes not only the early phases of a new historical process, but a nascent era of trans genocide in the United States - a constitutive organ within a global continuum of exterminatory violence against trans existence. Naming this process "the Invisible Genocide" in reference to our compulsory position within overarching discourse as a social presence that is both hypervisibilized and invisibilized at the same time, my research seeks to amplify transgender voices and document oral histories of diverse transgender experiences from all over the United States starting from 2013 and continuing through to the present. Constructing a theoretical framework that intersects the fields of trans studies and genocide studies, I conduct oral history interviews with trans people from multiple states to offer both fields much-needed transgender perspectives on the adolescent genocidal process. My hope for this research lies in summoning the moral imagination necessary to contend with the Invisible Genocide as it continues to escalate. More than a call to action or a plea for help, Invisible Genocide: Oral Histories of the Anti-Trans Onslaught is an explicitly contrapuntal history told in transgender words, through transgender eyes, with transgender hearts to stand as a polemic against centuries of historical silencing and an aegis in defiance of the mainstreamed Far-Right politics of trans genocide.

Sophia M. Martinez
University of California, Merced — Psychology & Sociology
UROC-H

Missing and Murdered Indigenous Relatives Database

By: Sophia M. Martinez, Blythe K. George PhD, School of Social Sciences, Humanities and Arts

The Missing and Murdered Indigenous Relatives (MMIR) epidemic is characterized by extensive and significant loss. As intense as this grief, this epidemic is not new; MMIR has been an epidemic for countless years, with Indigenous peoples and their allies mobilizing with calls to action spanning the globe. Government agencies have only recently begun to address this epidemic, therefore existing literature and data are limited. Through our research, we will create a database for MMIR in California. This database will serve as an essential resource in the ongoing work associated with AB 3099, passed in 2020 to help intervene in MMIR in California. Drawing on current statistics, reports, and online resources, such as Facebook MMIR groups and the missing persons database Namus, we will build this database from scratch, adding to Prof. Blythe George's ongoing data sovereignty efforts for better supporting our systems-impacted relatives. Specifically, I will be reporting on the areas near the Northern Bay Area through the Central Valley. I have chosen this range of areas because of my lived experiences having grown up in the Bay Area and now currently going to school in the Central Valley. Via this database, we aim to enhance understanding of this epidemic, raise awareness, and provide support for communities by facilitating access to the critical information they require to keep their relatives safe from violence.

Christopher Finley
University of California, Merced — English
UROC-H

From the Global North to the Global South: Rethinking the Waste-Human Relationship in Anglophone Science Fiction

By: Christopher Finley, Fatima Burney, PhD

The relationship between waste and humans is a major problem. Less and less thought is given to the objects consumed and thrown away each day. Reframing waste, where the waste itself has meaning outside of its human relationship, makes forgetting troublesome. This essay focuses on an Anglophone Science Fiction text, Chen Qiufan's Waste Tide, tracking how easily waste becomes concealed, in the human body, within language, and in the environment, even in a text meant to highlight and foreground waste. In a close reading of the text, a heavy emphasis will be placed on how waste is made to hide, both rhetorically and in the narrative. To help show how waste is revealed in the relationship, Rob Nixon's concept of 'slow violence' is used to highlight how waste renders harm to humans, always making humans primary. This essay argues that while Nixon's theory and current scholarship prioritize the human in the waste-human relationship, making waste the priority stops waste from being concealed by humans and allows the waste to present itself outside of a human correlation. Elevating the waste-human relationship suggests better ways of looking at aspects of the relationship in the world at large and in literature.

Holmi Calderon
University of California, Merced — Public Health and Spanish
UROC-H

A Sick Country: Novelistic Representations of Venezuela's Public Health Crisis Under Chavismo and its Current Relevance

By: Holmi C. Calderon, Bristin Scalzo Jones, PhD; School of Social Science, Humanities and Arts, University of California, Merced

Since 1998, Venezuela has experienced the slow decay of democracy and the strengthening of its current authoritarian regime. This has resulted in one of the largest humanitarian crises in the present day, with 7.7 million Venezuelans having fled the country. In a country where political, economic, and social structures have been broken by the Chavista regime, the once-internationally lauded public health system in Venezuela has deteriorated to the point that everyday citizens can no longer rely on the public and private sector to provide even the most basic of health services. In order to better understand how everyday citizens are affected by this situation in Venezuela, this project focuses on the country's current health crisis and analyzes qualitative data collected from interviews, articles, and contemporary novels such as Karina Sainz Borgo's La hija de la española and Bristin Scalzo Jones's The Voice of the Llanos. To help us understand these works and their political context, I use Timothy Snyder's On Tyranny, literary criticism, and texts connected to the current health crisis in Venezuela. Additionally, I highlight the resilience and coping mechanisms of Venezuelans, contributing to global discourse on health crises in politically unstable regions.
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Isaac Burge
University of California, Merced — English
UROC-H

Nerves & Spines: A Textual Analysis of the Significance of Nopal in the Florentine Codex

By: Isaac Burge, Felicia R. Lopez, PhD School of Social Sciences, Humanities and Arts, University of California Merced

The nopal, or prickly pear cactus, is a common cactus native to Mexico and the American Southwest. This cactus holds great cultural significance to the people of Mexico and is featured on the Mexican flag as an homage to the story of how Tenochtitlan, in today's Mexico City, became the capital of the Aztec Empire. The Aztecs, one of several indigenous Nahua groups of Central Mexico, have a rich tradition of oral and glyphic history, recorded in documents often referred to as codices. The Florentine Codex, a series of 12 books, meticulously documents the lives of the Nahua people and is written by Nahua authors and Spanish translators. By analyzing the textual and visual representations of the nopal in these books, I seek to understand the many roles that this essential plant played in the lives of the indigenous Nahua prior to and during Spanish colonization. By looking at the nopal's role as food, medicine, cultural and geographical symbol, and host for the parasitic and prized cochineal, I seek to foster greater understanding of the nopal's significance to the ancient Nahua people, and how their descendants have carried some of this knowledge into the modern world.

