SUMMER UNDERGRADUATE RESEARCH POSTER SESSION

ABSTRACT BOOK

Wednesday, July 30, 2025

Interdisciplinary Life Sciences Building Lobby

Morning Session

10:00 AM – 12:00 PM

Afternoon Session

2:00 PM – 4:00 PM

Undergraduate Research

DIVISION OF ACADEMIC AFFAIRS

Office of Undergraduate Research

Summer Poster Session

ABSTRACT BOOK

July 30, 2025

TABLE OF CONTENTS

MORNING SESSION | 10:00 AM-12:00 PM

Poster 1. Jason Castro **Page 16**
Design of an Automated Liquid Nitrogen Filling System for Germanium Clover Detectors

Poster 2. Gabe Daniels **Page 16**
Precision Quantum Sensing Spectroscopy of Radioactive Molecular Ions with Active Environmental Control

Poster 3. Lovie Deloney **Page 17**
Feasibility Study of Astatine-211 Production via Laser-Plasma Interactions

Poster 4. Adrian Martinez **Page 17**
Energy Distribution of Proton Beams Degraded by Rotating Aluminum Foil Wheel for Space Radiation Simulation

Poster 5. Zoie Gavel **Page 18**
Nutritional Status during Adolescent vs Adult Pregnancy in the US: A Systematic Review

Poster 6. Aubrey Shaw **Page 18**
Body Composition Analysis of Genetically Diverse Mice Fed American vs. Japanese Dietary Interventions

Poster 7. Kira Buza **Page 19**
Histological Assessment of Hepatic Steatosis and Fibrosis in Response to Intermittent Fasting and GHSR Deletion in High-Fat Diet-Induced Obesity

Poster 8. Sarah Grace Wisener **Page 19**
Nutritional Differences in Adolescent Versus Adult Pregnancy: A Systematic Review

Poster 9. Sam Gracia **Page 20**
GHSR-Mediated Fibrosis and Immune Cell Senescence in Mouse Hearts Across Chronological Aging

Poster 10. Roxanne Valle **Page 20**
Pcsk6 Deletion and Liver Lipotoxicity

Poster 11. Riya Tom **Page 21**
Aging Signatures and Inflammation with Epigenetic Reprogramming Intervention In B6 Mice

Poster 12. Anna Tillinghast **Page 22**
Impact of Binding Density on Measurement of Telomere Length Using Cas12a

Poster 13. Ashlee Ballard **Page 22**
A Low Frequency Atlas of Radio-Quiet AGN

Poster 14. Dalys Guajardo **Page 23**
Skipper CCD Spectrograph

Poster 15. Simone Sheridan **Page 23**
Python and GPIO Integration for Button Control Restoration on the Otto Struve 82' Telescope

Poster 16. Catherine Chaison **Page 24**
Power Spectrum Computation of Optically Confirmed Sunyaev-Zel'dovich Galaxy Clusters

Poster 17. Mary Knowlton **Page 24**
Measuring The Dust and Gas Fuel in a Sample of Distant Post-Starburst Galaxies

Poster 18. Nicholas Garcia **Page 25**
Low-Frequency Atlas of Swift-BAT X-ray Selected AGN

Poster 19. Izzi Oaks **Page 25**
Constructing a Library of OSIRIS Velocity Template Stars

Poster 20. Liv Moody **Page 26**
Peculiar Stellar Ages across a Peculiar Galaxy

Poster 21. Abigail Reynholds **Page 26**
Synthesis and Structural Characterization of Bifunctional Naphthalene Derivatives Featuring Antimony and Carbeniums

Poster 22. Emma Webb **Page 27**
Click Detect: Immuno-amplification-based Detection of Shiga Toxin 2

Poster 23. Justin Chan **Page 27**
4-Axis 3D Printing for Improved Mechanical Properties

Poster 24. Blaise Corcia and Alexandra Raimondi **Page 28**
Effects of Process Parameters in Creating Micro-Scale Features in Laser Powder Bed Fusion Parts

Poster 26. Neshini Sathishkumar **Page 28**
Understanding UV properties of Host Galaxies of Supernovae

Poster 27. LaVena Tilger **Page 29**
Exploring the Proper Motion of the Andromeda Galaxy with Gaia

Poster 28. Tomas Gomes, Savannah Miller, and Sarah Urbansky **Page 29**
Ultraviolet Observations of Exploding Stars

Poster 29. Megha Nagalla **Page 29**
Thin Foil Preparation for Excitation Function Measurement of the Medically Desirable 149-Tb

Poster 30. David Keltner **Page 30**
Modeling the Behavior of Heavy Ions Incident Upon a Novel Detector

Poster 31. Oliver Fast **Page 30**
Analysis of Toponium Mass Spectra with the T-Matrix Formalism

Poster 32. Gabriela Escobedo **Page 31**
Nuclear Matter Response Functions and Cross Sections in Core-Collapse Supernovae.

Poster 33. RJ Devlin **Page 31**
A Machine Learning Approach to Multi-Directional Neutron Detection

Poster 34. William Lippincott **Page 32**
Role of Meson Excited States in Hybrid Hadronization post Electron-Positron Annihilation

Poster 35. Nathan Morales **Page 32**
Sample Holder for High Purity Germanium Gamma Ray Detector

Poster 36. Layla Koon **Page 33**
Characterization of Thin natSn Targets for Nuclear Reaction Experiments

Poster 37. Erin Clark **Page 33**
The Concentration Distribution of Astatine-211 in Column for Transport

Poster 38. Eva Chalona **Page 34**
Characterization of Ion Bunches using GOLIATH, the Gas-Operated Large Ion bunch and Atomic Trap for He6-CRES

Poster 39. Isabelle Adams **Page 34**
Testing a Prototype Detector Array on a Chip Using Heavy-Ion Beams

Poster 40. Brooke Moskovitz **Page 35**
Optimizing Methods to Synthesize Low-Valent Aluminum Species