Michelle Vadillo Cuevas
University of California, Merced — Public Health and Psychology
UROC-H

Pharmacist Furnishing of Nicotine Replacement Therapy in California's Central Valley

By: Michelle Vadillo Cuevas, Sara Schneider, PhD, Nicotine & Cannabis Policy Center, UC Merced; Irene Yen, PhD, School of Social Sciences, Humanities and Arts, UC Merced

California's Central Valley region faces high rates of tobacco use, limited access to primary care providers, and poor access to proper tobacco cessation treatment. Through a process known as furnishing, pharmacists are authorized to prescribe Nicotine Replacement Therapy (NRT) products without a supervising physician. However, the extent to which Central Valley pharmacists are furnishing NRT products and the associated facilitators and barriers are not well understood. We explored these questions using qualitative data from three pharmacist interview transcripts and observational notes from one community member focus group. Interview transcripts were coded using ATLAS.ti to identify patterns within the data and analyzed using thematic analysis. Preliminary results from the interview data showed recurring furnishing barriers including pharmacists lacking provider recognition by insurance companies, the cost to patients, patients' preference for physicians, perceived lack of patient demand for furnishing, and cessation being a low priority. Within the focus group, two recurring barriers were participants' lack of knowledge of NRT furnishing and concerns about side effects. Future research should address these barriers and investigate shifts in furnishing practices resulting from interventions. These findings highlight areas where improvement is needed and ideas for how pharmacies may increase furnishing rates, which can help make NRT products more accessible and ultimately decrease tobacco-related diseases in the region.

Sarah Avina
University of California, Merced — Sociology
UROC-H

TAing for the UC system: A Qualitative study of the relationship between TA's, Instructors, and the UC System

By: Sarah M. Avina, Amanda Mireles, PhD; School of Social Science, Humanities, and Arts, University of California, Merced

The UC system is the biggest research university system in CA. Teaching assistants are both PhD students and training to be faculty. The relationship between instructors (faculty) and teaching assistants is central to the University of California's mission. This relationship can have challenges that lead to consequences for students' learning. This qualitative interview study explores the experiences of instructors and teaching assistants teaching core courses in Sociology across the UC system. The goal of our study is to understand the challenges instructors and TAs experience, how instructors and TAs communicate and work together, and how departments, instructors, and TAs support one another. In addition to better understanding the relationships and processes that support sociological teaching, another goal is to identify solutions that would improve TA management and experiences. Within this study, we anticipate finding evidence of challenges relating to communication, structure, as well as overall confidence teaching courses. This study will help us to not only understand the challenges that are happening but be able to combat them in the UC system to bring about a better environment for both TA's and Faculty and a better educational experience for students.

Niove Aragon
University of California, Merced — Public Health
UROC-H

Face Validity of the Spanish Version of the EFNEP Adult Questionnaire Across Multiple States

By: Niove Aragon, Karina Diaz Rios PhD RDN

In the U.S., approximately 41 million people speak Spanish as their primary language, with an additional 15 million using it as a second language. Despite the shared language, each Spanish-speaking country has its own distinct culture and vernacular. The objective of this study is to assess the suitability, face validity, and semantic equivalence of the Spanish version of the questionnaire used to evaluate the Expanded Food and Nutrition Education Program (EFNEP). EFNEP is offered nationwide and provides education to income-eligible youth and adults. The program focuses on improving diet quality, increasing physical activity, and strengthening food resource management skills. While the English version of this questionnaire has been extensively tested for validity and reliability, the Spanish version lacks similar validation. Given that a significant proportion of EFNEP participants are Spanish speakers, this study will provide evidence on the validity of the questionnaire to accurately measure changes due to EFNEP participation. We will use cognitive interviewing to understand participants' perceptions and ensure comprehension of the questions. These interviews will be conducted in Spanish by trained investigators via Zoom and guided by a semi-structured interview protocol. Researchers from California, New Jersey, Oklahoma, and Texas are collaborating to recruit EFNEP-eligible Spanish-speaking adults for this study.

Jose Meza-Pantoja
University of California, Merced — Psychology
UROC-H

Writing/Righting Authoritarian Regimes in Real Time: Political and Personal Struggles In Venezuelan Daily Life Under Chavismo

By: Jose Meza-Pantoja, Bristin Scalzo Jones, PhD; School of Social Sciences, Humanities, and Art, University of California, Merced

Since 1998, Venezuela has experienced the slow decay of democracy and the strengthening of its current authoritarian regime. This has resulted in one of the largest humanitarian crises in the present day, with 7.7 million Venezuelans having fled the country. In order to maintain its status quo, the Chavista regime has exposed countless Venezuelans to daily acts of violence, torture, and other traumatic events which have disrupted daily life. This research project focuses on analyzing the experiences of Venezuelans to understand how they experience these political and personal struggles and how they situate themselves in their present historical context. To do so, I analyze recent texts, both fictional — including the novels La hija de la española and The Voice of the Llanos — and nonfictional—including the text Testimonios de la represión, that relate to Venezuela's current political situation, as well as interviews conducted with Venezuelans who have lived through this authoritarian regime. These findings help us to understand the role that everyday citizens play in shaping the social and political structures that surround them and in turn to promote democratic processes, not just in Venezuela but across the American continent.