Poster 41. Ava Daly **Page 35**
Chemical Probing of Variant BoxB RNA library Reveals Structural Determinants of λN Protein Binding

Poster 42. Andy Oliveira **Page 36**
Mechanochemical Synthesis of Divalent Lanthanide Iodides

Poster 43. Jonathan Lopez-Hernandez **Page 36**
Leveraging Machine Learning to Predict Promising Mechanochemical Reactions

Poster 44. Mackenzie Gray **Page 37**
Studies on Copper Catalyzed Azide-Alkyne Cycloaddition (CuAAC) Reactions by Ball-Milling

Poster 45. Ahmad Tantish **Page 37**
Quantifying Energy Dissipation in Free-Flowing Powders

Poster 46. Matt Mansfield **Page 38**
How the Qβ Coat Protein Recognizes RNA Hairpins: Insights from Chemical Probing

Poster 47. Jaydaliz Rivera- Rivera **Page 38**
Expression of Epigenetic Proteins BRD9 and ENL for Phages Display Selection and Crystallization

Poster 48. Yuniel Velez **Page 39**
Synthesis of Nickel Oxalate Complexes for Catalytic Carboxylation of Alkenes

Poster 49. Elian Montas **Page 39**
Synthesis of SuFEx Hubs with Fluorosulfonyl Azide via Strain-Promoted Cycloaddition

Poster 50. Maya Schauber **Page 40**
Mapping How Mutations Shape RNA Folding and Modulate PP7 Capsid Binding Specificity Using DMS-MaPseq

Poster 51. Mason Bayles **Page 40**
A Metal-First Approach to Ruthenium Pincer Complexes Incorporating Main Group Elements

Poster 52. Stefanía Borges Rivera **Page 41**
Aziridination-Assisted Bifunctional Tagging Strategy for Accurate Relative Quantification and Isomer Characterization of Lipids

Poster 53. Carmen Sánchez Delgado **Page 41**
Exploring N-Aminopyridinium Reagents for Cross-Electrophile C(sp^3)–N Coupling

Poster 54. Emmanuel Cruz **Page 42**
Leveraging Sulfamide Chemistry for Novel Diazirine Formation

Poster 55. Vance Couturier **Page 42**
Spatial 2'-Hydroxyl Acylation Reversible Crosslinking (SHARC) Mediated Identification of in vivo Heterochiral RNA–RNA Interactions

Poster 56. Emma Conrey **Page 43**
Design and Development of Phosphine Urea Ligands for Enantioconvergent Cross-Coupling Reactions

Poster 57. Isaac Deavenport **Page 43**
Metal-Free C–N Bond Formation Using N-Aminopyridiniums via EDA Complexes

Poster 58. Guilherme Ragi Berto **Page 44**
Photochemically Driven PCO Group Transfer to Olefins via Ni(II)-Based Precursors

Poster 59. Megan Minassian **Page 44**
Lanthanide Iodides Across Oxidation Extremes: Solid-State and High-Pressure Approaches to LnI_2 and LnI_4 Compounds

Poster 60. Liam Taylor **Page 45**
Accessing Chemically Recyclable Poly(Squarate Ester) via Ring-Opening Metathesis Polymerization

Poster 61. Davis Beauvais **Page 45**
Yeast-Based Screening of Protein Variants for Binding Site Characterization

Poster 62. Anabela Meier **Page 46**
Insights Into the Effect of Charged Phospholipid Headgroups on Valinomycin Incorporation in Model Lipid Monolayers

Poster 63. Sreeram Shankar **Page 46**
When Solvers Shape Ecosystems: A Race for Ecological Realism in Numerical Predator Prey Models

Poster 64. Abelino Garcia **Page 47**
Modeling Biofilm Growth and Detachment Under Varying Hydrodynamic and Nutrient Conditions in Tropical Freshwater Systems

Poster 65. Bailey Castaneda **Page 47**
Uncovering the Impact of Leaf Cutter Ants Nesting Activity on Soil Biogeochemical Properties in a Tropical Forest Plantation

Poster 66. Kayla Mitchell **Page 48**
Soil Aggregation Effects on Water Movement and Nutrient Dynamics Across Costa Rican Land Uses

Poster 67. Mehreen Rahman **Page 49**
Sulfide Oxidation of Sediments in the Aguas Zarcas River Reduces Dissolved Inorganic Carbon Loads from Silicate Weathering

Poster 68. Cassandra Montano Arellano **Page 49**
Mineralogical and Chemical Patterns in Volcanic Soils Across Elevation Gradients in Costa Rica

Poster 69. Pedro Mendoza-Zamora **Page 50**
Using Simulated Rainfall on Large Leaves Growing in Neotropical Climates to Determine Convergent or Divergent Water Flow Paths Among Tree Species

Poster 70. Vicktoria Holdaway **Page 51**
Evaluation of Tropical Soil Aggregate Structure Across Various Land Uses and Its Influence on Hydrological Properties

Poster 71. Flo Streeter **Page 51**
The Effects of Chemically Embalmed Carrion on Fire Ant Foraging

Poster 72. David Hernandez **Page 52**
Investigating the Role of Arbuscular Mycorrhizal Fungi (AMF) in Squash Plant Tolerance to Water Stress and Resistance to Aphid Herbivory

Poster 73. Haley Olvera **Page 53**
The Effect of Vairimorpha (Nosema) ceranae on Honey Bee Queen Behavior (Apis mellifera)

Poster 74. Gabriel Esguerra **Page 53**
Comparison of SARS-CoV-2 Prevalence in White-Tailed Deer Populations of Texas

Poster 75. Javier Gonzalez **Page 54**
Splicing and Gene Editing Studies in Aedes aegypti

Poster 76. Andrea Rodriguez **Page 54**
Comparing SARS-CoV-2 Detection Among White-Tailed Deer in Texas Ranches

Poster 77. Sarah Rodriguez **Page 55**
Predation Between Chrysomya rufifacies and Cochliomyia macellaria