Sandra Hernandez
University of California, Merced — History
UROC-H

Analysis of Amaranth Use in the Nahua Culture: Insights from the Florentine Codex

By: Sandra Hernandez

The Florentine Codex is a digital encyclopedia that offers access to a unique manuscript created in the 16th century by Franciscan friar Bernandino de Sahagun and Nahua artists, elders, and authors. This encyclopedic codex contains texts in both Nahuatl and in Spanish as well as hundreds of hand-painted images. These detailed descriptions provide an invaluable insight into various aspects of the Nahua culture. This research project focuses on the use of amaranth in the Nahua culture. Amaranth was banned among the Nahua people by Spanish colonizers during the conquest of the Americas. The religious and cultural significance of amaranth in Nahua culture is profound and multifaceted, extending beyond its nutritional value to encompass ceremonial and symbolic dimensions. This research project aims to uncover and analyze these dimensions by studying entries from the Florentine Codex. This involves identifying and examining entries that reference amaranth, as well as contextualizing these references within the broader scope of religious and cultural practices of the Nahua people. The analysis of the entries indicate that amaranth was essential in creating ritual items to honor deities and ancestors. Amaranth seed dough was used to shape the embodiments of deities which would be part of important festivals and rituals. This research project also contributes to a broader understanding and appreciation of Nahua culture and heritage. In recent decades, the resurgence in the interest and cultivation of amaranth serves as a powerful reminder of the importance of preserving and honoring indigenous traditions and knowledge.

Wolf Race

Wolf RACE (Resource Availability and Competition in Ecosystems) Examining the effects of Climate Change on Wolf Ecology - Insights from The McKittrick and Rancho La Brea Lagerstätte

This project explores how marine resources impact wolf and coyote ecology both in modern and ancient systems. One component of the project studies pre-historic and historic wolf ecology in Sweden. The UROC project this summer developed a method to screen fossil samples from ‘tar pit’ sites for suitability for stable isotope analysis and C-14 dating. This project is funded by a NSF award from Sedimentary Geology and Paleobiology (2138163) to Drs. Robin Trayler and Sora Kim.

DaeVionn Chew
University of California, Merced — Anthropology
Wolf Race

A Morphometric Approach to Dietary Identification within Prehistoric Sharks

By: DaeVionn Chew1, Mohamad Bazzi2, Gabriele Larocca Conte1
1Life & Environmental Sciences, University of California Merced; 2Earth & Planetary Sciences, Stanford University.

Elasmobranch fishes, which include sharks, rays, and skates, have an extensive evolutionary history. Their fossil record, predominantly comprising isolated teeth, is globally distributed across various marine deposits. While many studies focus on their taxonomy, the ecology of fossil taxa remains largely unexplored. Here, we compared the functional morphology of shark tooth specimens (n = 37) from two fossil sand tiger taxa collected from the Eocene deposits of Antarctica, Carcharias sp. and Striatolamia macrota. We digitalized sand tiger shark teeth using a two-dimensional landmark-based geometric approach in order to assess differences in dietary preferences based on the breadths of their dental morphospace. We quantified the morphological disparity between species using Principal Component Analysis (PCA) and a Procrustes Analysis (GPA). The PCA shows that the PC1 and PC2 explains the 70.99% and 11.87% of the total variation, respectively, where species share similar distributions along both principal components. The GPA supports no statistically significance between species (p value < 0.05). These findings infer that there are no differences in tooth shape between species, which could indicate similar dietary preferences between Carcharias sp. and S. macrota. Further investigation on tooth morphology could determine generalist or specialist feeding behavior of the species, a critical component to understanding the evolutionary history of some sand tiger sharks.

NSF ECO-CBET

NSF ECO-CBET: Collaborative Research: Effect of surface-fuel attributes and forest-thinning patterns on wildfire, carbon storage, and advancing forest restoration

The goal of this project is to develop metrics of the impact of fuel treatments on fire behavior across a range of spatial and temporal scales. This project will contribute to improved understanding of how surface-fuel attributes, resulting from management decisions, influence fire behavior and severity and thus forest biomass carbon storage. This material is based upon work supported by the National Science Foundation under Grant Number (NSF Grant Number: 2318717). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Marie Cruz
University of California, Merced — Biology
NSF ECO-CBET

Investigating the Effect of Wind Speed and Fuel Size on the Heat Release Rate of Wildland Fire at a Laboratory Scale

By: Marie M. Cruz, Ehsan Ameri; Department of Mechanical Engineering, Jeanette Cobian-Iñiguez, PhD; Department of Mechanical Engineering

Wildfires can often spread rapidly due to multiple factors. A forest fuel management technique known as mastication eliminates smaller, non-fire-resistant trees, leaving wide spacing between the remaining trees. Mastication has been an effective way to create fuel breaks, decreasing the fire spread rate and reducing the risk of wildfire. However, the chopped fuels left on the forest floor increase the surface fuels, which can lead to higher fire intensity. Wind can exacerbate these surface fires, allowing them to spread more easily. To imitate real forest fuel on a laboratory scale, a wind tunnel and three fuel sizes of 1/8, 1/4, and 3/8 inch polar wood are used. The output parameter is the heat release rate, which is computed by analyzing the mass loss rate. By comparing the weight before and after burning, the mass loss rate is measured on a precise scale. Additionally, the effect of a uniform wind speed is investigated. Thus far, the results have shown that increasing the fuel size diameter decreases the heat release rate.