Poster 78. Zoe BeDell **Page 55**
Native Bee Gut Microbiomes in the College Station/Bryan Texas Area

Poster 79. Carmen Aguilar **Page 56**
Disruption of Plant Immune Responses by Candidate Salivary Effectors of the Potato Psyllid

Poster 80. Sam Guerra **Page 56**
Uncovering the Hidden Virome: Surveillance of Insect-Specific Viruses in Aedes Mosquitoes Across Developmental Stages

Poster 81. Mae Law **Page 57**
Assessing the use of Fecal Spore Load as a Proxy for Host Spore Burden (Nosema ceranae) in European Honey Bees (Apis mellifera)

AFTERNOON SESSION | 2:00 PM-4:00 PM

Poster 1. Izma Akbar **Page 59**
All-in-One Device for Measuring Tissue Oxygenation, Temperature, and Providing Feedback with Red Light Therapy

Poster 2. Rishee Shah **Page 59**
Point-of-Care Electrochemical Biosensor to Detect BNP Levels for Heart Failure Diagnosis

Poster 3. Sofia Morais **Page 60**
Developing Semi-Interpenetrating Network Polyampholyte Hydrogels to Further the Development of Subcutaneous Glucose Biosensors

Poster 4. Isabela Recendez **Page 60**
Developing Methods for the Integration of Single-Analyte Sensors Into a Hollow Fiber

Poster 5. Joshua Rowland **Page 61**
Pulse of Evolution: Heart Rate Adaptation in Astyanax Larvae

Poster 6. Athena Ramirez **Page 61**
The Role of Neural Activity in Stress-Induced Muscle Remodeling

Poster 7. Philip Ugochukwu **Page 62**
Exploring the Effect of Mating System Variation On Genome Evolution in Solanaceae

Poster 8. Hailee Coleman **Page 63**
Elucidation of Genes Involved in the ElyC-Mediated Regulation Pathway

Poster 9. Jacob Orange **Page 63**
Evaluating Proliferation and Migration in Triple-Negative Breast Cancer Using MTT and Scratch Assays

Poster 10. Mackenzie Ross **Page 64**
Unveiling the role of ABC transporters A1 and A7

Poster 11. Jadyn Mckinney **Page 64**
Identification of Toxoplasma gondii Excretory Proteins Responsible for HIF-1α Stabilization

Poster 12. Yanni McCray **Page 65**
Using HiC to Improve Draft Assemblies: de novo Chromosome-level Assembly of Oochoristica javaensis to Advance Population Genomic Studies in Parasitic Tapeworms

Poster 13. Jimena Vega **Page 65**
The Impact of Autism Spectrum Disorder on Oral Hygiene Practices and Preventative Dental Care Use Among U.S. Children Aged 6–17

Poster 14. Sukhmani Nanda **Page 66**
A Comparative Analysis of Bayesian Additive Regression Trees (BART) and Gradient Boosting Models (GBM) Against Linear Mixed Effects Risk Models

Poster 15. Sushruti Vasireddy **Page 67**
Identifying Dental Care Access Differences in Texas for People with Physical Disabilities: A Cluster-Based Spatial Analysis

Poster 16. Harsha Mangalagiri **Page 67**
The Association Between Concussions and Risk Factors for Bruxism in Adolescents

Poster 17. Wiley Liou **Page 68**
Maxillary Retromolar Distalization Limits for Subjects with Different Growth Patterns, Gender, and Growth Status

Poster 18. Sai Konda **Page 69**
Von Frey Filament Testing in a Rodent Pain Model as Part of Developing a Behavior-Based Orofacial Pain Assay

Poster 19. Zoe Tow **Page 69**
AI-Based Detection of Spontaneous Pain Behaviors in a Rodent Pain Model

Poster 20. Tyler Phan **Page 70**
Investigating the Role of Butyrate-Producing Gut Bacteria, Ruminococcus, in Modulating Comorbid Painful Temporomandibular Disorders and Opioid-Induced Hyperalgesia in Mice

Poster 21. Meghan Hash **Page 71**
Improving Preeclampsia Outcomes: A Literature Review on Prevention, Screening, and Patient-Centered Care

Poster 22. Sadie Rollston **Page 71**
Literature Review on Factors Affecting Maternal Self-Efficacy and Depression

Poster 23. Miguel Leal **Page 72**
The Impact of Gamification-Based Education on Blood Glucose Management in Diabetes: A Systematic Review of Reviews

Poster 24. Anushka Ganoo **Page 72**
How Parenting Styles Affect OCD Symptom Severity

Poster 25. Donald Rawls **Page 73**
Translational Measurement During Viral Infection Under G3BP Inhibitor Treatment Using Puromycin

Poster 26. Kala Dumas **Page 74**
Identification of Macrophage Polarization States in the Injured Mouse Spinal Cord 7 days Post Injury

Poster 27. Christopher Gonzalez **Page 74**
Exploring the Association Between Toothaches and Adverse Childhood Experiences (ACEs) among Low-Income Children

Poster 28. Savannah Bean, Alex Chaiken, Jesus Marroquin, Jiwoo Nam, and Jayani Singh **Page 75**
Development of a Breath Analyzer for Disease Diagnosis

Poster 30. Lilly Juarez **Page 76**
Aha! Moments in Memory Retrieval

Poster 31. Juan Davila **Page 76**
Reducing Recidivism Through Psychology: A Literature Review of Prison-Based Interventions Since 2000

Poster 32. Timothy Stout **Page 77**
Effect of Cell Arrangement on Vaccinia Virus Replication

Poster 33. Sarah Hurt **Page 77**
Hyperandrogenemia Related Liver Disease in Females Demonstrates a U-Shaped Dose-Response Pattern

Poster 34. Maddie Perez **Page 78**
Quantification of Fecal Bile Acids During the Postnatal Period in Cats

Poster 35. Jeffrey Ock **Page 79**
Extracellular Matrix Morphology and Cellular Mechanobiology on Interwoven versus Interwoven-Aligned PDMS Scaffolds

Poster 36. Avinash Kakarala **Page 79**
Semantic Data Interoperability Technologies Across Life Cycle of Process Plant Projects

Poster 37. Heidi Thiele **Page 80**
Energy Retrofit Strategies for U.S. Single-Family Houses Using an Automated Framework

Poster 38. Aushmeet Singh **Page 81**
VISIT-MR: Virtual, Intelligent, and Scalable Immersive Site Training through Mixed Reality in AEC Education

Poster 39. Michael Redelick **Page 81**
Use of Conversational AI to Enhance Cultural Competency in Construction Education

Poster 40. Hannah Montelongo **Page 82**
Simulation of Repetitive Work & Kaizen and its Application to Drywall Installation in Commercial Construction Projects

Poster 41. Giselle Morocho Aguilar **Page 82**
Impacts of Socio-Technical Barriers on Decentralized Wastewater Management in Rural Alabama’s Black Belt

Poster 42. Archit Avhale and Isaiah Thomas **Page 83**
Advanced Sensing Technologies for Preventing Construction Workers' Work-Related Musculoskeletal Disorders (WMSDs)

Poster 43. Natalia Quesada Marshall **Page 84**
Assessment of Test Methods for Freeze-Thaw Performance of Concrete Material for Additive Construction by Extrusion

Poster 44. Arnia Goode **Page 85**
Physical Fatigue Monitoring of Construction Workers Using Edge-Based Machine Learning and Wearable Sensors

Poster 45. Arun Muthukumar **Page 85**
Detection of Smears in Spray Cards Using Machine Learning and Computer Vision

Poster 46. Marshall Meyer **Page 86**
The Effect of Ventilation on Bacterial Cells with Deleted Membrane Channels
Poster 47. Aloyo Paul **Page 86**
Atmospheric Cold Plasma: Applications in Heavy Metal Water Purification and Cotton seed Germination

Poster 48. Marijoe Vogtembing **Page 87**
Harnessing Atmospheric Cold Plasma for Kernel Sanitization

Poster 49. Emilio Jimenez **Page 88**
Efficiency of Activated Food Waste Biochar in Removing Long-Chain Organic Contaminants from Wastewater

Poster 50. Drew Streckwald **Page 88**
Textural Analysis of Different Protein Balls with Emphasis on Atmospheric Cold Plasma-Treated Cricket Protein

Poster 51. Ayanah McCabe **Page 89**
Activated Corn Waste-Derived Biochar Enabled Efficient Removal of Organic Pollutants from Aqueous Solutions

Poster 52. Maria Quireza **Page 89**
Effect of Blanching and Drying Conditions on the Functional Properties of Black Soldier Fly Larvae Protein

Poster 53. Sara Nunez **Page 90**
Effect of Atmospheric Cold Plasma (ACP) on the Nutritional Composition and Physical Characteristics of Cricket Protein Compared to Whey, Egg-White, and Plant-Based Proteins

Poster 54. Ethan Do **Page 90**
Expression, Purification, and Quantification of Relative Activity of Polycaprolactone(PCL) Degrading Enzymes Expressed in E. coli

Poster 55. Emilio Lugo Gutierrez **Page 91**
Techno Economic Analysis Data Analytics Tool

Poster 56. Natalie Borrero Ramírez **Page 92**
ACP Impact on Cricket Protein Powder Functional Properties

Poster 57. Noël Ndalamba **Page 92**
Atmospheric Cold Plasma Treatment on Corn Stover

Poster 58. Xavier Figueroa and Daniel Jeong **Page 93**
Thin Film Thickness Analysis using White Light Reflectance Spectroscopy (WLRS)

Poster 59. Edwin Xiao **Page 93**
Towards Resilient Cyber-Physical Power Systems: Simulating and Classifying Anomalies

Poster 60. Pranav Sundar **Page 94**
Modernizing CNC Control: A Cyber-Physical Testbed for Intelligent, Secure, and Adaptive Manufacturing

Poster 61. Paige Warren **Page 94**
Investigation of an AI-Based Robust Threat Detection Framework for Multi-UAS Agents Using Reinforcement Learning

Poster 62. Kov Satlykov **Page 95**
Multilingual Molecules: AI Agents for Cross-Domain Learning in Proteins and Biomedical Texts

Poster 63. Leron Gundlur **Page 96**
Determination of Return Trajectories from Cislunar Regions to Low-Earth Orbit

Poster 64. Brinlee Goggans **Page 96**
Efficacy Screening of Oxaliplatin in Dormant and Non-Dormant Colorectal Cancer Spheroids

Poster 65. Celine Cho and Miguel-Angel Lopez **Page 97**
Impedance Characterization and Flaw Detection of Silicon Bonded Wafers Using EIS

Poster 66. Bhavika Kaparthi **Page 97**
Evaluation of CPA-Induced Cytotoxicity in HepG2 and U937 Cells

Poster 67. Dan Choi **Page 98**
Implementing Triangle Centrality with YGM

Poster 68. Jayden Koh **Page 98**
Hardware Fuzzing for Secure Open-Source RISC-V Core Validation

Poster 69. Maxwell Zhou **Page 99**
Multimodal Molecules: Foundation Models for Protein Understanding Across Biological Tasks

Poster 70. Venkat Nallam **Page 99**
PELT: Plagiarism Evasion via LLM-Based Transformations of C++ Code

Poster 71. Brice Ockman **Page 100**
Performance Analysis of Privacy-Preserving Techniques in Federated Learning

Poster 72. Thomas Wismar **Page 100**
Restoration and Improvement of a CERT Frame

Poster 74. Zach Krueger **Page 101**
A Benchmark for Quantum Chemistry Relaxations via Machine Learning Interatomic Potentials

Poster 75. Abdoulaye Diop **Page 101**
Physically Grounded Correction of Transmission Line Parameters in Synthetic Grids: A Multiverse Approach

Poster 76. Mustafa Eltayeb **Page 102**
Vision-Based Autonomous Railway Fault Detection UAV