Juan Hernandez
University of California, Merced — Mechanical Engineering
NSF ECO-CBET

Investigating the effect of wind speed and fuel size on the rate of fire spread for wildland fuels in the laboratory scale

By: Juan Hernandez, Jeanette Cobian-Iñiguez, PhD, School of Engineering; Ehsan Ameri; Shusmita Saha

To mitigate the risk of wildfires during forest fuel management, the fuel reducing treatment of mastication allows for more widely spaced trees through the chopping of smaller, less fire-resistant trees. This effectively creates fuel breaks to stop a fire from spreading, thus reducing the risk of rampant wildfires. However, the resultant chopped fuels left on the forest floor increase the surface-fuel loading and as a result, may increase potential fire intensity, along with the effects of wind. In this research, 1/8, 1/4, and 3/8 inch uniform diameter fuels constructed from poplar wood are utilized to be burned to imitate real forest fuel, which is achieved in the laboratory scale through the use of a fire wind tunnel at UC Merced. The resulting output parameter is the rate of spread (ROS) at which the fuels burned, which is computed from evenly spaced thermocouples embedded in the fuel bed, as well as a computer vision algorithm that analyzes the visual data from the flame recordings via a high-quality camera. Moreover, the effect of a uniform wind speed is investigated in this research and thus far, our results show that increase of fuel size diameter causes a decrease in the rate of spread, demonstrated by both ROS calculation methods.

Fort Lewis College REU

The Summer Research Program for Fort Lewis College students, is a partnership designed to engage undergraduate students from Fort Lewis College in academic research alongside a faculty mentor at the University of California, Merced. Participants will develop critical research skills as well as improve their communication skills through the presentation of their research results in both written and oral forms. The training students receive through this program will prepare them to succeed in graduate school and jumpstart their careers in research, leadership, and public service. Fort Lewis College students will be integrated into the rich research culture at UC Merced, with the hopes that they will ultimately enroll in a doctoral program of study at UC Merced.

Jaelynn Begay
Fort Lewis College — Biology with a concentration in Cellular and Molecular Sciences
Fort Lewis College REU

Effects of exogenous thyroxine on cardiac GLUT4 in response to a glucose challenge in insulin resistant OLETF rats

By: Jaelynn S. Begay, Dora A. Mendez, Rudy M. Ortiz

Metabolic Syndrome (MetS) is characterized by six risk factors: dyslipidemia, high blood pressure, high blood sugar, inflammation, insulin resistance, and obesity. The presences of three or more of these characteristics indicates that the individual is at high risk for developing diabetes. Previous studies have shown that exogenous Thyroxine (T4) has increased GLUT4 translocation, AS160 phosphorylation, hexokinase proteins and PFK-1 mRNA in heart tissues of the model Otsuka Long Evan Tokushima Fatty (OLETF) rats. Therefore, to further understand the effects of exoT4 on cardiac glucose metabolism rats were assigned to three groups 1) lean, Long Evans Tokushima Otsuka (LETO; n=7), 2) untreated OLETF (n=6), and 3) OLETF+T4 (8 µg/100g BM/d × 6wks, n=7). To investigate the dynamic shifts in glucose metabolism and GLUT4, animals were dissected after an oral glucose challenge (fasting 1 and 2 hours post-glucose). Based on previous data we hypothesize that T4 will continue to increase and restoreGLUT4 translocation in response to a glucose loas in OLETF rats. The results of this study will help to further an understanding of how exogenous T4 can help increase glucose metabolism in type 2 diabetic individuals while lowering the risk of MetS.

Tyler Eckerman
Fort Lewis College — Biochemistry
Fort Lewis College REU

The Role of Proline Residues in the Metamorphic Fold Switching of KaiB

By: Tyler Eckerman, Andy LiWang, University of California Merced

Circadian clocks provide an internal representation of time to ensure that metabolic processes are regulated in anticipation of sunrise and sunset. It is now widely accepted that the metabolic rhythms produced by circadian clocks are profoundly important to health and reproductive health fitness. Our lab investigates the cyanobacterial circadian clock because it is composed of only three relatively small proteins, and uniquely it can be reconstituted in vitro. Understanding the mechanisms behind these proteins can help us understand how circadian rhythms work in more complex organisms. KaiB is an essential part of this three-protein complex and plays a large role due to its ability to switch between two different folded states. Three proline residues in KaiB (P63, P70, P72) play important roles in KaiB's ability to switch folds isomerizing between cis and trans configurations. We hypothesize that by separately substituting each proline residue to alanine will allow us to determine whether their isomerizations are equally important for fold switching or whether their roles are hierarchical. To measure the effects of these proline-to-alanine mutations we also substituted residue K26 for cysteine, allowing us to attach a thiol-reactive 19F label to the protein. We will carry out 19F NMR to see how the separate P63A, P70A, and P72A substitutions affect the fold-switching behavior. We suspect that one of these prolines will play a more important role in KaiB's ability to switch folds.

Adrian Magun
Fort Lewis College — Environmental Science
Fort Lewis College REU

The Effect of 20 Years' Added Seasonal Precipitation on Deep Soil Biogeochemistry
By: Adrian L. Magun1, Leila M Wahab2, Stephany Chacon2, Asmeret Berhe2
1Fort Lewis College, 2University of California, Merced

Due to global climate change and South-migrating sub-polar lows, California is expected to receive additional rainfall. However, the timing of the additional precipitation remains to be determined, with some models predicting that it will occur as additional rainfall during the already wet season, while others predict that it will occur during the late spring and summer months. It is not currently fully understood what the effects of California's changing precipitation regime will be on soil biogeochemistry and at what rate the effects may occur. To determine if nutrient cycling and availability could change significantly over a 20-year period of mild precipitation change, we analyzed soil samples collected from a 20-year-long controlled precipitation experiment designed to mimic future precipitation trends. By comparing exchangeable cation (EC) and X-ray fluorescence (XRF) mineral data across a range of soil depths, we quantified differences in major and minor element concentrations in soil across soil depths of 50-280cm. Preliminary XRF results suggest no significant element concentration differences between treatments. Complete results and conclusions will be presented at the 2024 UROC Annual Summer Symposium.

Mariah Benally
Fort Lewis College — B.S. Cellular & Molecular Biology
Fort Lewis College REU

"I could be red, I could be blue, I could be... purple?". Insertion of a purple, fluorescent marker into the Tn7 site for in situ visualization of Vibrio fischeri during colonization.
By: Mariah R. Benally, Joaquin Lucero, Michele K. Nishiguchi, Ph.D.

Vibrio fischeri is a bioluminescent marine bacterium that forms a mutualistic relationship with sepiolid squids (Cephalopoda: Sepiolidae), providing counter-illumination from prey, by using bioluminescence. This environmentally transmitted symbiosis involves host specificity, by selecting only V. fischeri strains to colonize the squid's light organ. Evidence supports a native strain bias in different host sepiolids,, but the localization of native versus non-native strains during competition is not well understood. Thus, we hypothesize that native V. fischeri strains outcompete subdominant and non-native strains due to a preference for nutrient-rich areas in the light organ. To test this, we genetically modified V. fischeri to produce a fluorescent pigment, allowing visualization of their localization within the light organ. Our study focused on V. fischeri ETTB1-C, isolated from the Australian dumpling squid, Euprymna tasmanica. The plasmid pJCL003, contains fluorochrome mRFP_Magenta, was integrated into the ETTB1-C genome at the Tn7 site. Fitness assays were performed to measure if there are any costs to the bacteria due to the insertion of the mRFP_Magenta. Results from this study will provide tools to better visualize and understand the behavior and interactions within symbiotic systems.

I-BEST REU

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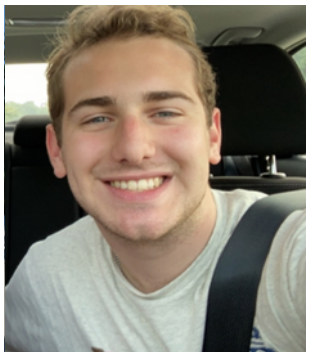
Katelyn Lunny
Worcester Polytechnic Institute — Biomedical Engineering
I-BEST REU

Elucidating the role of fibronectin conformation on synovial fluid film formation using a simple model of articular cartilage surface

By: Katelyn L. Lunny, Syeda Tajin Ahmed, PhD, Dept. of Materials Science and Engineering, University of California-Merced; Roberto C. Andresen Eguiluz, PhD, Dept. of Materials Science and Engineering, University of California-Merced

Synovial fluid (SF) is a lubricant found between articulated joints that reduces friction and surface damage during movement. The molecular mechanisms through which articular cartilage surface extracellular matrix proteins regulate the adsorption of SF components remain unclear. Pathologies like arthritis can impact the concentration and conformation of these proteins, such as fibronectin (Fn). This research investigates the hypothesis that unfolded Fn protein conformation facilitates the adsorption of SF components for the formation of a lubricating and protecting film. The adsorption of SF components is quantified using Quartz Crystal Microbalance with Dissipation (QCM-D), recording frequency and dissipation changes in a resonating quartz crystal. The QCM-D crystal surface is functionalized in this model with Fn, to mimic the Fn at the articular cartilage surface. The Fn precursor film is formed from 10-100 ug/ml in pH 4 to induce conformational changes. Then, SF at 25% dilution is flowed over the crystal surface in the QCM-D fluidic chamber. The adsorbed mass of these films is quantified using the Sauerbrey equation, which relates frequency changes of an oscillating quartz crystal to mass changes. Preliminary results show important differences in SF adsorption on Fn films formed at pH 4 (unfolded) vs. pH 7 (compact).



Michael Ziegenfus
Worcester Polytechnic Institute — Physics - Biophysics Concentration
I-BEST REU

Passivated Near-Infrared Emitting Microcrystals for In-Vivo Fluorescent Imaging

By: Michael A. Ziegenfus, Thomas Adams, School of Natural Sciences; Sayantani Ghosh, PhD, School of Natural Sciences

Near-infrared (NIR) light, with wavelengths ranging from 700-1000nm, offers superior prospects for biological imaging compared to visible light. NIR-absorbing and emitting materials have shown promising results in in-vivo fluorescent imaging, enabling high-resolution deep-tissue imaging. However, these materials often contain lead and are susceptible to photobleaching, raising toxicity concerns and limiting their utilization.
Metal halide perovskites, such as CsSnI3, demonstrate resistance to photobleaching, high light absorption/emission efficiencies, and low-cost synthesis. However, CsSnI3 faces stability issues due to the oxidation of Sn^{2+} to Sn^{4+} when exposed to humidity. Phthalimide (PTM) has been identified as an effective passivating agent that restricts this oxidation by engineering the localized electron density.
This research fabricated and optically characterized passivated CsSnI3 microcrystals (CsSnI3-PTM). The CsSnI3-PTM was synthesized by adding 1.0 mg PTM to the CsSnI3 precursor solution in a nitrogen atmosphere under low humidity (10%-16%). CsSnI3-PTM was characterized using photoluminescence (PL) spectroscopy. CsSnI3 and CsSnI3-PTM microcrystals were excited using a 532nm laser, with respective excitations of 2450μW and 209μW. Comparable PL intensities demonstrated over 10x greater efficiency of NIR emission relative to excitation power. Results showed little to no degradation after 120 hours in vacuum and 4 hours of high humidity (45%-61%) exposure. With increased PL efficiency and resistance to degradation in high-humidity environments, CsSnI3-PTM presents significant potential as an NIR emitter for in-vivo fluorescent imaging.