Poster 77. Railee Fernandez **Page 102**
Investigating the Common Ion Effect for Brine Mining

MORNING SESSION

10:00 AM – 12:00 PM

1. Design of an Automated Liquid Nitrogen Filling System for Germanium Clover Detectors

Jason Castro (Texas Lutheran University)
Texas Research Expanding Nuclear Development (TREND)
Research Advisor: Phil Adsley

High-purity germanium (HPGe) clover detectors offer high resolution for gamma-ray detection and identification. To prevent leakage current caused by thermal excitation, these detectors must be kept at cryogenic temperatures using liquid nitrogen. At the Cyclotron Institute at Texas A&M, the Hyperion array can hold up to 14 HPGe detectors, each equipped with their own LN2 dewars. These must be manually filled every 8-12 hours using a funnel, which poses safety risks, is time consuming, and is physically impractical. To improve safety and reliability, this project introduces an automated LN_2 filling system. Using an Arduino, PT-100 temperature sensor, solenoid valves, and cryogenic tubing, the system detects fill completion via thermal feedback. Custom PCBs and a Python-based GUI were developed to enable remote operation, offering both manual and automatic control with real-time monitoring and built-in safety interlocks. This design reduces the need for overnight labor and ensures consistent thermal conditions across the detector array.

2. Precision Quantum Sensing Spectroscopy of Radioactive Molecular Ions with Active Environmental Control

Gabe Daniels (Texas A&M University)
Texas Research Expanding Nuclear Development (TREND)
Research Advisor: Jonas Karthein

The standard model while successful is still fairly limited in its ability to describe 95% of mass and energy in the Universe. In our group, we are studying radioactive atoms and molecules to search for violations of fundamental symmetries that may uncover new physics beyond the standard model. We are currently commissioning a new quantum-sensing lab on campus that will soon enable background free spectroscopy of single radioactive molecular ions.

Precision in our measurements is of utmost importance, hence any small fluctuations in the ambient temperature can affect our measurements.. To track and control the environment of our lasers and traps, we are currently implementing temperature, pressure, and humidity sensors. In addition, we are developing a test setup for temperature stabilization of our lasers and ion traps based on a Peltier-element controlled environment.

Lastly, literature data on radioactive molecules is extremely sparse. To explore the vast possibilities of radioactive isotopes on campus at Texas A&M’s Cyclotron Institute and advertise our local capabilities to current and future collaborators, we are currently developing a new website with historic and future accelerated beam capabilities.

3. Feasibility Study of Astatine-211 Production via Laser-Plasma Interactions

Lovie Deloney (Prairie View A&M University)
Texas Research Expanding Nuclear Development (TREND)
Research Advisors: Justin Mabiala and Aldo Bonasera

Astatine-211 (At-211) is a potent alpha-emitting radionuclide with significant potential in targeted cancer therapy due to its high linear energy transfer and short path length in tissue. However, its widespread application is hindered by challenges in production scalability and accessibility. This study explores an alternative production method utilizing laser-driven nuclear reactions to synthesize At-211. Specifically, we investigate the feasibility of producing At-211 through the interaction of secondary alpha particles generated by the proton–boron fusion reaction ($p + {}^{11}B \rightarrow 3\alpha$) with Bi-209 via the ($\alpha$,2n) reaction channel. Experiments were conducted at the PW-ELI Beamlines facility at CLPU using petawatt-class laser pulses to accelerate protons up to ~40 MeV. A Bi-209 target was placed behind natural boron wires to facilitate alpha generation and subsequent exposure. Offline analysis included silicon detector measurements of alpha and beta emissions to identify potential At-211 formation. This approach presents an interesting pathway for decentralized At-211 production using compact laser systems.

4. Energy Distribution of Proton Beams Degraded by Rotating Aluminum Foil Wheel for Space Radiation Simulation

Adrian Martinez (Texas Lutheran University)
Texas Research Expanding Nuclear Development (TREND)
Research Advisors: Henry Clark and Gabriel Tabacaru

Radiation effects are a critical concern in the space industry, particularly for electronics operating in high-radiation environments. The TAMU Cyclotron Institute provides simulated space radiation using proton beams across a wider energy range. To minimize downtime when changing beam energies, a rotating degrader-wheel is used to lower the energy of a fixed high-energy proton beam (e.g. 45MeV) by passing through Aluminum foils of varying thickness. While this method offers faster turnaround for users, it results in broader energy distribution, especially at lower final energies, which may impact experimental precision.

This project aims to characterize the energy distributions resulting from proton beam degradation at selected energies (e.g. 30MeV, 15MeV, 7MeV). Calibration was performed using known peaks from a Thorium-232 source.

Experimental results were compared with SRIM (Stopping and Range of Ions in Matter) calculations to validate expected energy loss and spread. Preliminary findings agree that lower energy degradations (e.g. 45MeV to 7MeV) result in significantly broader energy distribution. These results provide critical insight into the tradeoff between speed and energy resolution, informing TAMU Cyclotron users whether the convenience of the degrader-wheel use outweighs the uncertainty introduced by the energy spread.

5. Nutritional Status during Adolescent vs Adult Pregnancy in the US: A Systematic Review

Zoie Gavel (California State University, Fresno)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisor: Heidi Vanden Brink

Adolescent pregnancy is associated with adverse maternal and neonatal outcomes, attributed to social and biological risk factors. Nutritional status intersects both social and biological risk factors; adolescents themselves undergoing reproductive maturation and therefore may have unique nutritional needs, and adolescent pregnancy is associated with social determinants of health which may further exacerbate nutritional disparities. However, whether pregnant adolescents experience nutritional deficiencies in the United States is poorly understood. Therefore, we conducted a systematic review to assess the biochemical nutrition status of pregnant adolescents compared to adults. A comprehensive search was conducted across several databases: Embase, MEDLINE, CINAHL, and ProQuest. Studies were included if they took place in the US, were published in English, and reported nutritional biomarker data on pregnant adolescents, with or without an adult comparator. Following abstract screening and full text review in duplicate, 31 studies have been identified. Data extraction and risk of bias assessment are ongoing. Of the 31 studies, 12 were published before 2000, with one study published in 1969. Twenty-two publications from 2012-2016 appear to originate from two main datasets, limiting the amount of recent independent data. Thus, much of the available data may not accurately reflect current nutritional disparities among pregnant adolescents. Initial qualitative evaluation of risk of biases suggest that many studies lacked adjustment for confounding variables, such as gestational age, assessed few nutrients, and contained heterogeneous designs and cohort demographics. These limitations may compromise data quality and hinder the observation of overarching trends across studies.

6. Body Composition Analysis of Genetically Diverse Mice Fed American vs. Japanese Dietary Interventions

Aubrey Shaw (Grove City College)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisor: Masako Suzuki

While previous studies have investigated the effects of high-fat versus low-fat diets on body composition in inbred mouse models, the impact of such diets in genetically diverse mice remains largely unexplored. This study aims to address that gap by examining how Simplified Diverse Outbred (SDO) mice respond to two humanized dietary patterns: a high-fat, high-cholesterol American diet and a low-fat, low-cholesterol Japanese diet, each modeled after typical diet compositions in their respective populations. The target cohort includes 150 mice (n = 75 per diet group, split evenly into males and females) and the study is still ongoing. Mice are weighed weekly, and body composition is assessed using EchoMRI at baseline (before diet), 6 weeks, and 12 weeks. The midpoint data collection has begun for a subset of the cohort. Preliminary analysis of the initial body composition reveals considerable variation among mice on the same diet, highlighting the influence of genetic background on dietary response. These results exemplify the importance of using outbred models to better capture real-world biological variability and inform more personalized approaches to nutrition and metabolic health.

7. Histological Assessment of Hepatic Steatosis and Fibrosis in Response to Intermittent Fasting and GHSR Deletion in High-Fat Diet-Induced Obesity

Kira Buza (Madonna University)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisors: Yuxiang Sun and HyeWon Han

High-fat diet (HFD) consumption contributes to hepatic steatosis and chronic low-grade inflammation both systemically and in peripheral tissues, promoting the development of metabolic disorders such as obesity and metabolic associated fatty liver disease (MAFLD). Intermittent fasting (IF) has emerged as a promising intervention capable of reducing fat mass and inflammation, though the exact mechanisms remain unclear. The growth hormone secretagogue receptor (GHSR), a key mediator of ghrelin signaling, may influence inflammatory and metabolic responses to IF. This study explores how GHSR influences responses to a HFD combined with IF.

Wild-type and GHSR knockout mice were fed a HFD for 12 weeks to induce obesity, then assigned to either ad libitum (AL) feeding or IF. This produced five groups: RD control, HFD-AL WT, HFD-AL KO, HFD-IF WT, and HFD-IF KO. Liver tissue was examined using hematoxylin and eosin (H&E) staining for steatosis and Masson's trichrome staining for fibrosis. Liver Quant, a Python-based tool for whole-slide analysis, was used to quantify steatosis via steatosis proportionate area and fibrosis via collagen proportionate area. Qupath was used for visualization.

IF significantly reduced body fat percentage in both wild-type (WT) and GHSR knockout (KO) mice compared to their respective HFD-AL controls. Additionally, IF-KO fat mass was lower than IF-WT fat mass. Analysis of steatosis proportionate area through H&E-stained liver is expected to support previous results on body fat percentage. Masson's trichrome results are expected to align with observed increases in infiltrating monocytes in HFD WT and KO mice compared to IF groups.

8. Nutritional Differences in Adolescent Versus Adult Pregnancy: A Systematic Review

Sarah Grace Wisener (Ouachita Baptist University)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisors: Heidi Vanden Brink and Honghui "Amber" Chang

The incidence of adolescent pregnancy in Texas has started to increase after several years of decline. Several studies report poorer fetal and maternal health outcomes among pregnant adolescents. Since adolescents aged 14-18 have the lowest diet quality across all age groups in the US, we hypothesize that nutritional disparities during adolescent pregnancy may contribute to the increased risk of adverse health outcomes. Therefore, the objective of this study is to compare dietary intake in adolescent versus adult pregnancy in the United States. Studies were eligible for inclusion if they included US data, pregnant adolescent participants, and nutrition-related outcomes. A library scientist developed a search strategy, and searches were conducted across four databases. Following de-duplication, a total of 2,094 articles were identified. After abstract screening, 123 articles were eligible for full-text review to verify inclusion versus exclusion in the systematic review. Abstract screening, full-text review, and data extraction were conducted in duplicate by two investigators. A senior member of the research team resolved disagreements. Of the 123 articles that underwent full-text review, 68 were deemed eligible for inclusion, and 49 included assessments of dietary intake. The final review of studies is underway to identify multiple publications that report on the same study sample. Of the individual studies currently identified, 47 include dietary assessment data for pregnant adolescents only, and 2 include an adult comparator. Data extraction and risk of bias assessment are currently underway.

9. GHSR-Mediated Fibrosis and Immune Cell Senescence in Mouse Hearts Across Chronological Aging

Sam Gracia (University of Texas Rio Grande Valley)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisors: Yuxiang Sun and Zeyu Liu

Aging induces progressive structural and cellular changes in the heart, including signs of fibrosis and altered immune activity. The Growth Hormone Secretagogue Receptor (GHSR) is known to regulate inflammatory and fibrotic pathways, yet its role in cardiac aging remains unclear. This study investigates how GHSR expression is associated with aging-induced cardiac structural change, fibrosis, and immune cell senescence in mouse hearts. Heart tissues were collected from mice at multiple chronological ages. Histological analysis suggests that aging impairs cardiac structure and function, largely due to increased collagen accumulation that contributes to fibrotic remodeling. Additionally, we observed greater accumulation of β-galactosidase in aged hearts, which potentially further promotes fibrosis and cardiac dysfunction. To examine the relationship with GHSR, in situ hybridization was performed and revealed elevated GHSR expression in aged cardiac tissue, particularly within immune cells. These findings suggest that increased GHSR expression is associated with aging-related cardiac fibrosis, structural damage, and functional decline, potentially through its role in immune cell senescence.