Donte Wyatt Jr.
Hampton University — Integrative Biology
I-BEST REU

Pillars of Bacteriology: Swimming E. coli in Microfluidic Structures
By: Donte T. Wyatt Jr, Pooja Chopra, PhD, Bin Liu, PhD

Bacterial motion through microfluidic structures has been a promising field of research. In this experiment, wild-type Escherichia coli bacteria were added to a pre-made polydimethylsiloxane (PDMS) micropillar array, in order to observe the organisms' motility under given microstructure geometry. The microscopic pillars were 10 µm in height and 30 µm in diameter, with a 10 µm edge-to-edge distance. The reduced height in this experiment (compared to prior research) prevents the bacteria from moving vertically, allowing them to be observed in solely two-dimensions. Other experiments, utilizing non-tumbling E. coli, discovered that they tended to move in rotation around the pillars. This experiment hypothesizes that the tumbling behavior of the bacteria will cause them to spend less time moving around the pillars, and more time moving between them. The bacteria were observed through a tracking microscope that used a camera to record their location and motion, saving the data as images, which were then analyzed using MATLAB. The results help to explain how the tumbling behavior of wild-type bacteria affects their motility in their natural environment.

Avery Dolins
Emory University — Physics - Biophysics
I-BEST REU

Snug as a Hexbug in a Boundary: Escape Times of Differently Shaped Chiral Hexbugs
By: Avery E. Dolins; Monika Sanoria, PhD, School of Natural Sciences; Ajay Gopinathan, PhD, School of Natural Sciences; Kinjal Dasbiswas, PhD, School of Natural Sciences

From microtubules to flocks of birds, many biological and natural systems can be treated as active matter. Recent studies have shown that Hexbugs – a bug-shaped children's toy powered by a vibrating motor – are an effective tool to model the movement of many types of active matter. We are interested in studying the escape times of Hexbugs to understand how bacteria maneuver through porous spaces, such as soil or extracellular matrices. While the escape times of active matter in circular spaces have been studied theoretically, researchers have yet to study the escape times of active objects of different shapes with an experimental approach. For this project, singular Hexbugs with attached Styrofoam shapes were released in a circular boundary. Their movement and time spent inside the boundary before escaping were tracked and analyzed. This method has shown that shape and chirality have a significant impact on the movement and escape time of experimental active matter models. These results provide a better understanding not only of how differently shaped bacteria could move through and interact with a porous space but also an expansion of the applications of Hexbug modeling to the study of active matter.

Yovanny Solorio
University of California, Merced — Molecular & Cell Biology
I-BEST REU

The Role of the N - Terminal Half of the Metamorphic Protein KaiB

By: Yovanny Solorio, Andy LiWang, University of California Merced

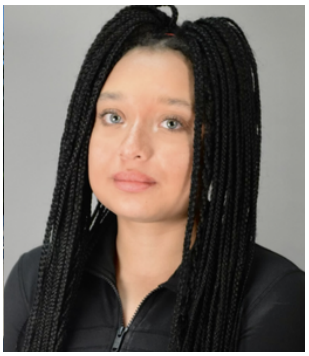
It is now commonly acknowledged that circadian clock-produced metabolic rhythms play a significant role in maintaining health. Our research investigates the cyanobacterial circadian clock as it consists of only three proteins and is the only clock that can be reconstituted in vitro. Comprehending the workings of these proteins can aid in our understanding of how circadian rhythms function in more intricate systems. During the circadian clock oscillations in cyanobacteria, KaiB is responsible for inactivating the autophosphorylation activity of KaiC. KaiB belongs to the rare class of so-called metamorphic proteins, which can adopt two distinct folds reversibly. This fold-switching behavior of KaiB was discovered unexpectedly by the A. LiWang lab. Our goal is to better understand the mechanism of KaiB fold switching by testing the hypothesis that the N-terminal half is stable by itself. Thus, we will express the first 45 amino acids on the N-terminal half of KaiB and determine the extent to which it is stably folded on its own. We aim to test our hypothesis on the Thermosynechococcus elongatus(T.elongatus) and Synechococcus elongatus (S.elongatus) bacterial strains. T. elongatus is significant for structural biology studies and its thermophilic nature, allowing it to tolerate high temperatures. S. elongatus, on the other hand, is best used for technical experiments, such as studying circadian rhythmic oscillations. By engineering DNA plasmids, expressing the protein, and using chromatography techniques to purify the protein constructs, we finally verify the fold-switching mechanism with two-dimensional N15 NMR spectroscopy.

Rose Rudresh
University of California, Merced — Human Biology
I-BEST REU

Proximity Labeling in Ciliary Research: Overcoming Challenges in Biotin-Rich Environments

By: Rohana Rudresh, Emily Skates, PhD, Xuecai Ge, PhD

Primary cilia are sensory organelles present in most cells and play a fundamental role in essential cell-signaling pathways. They are critical for the proper development and function of the body, with dysfunctions of cilia underlying a diverse spectrum of human pathologies. Ciliopathy patients will commonly exhibit atypical neurodevelopment. To understand how primary cilia signaling pathways control brain development, proximity-labeling techniques can be used to specially label proteins in the cilium. The APEX2-proximity labelling technique utilizes a genetically engineered peroxidase enzyme that can be expressed to a specific subcellular compartment, such as the primary cilia, and tag nearby proteins. However, due to the technique's reliance on biotin, the high levels of endogenous biotin in the brain causes non-specific labeling and high background signal. To mitigate the interference of endogenous biotin, we aim to optimize and modify the APEX2 proximity-labeling method. Our initial work has successfully confirmed the localization APEX2 within the primary cilia by immunofluorescent staining in both our stable cell lines and transgenic mouse model. Further work has determined conditions which provide the optimal labelling of proteins in live cells and begun to work towards optimizing in our mouse model. As a result, we now begin to explore modification of the methodologies to further improve on existing labelling methods.