10. Pcsk6 Deletion and Liver Lipotoxicity

Roxanne Valle (University of Florida)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisor: Linglin Xie

Obesity is a chronic condition characterized by excessive body fat accumulation that poses serious health risks. One harmful consequence of obesity is liver lipotoxicity, which results from fat spilling over from adipose tissue into the liver. Pcsk6 is a protease that activates substrates involved in tissue remodeling and fibrosis. This study explores the role of Pcsk6 deletion in adipose tissue and its subsequent effects on liver steatosis and fibrosis in mice fed a high-fat diet (HFD). All mice were placed on a HFD 8 weeks after birth for 14 weeks, and knockout treatments were administered at either week 0 or week 8 of the HFD. Liver tissues were embedded, sectioned, and stained with Sirius Red or Hematoxylin and Eosin (H&E) to

assess fibrosis and steatosis levels, respectively. NAFLD Activity Scores (NAS) were also assigned to evaluate steatosis, lobular inflammation, and hepatocellular ballooning. Results showed that a TMX-induced Pcsk6 knockout in adipose tissue at week 0, and a general knockout at week 0 combined with LPS-induced inflammation at week 8, significantly reduced hepatic steatosis compared to respective controls. Additionally, a TMX-induced knockout with LPS-induced inflammation at week 0 significantly reduced fibrosis. NAS analysis revealed that a TMX-induced knockout at week 8 and a general knockout at week 0 with LPS-induced inflammation at week 8 significantly increased liver inflammation. Overall, these findings suggest that early Pcsk6 deletion in adipose tissue may help prevent obesity-induced liver steatosis and fibrosis. Further studies are needed to better understand the mechanisms involved and to evaluate its therapeutic potential.

11. Aging Signatures and Inflammation with Epigenetic Reprogramming Intervention In B6 Mice

Riya Tom (Texas A&M University)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisor: David Threadgill

Obesity has steadily increased in the United States, showing that current interventions are not effective. There has been an interest in a ketogenic intervention, low in carbohydrates and high in fat, for diet induced obesity. However, not everyone responds to a ketogenic intervention. Our group previously showed that male C57BL/6J (B6) mice do not respond to a ketogenic intervention after exposure to an American diet, which is high in fat and carbohydrates. This is supported in literature that diet can impact the epigenome. To investigate, we generated an epigenetic reprogramming intervention (ERI) to determine if there is an epigenetic memory associated with the American diet exposure. The generated diet contains an altered methyl profile to attempt to target obesity induced by exposure to the American diet. We found that B6 male mice who were given a diet that is altered in its methyl profile responded to a ketogenic intervention at 3 months post American diet exposure, this response is continued through an additional 3 months of ketogenic diet exposure. Since we observed a rescued response to the ketogenic diet after the ERI, we were interested in the impact of the intervention on gene expression associated with inflammation and aging signatures. To investigate, we generated a panel of related genes to measure gene expression between mice exposed to the ERI and the American diet. We expect that the ERI would have a measurable impact on expression of inflammation and aging-related genes compared to the American diet.

12. Impact of Binding Density on Measurement of Telomere Length Using Cas12a

Anna Tillinghast (Texas A&M University)
Nutrition Undergraduate Research Immersion in the Summer (NURISh)
Research Advisor: Waylon Hastings

Cas12a, a cousin to the famous CRISPR Cas9 enzyme, performs the same function: double stranded DNA cleavage. It differs, however, when it binds to its target site and gains a new function to indiscriminately cleave single stranded DNA. This activity can be utilized in combination with a ssDNA fluorescent probe to detect and quantify DNA, such that the amount of fluorescent signal is proportional to the amount of target DNA, in this investigation's case, telomeres. Telomeres are repeating sequences, specifically TTAGGG, present at the end of chromosomes that shorten over a lifespan. It is unknown whether Cas12a binding density remains constant as telomere length increases, as telomeres fold back on themselves in their guanine rich regions, forming g-quadruplexes. To investigate further, this study uses oligomers of different lengths (48bp, 84bp, 126bp, 168bp, 336bp, 496bp) and a telomere-specific guide RNA to estimate the length of telomeres. Preliminary quality control confirmed the lengths of the synthesized oligomers ordered using Tapestation analysis and Polyacrylamide Gel Electrophoresis. The impact of standard length on fluorescence emission will be measured using two approaches: qPCR and a kinetic fluorescence reader (Tecan Spark). The expected result is a standard curve representing relative fluorescence (y-axis) and assay time (x-axis) that shows clear separation between the telomere standard based on total telomeric content, which will provide a reference for future telomere length quantification for unknown samples.

13. A Low Frequency Atlas of Radio-Quiet AGN

Ashlee Ballard (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisors: Krista Smith and Macon Magno

Active galactic nuclei (AGN) are supermassive black holes located at the center of galaxies that emit energy across the entire electromagnetic spectrum. In this project, we start with the 70 month Swift-BAT catalog. Of the AGN in this catalog, there exists VLA 22 GHz imaging of 231 sources. We then narrow this sample down by cross-matching each host galaxy with data from the LOw-Frequency ARray (LOFAR) Two-metre Sky Survey (LoTSS), resulting in a final sample of 51 radio-quiet AGN. By overlaying these LoTSS radio contours onto corresponding optical images, we classify the AGN into several categories: resolved, star formation, and outflow-like. Additionally, we can measure the spatial extent of the AGN outflows in parsecs, where these values can then be compared to the AGN host's hard X-ray luminosity (2-10 keV), ultra-hard X-ray luminosity (14-195 keV), and their Eddington ratios to explore their correlations. By using Python-based packages and analysis tools, we assess each plot and contour overlay to determine the behavior of the radio emissions of each AGN in our sample. This approach provides new insights into our understanding of the mechanisms that drive radio emission in radio-quiet AGN.