Lourdes Johnson
Wilbur Wright College — Biomedical and Chemical Engineering
I-BEST REU

Evaluating effects of consensus based mutations on each independent EF-hand of calnuc

By: Lourdes Johnson, Jesse Rodriguez-Reyes, Victor Muñoz

Calcium serves as a secondary messenger and is imperative in the function of cells, such as muscle cell contraction, T-cell activation, cellular apoptosis, and more. Previous work in the Munoz lab led to the engineering of a high-performance biosensor that paired the protein calnuc with Förster resonance energy transfer, or FRET, to detect and measure calcium ions. Consensus protein design had been used to engineer variants with a higher affinity by introducing mutations into both EF-hands, but a broadened dynamic range variant was made instead and it is not understood why the mutations had this effect. The goal is to understand which amino acid mutations led to the broadened dynamic range. To study how the mutations on each EF-hand affect the sensor, we created two variants with the broadband sensors mutations only on EF-hand 1 or EF-hand 2. The new variants were expressed in e-coli and were purified using different chromatography techniques, such as affinity chromatography, ion exchange chromatography, and size exclusion chromatography and the purity assessed by SDS-PAGE and mass spectrometry. By using fluorimetry to conduct calcium titrations on these purified proteins, we were able to study the effects of these mutations. The fluorimetry experiments show that the sensors can still respond to calcium by increasing its FRET ratio and the titrations reveal the effects of the mutations on each EF-hand.

Asher Skiles
Indiana University of Pennsylvania — Physics
I-BEST REU

Filament Dynamics of Chained Active Matter Hexbugs

By: Asher I. Skiles, Monika Sanoria PhD School of Natural Sciences, Kinjal Dasbiswas PhD School of Natural Sciences, Ajay Gopinathan PhD School of Natural Sciences

Filament dynamics are an important part of biophysics which govern how filents move and behave. A prominent example of filament dynamics occurs within microtubules. While active chains have been studied, chiral active ones have not where propulsion is off-axis. Recent theoretical work from our group has shown that such filaments can exhibit non-Gaussian curvature distributions and symmetry broken rotations. We plan to test these results experimentally by building macroscopic active filaments composed of hexbugs. We studied how persistence, rotation and escape times changed with flexibility and off-axis propulsion and compared them to theory. We have built an experimental platform to test the theories and that this work can lead to more insights into the dynamics of chiral active filaments.
"

Anthony Ramos
University of California, Merced — Bioengineering
I-BEST REU

Investigating the DNA binding behavior of WOPR

By: Anthony A. Ramos, Joshua Quintong, Muñoz Lab, School of Engineering, University of California, Merced

Transcription factors (TFs) such as Wor-1 are an important regulator for managing the expression of hundreds of genes in the cell. Understanding how these proteins bind to different DNA sequences can help grasp cellular dysfunction and pathogenesis. WOPR is the DNA binding domain within Wor-1 that binds to naked DNA, and the lab hypothesizes that it will bind to nucleosomes, which would make Wor-1 a pioneer transcription factor. WOPR was expressed within E. Coli cells and purification of the protein was accomplished with Ion exchange chromatography since WOPR has a high isoelectric point. Next the lab plans to label the protein with Alexa 488 (fluorescent probe) via maleimide chemistry to ultimately calculate binding affinities using single-molecule fluorescence correlation spectroscopy (FCS) with different DNA sequences and the lab's proprietary analysis methods. Absolute affinities can be found by fitting our FCS data globally to our model of 2D-translational diffusion for the WOPR protein with a range of DNA concentrations. With regards to nucleosome binding, the lab will test various imperfect motif clusters that are expected to have broad binding affinities. This might be due to the clusters having many short simple sequences that WOPR can recognize easily. To these ends, the lab has established an expression/purification protocol for WOPR, and the lab plans to determine WOPR binding affinities in the near future.

Amy Thiam
University of California, Santa Cruz — Neuroscience
I-BEST REU

Tissue-Specific Fluorescent Protein Tagging in Developmental Research

By: Amy D. Thiam, German Paniagua, Dr. Stephanie Woo

There are many tools to study developmental biology, aiding in understanding how organisms grow and change from a single cell to a complex being. Fluorescent protein fusion is a key method, but it faces challenges, such as difficulties in inserting the full-length fluorescent protein sequence at the endogenous gene locus and the inability to visualize broadly expressed proteins in a tissue-specific manner due to overlapping fluorescence signals. Splitting a fluorescent protein like mNeonGreen2 (mNG2) into $mNG2_{1–10}$ and $mNG2_{11}$ can address these issues. Individually, these fragments are non-fluorescent, but they self-assemble into a functional fluorescent protein when co-expressed. This method involves inserting $mNG2_{11}$as a tag at the protein's gene locus and expressing $mNG2_{1–10}$ under a tissue-specific promoter via transgenesis. The newer mNeonGreen3$K_{1–10}/_{11}$ (mNG3$K_{1–10}/_{11}$) system improves on this with higher resolution, brightness, and earlier fluorescence detection in zebrafish embryos. To create transgenic zebrafish expressing mNG3$K_{1–10}$, a plasmid is assembled for Tol2 transgenesis using Gibson assembly, combining DNA regulatory sequences like the Sox32 promoter (specific to the zebrafish endoderm) and the mNG3$K_{1–10}$ coding sequence. Overall, the mNG3$K_{1–10}/_{11}$ system enables tissue-specific visualization of proteins at endogenous levels by controlling the co-expression of both fragments, offering a powerful tool for developmental biology studies.

SHARKS

The Earth's climate has changed through time and during the Eocene Epoch (56 to 34 million years ago) there was a transition from 'greenhouse' to 'icehouse' conditions. During the Eocene, a shift to cooler temperatures at high latitudes resulted in the inception of polar glaciation. This in turn affected the environment for living organisms.

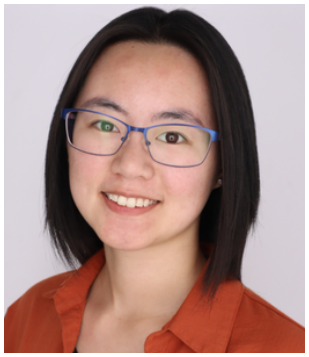
This project looks to uncover the interaction between biological, oceanographic, and climate systems for the Eocene in Antarctica using chemical analysis of fossil shark teeth collected during past expeditions. The combination of paleontological and geochemical analyses will provide insight to the past ecology and ocean conditions; climate models will be applied to test the role of tectonics, greenhouse gas concentration and ocean circulation on environmental change during this time period. The study contributes to understanding the interaction of increased atmospheric carbon dioxide and ocean circulation. This project also seeks to improve diversity, equity, and inclusion within the geosciences workforce with efforts targeted to undergraduate, graduate, postdoctoral, and early career faculty.

Anthony Vazquez
University of California, Merced — Environmental System Sciences
SHARKS

The Diet and Movement of Neonatal through Juvenile Bull Sharks (Carcharhinus Leucas) in Crystal River/Kings Bay, Florida

By: Anthony Vazquez, Alyssa Andres, PhD, Sora Kim, PhD

Natural Florida freshwater springs that provide thermal and saline stability year-round make coastal springs systems ideal nursery habitat for temperature-sensitive bull sharks that rely on low-salinity coastal waters for survival. To understand the shifting importance of such ecosystems for the success of this top predator in an era of rapid climate change, we must understand how this species' young associates with spring-fed systems as nurseries and thermal refuge. Through stable isotope analysis of water/shark biological samples collected in Kings Bay/Crystal River, we hope to identify shark waterway use and relative trophic trends across time and ontogeny in the C. leucas population. Muscle biopsies were collected from neonate-juveniles through the Crystal River Bull Shark Project fisheries independent survey between 2023-2024. Samples were transported to UC Merced where we conducted stable isotope analysis (δ13C/δ12C and δ15N/δ14N) through a series of lipid/urea extractions via elemental analyzer. Results from stable isotope analyses allow us to identify shark use of the Crystal River/Kings Bay waterway across seasons and life stages, identify habitat/diet partitioning, and trophic trends in the population. Results contribute to a larger effort categorizing this springs system as nursery, effective juvenile habitat, and thermal refuge for C. leucas and to identify how it associates with this ecosystem across vulnerable life stages.



Ashley Liao
University of California, Merced — Biological Sciences, Emphasis in Microbiology & Immunology
SHARKS

Killer Whale Ecology in Sweden: Isotopic Food Web Analysis of the Past 150 Years

By: Ashley Liao, Robin B. Trayler, PhD, Sora L. Kim, PhD, School of Natural Sciences, University of California, Merced

Trophic niche and dietary patterns of organisms can be determined by stable isotope analysis of their tissues which can be used to reconstruct food webs. Currently, there is a lack of data regarding how apex marine predators (killer whales; Orcinus orca) have adapted to environmental changes through time. Furthermore, killer whale prey specialization can vary within limited geographic areas. We analyzed killer whales and their potential prey to gain insight into how the marine ecosystem has been affected by and adapted to factors including climate change and resource availability throughout the past ~150 years. Tissue samples from killer whales (n=29) and their prey (n=33), e.g. fish, seals, and sharks, were collected by the Swedish Museum of Natural History and analyzed at UC Merced for δ13C and δ15N values. δ13C and δ15N values reflect diet and trophic position and can be used to determine prey preferences. We used a Bayesian mixing model to calculate the proportion of each prey species in the diet of the killer whales. We also investigated changes in their isotope niche space through time to shed light onto how species have adapted and changed their diets in response to a changing climate over the past ~150 years. This information will help identify long-term challenges that marine predators face and support conservation efforts for these species.

Lelah Munyer
University of California, Merced — Environmental System Sciences
SHARKS

Using Stable Isotope Analysis to Understand Ecological Dynamics of Bull Sharks (Carcharhinus leucas)

By: Lelah A. Munyer, Sora Kim, PhD, School of Natural Sciences; Life and Environmental Sciences University of California, Merced

Crystal River in Tampa Florida is home to many species of wildlife one of which is bull sharks or Carcharhinus leucas.This location believed to house the pupping grounds and home to the neonates of bull sharks, making this area a critical location for the reproduction and fostering of Bull Sharks. By analyzing the dissolved inorganic carbon (DIC) in the water and the organic components in the dentin, collagen, and enameloid from bull shark teeth, we seek to understand the relative contributions of environmental and dietary carbonates. This will create a bridge between classical paleo and modern techniques. The results of this research will provide insights into the ecological dynamics of bull sharks in the Crystal River and contribute to the broader efforts to preserve their habitat and support their population growth.

Acknowledgements

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