14. Skipper CCD Spectrograph

Dalys Guajardo (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisors: Jennifer Marshall and Erica Cook

The Munnerlyn Astronomical Instrumentation Lab is teaming up with Fermilab and the University of Illinois Urbana-Champaign to explore a quantum spectroscopy application that utilizes a Skipper CCD for counting photons from a fiber-fed spectrograph on an optical bench. Our lab is designing and building the spectrograph required to disperse the light onto the CCD. Originally, the spectrograph was calibrated to a wavelength of 560 nm, a wavelength range of 20 nm, and a resolution of 10000. However, the spectrograph has been adjusted to a wavelength of 810 nm +/- 20 nm calibration. The goal is for the final application to detect nanometer shifts in the spectrum.

15. Python and GPIO Integration for Button Control Restoration on the Otto Struve 82' Telescope

Simone Sheridan (Prairie View A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisors: Jennifer Marshall and Erica Cook

The Otto Struve 82-foot telescope at McDonald Observatory, a historic instrument in astronomical research, experienced a failure in its control panel that rendered six essential buttons non-functional. This project aimed to replicate the original functionality of these buttons using a modern embedded systems approach. I developed a Python-based control system on a Raspberry Pi, using GPIO pin mapping to detect button presses and send corresponding HTTP POST requests to control the telescope's relays. This replaced the original ADA-based interface, improving maintainability while preserving operational logic. The restored system was successfully tested and demonstrated full functional recovery of all six control buttons. The project highlights the practical application of embedded programming, hardware-software integration, and control system design in addressing legacy equipment failures. This work was completed independently as part of the Aggie Scholarships for Technology Advancements in Astronomical Research (AggieSTAAR) program and was guided by advisors Erika Cook, Jennifer Marshall, and John Kuehne.

16. Power Spectrum Computation of Optically Confirmed Sunyaev-Zel'dovich Galaxy Clusters

Catherine Chaison (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisor: Kevin Huffenberger

Galaxy clusters are among the largest mass structures in the universe, exhibiting clustering into matter-dense regions. This makes their distribution a useful tool for probing the distribution of matter in the universe. A primary method of studying galaxy cluster distribution is through the use of power spectra, which allow for the analysis of the strength of clustering at different scales.

We utilized a catalog of 4195 galaxy clusters identified using the Atacama Cosmology Telescope (ACT) and selected using the Sunyaev-Zel'dovich (SZ) effect. This effect identifies galaxy clusters as low signal spots in the cosmic microwave background when observed below 220 GHz, as photons in these areas are scattered to higher energy levels through inverse Compton scattering when they come into contact with the galaxy clusters. The sample ranges across redshifts from z=0.04 to z=1.91, allowing for an understanding to be developed of the matter distribution across a wide range of cosmological time.

For power spectrum calculation, the galaxy cluster sample was divided into redshift bins. Power spectra for each bin were produced using a cross-correlation analysis performed using PyPower, splitting each bin into two subgroups and generating matched random catalogs. Iteratively replicating this process allows for robust estimation of the power at each redshift. With this analysis, we hope to describe the matter distribution of the universe at large scales and track its evolution to inform estimates of cosmological parameters such as the matter density of the universe (Ω_m) and amplitude of its fluctuations (σ_8).

17. Measuring The Dust and Gas Fuel in a Sample of Distant Post-Starburst Galaxies

Mary Knowlton (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisors: Justin Spilker and Vincenzo D'Onofrio

The majority of galaxies in the universe come in two types: bright, blue, star forming galaxies and red, dusty, galaxies that have stopped forming stars. There is a third, rarer type of galaxy though: the post-starburst galaxy. These are galaxies that have formed a lot of stars in a short period of time, but have recently become quiescent. By examining the gas and dust masses in these galaxies, we can determine if they are completely done forming stars, or if another starburst is on the horizon. We used observations from the ALMA radio telescope to analyze 9 post-starburst galaxies at z~0.7. Each of these galaxies contain a CO(5-4) spectral line, a tracer of cold, molecular gas. This line was removed in order to isolate and study the dust continuum, from which the dust mass of each galaxy was calculated. We find that there is a wide range of dust properties in the galaxies in our sample, suggesting that the causes or effects of the post-starburst phase are not the same in all cases.

18. Low-Frequency Atlas of Swift-BAT X-ray Selected AGN

Nicholas Garcia (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisors: Krista Smith and Macon Magno

Active galactic nuclei (AGN) are supermassive black holes located at the center of galaxies that emit energy across the electromagnetic spectrum. Our sample was selected from the Swift-BAT 157-month survey, and, from this sample of 1330, I found 172 within the LOw-Frequency ARray (LOFAR) Two-metre Sky Survey (LoTSS) footprint. By overlaying the LoTSS contours on PanSTARRS-1 optical images, we were able to classify the various radio AGN morphologies (compact, extended, and jet-like) present within this X-ray selected sample. By using the Kolmogorov-Smirnov test, we find that the jet-like sources come from a statistically different sample than the compact and extended sources.

19. Constructing a Library of OSIRIS Velocity Template Stars

Izzi Oaks (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisor: Jonelle Walsh

Velocity template stars are used as the foundation for measuring the stellar kinematics in galaxies beyond the Milky Way. From such kinematics, we can learn about the fundamental components of galaxies, like the central supermassive black holes, stars, and dark matter halos, and how these components grow and evolve together. Here we present a velocity template library composed of 17 individual K and M giant stars and K dwarf stars, which are the types of stars expected to be found in nearby early-type, massive galaxies. The stars were observed with the OH-Suppressing Infra-Red Imaging Spectrograph (OSIRIS) instrument coupled with adaptive optics on the 10m Keck I telescope. The spectra span a wavelength range of 1.965 – 2.381 mm, and cover the near-infrared, K-band CO bandhead absorption features. We reduced the observations using the OSIRIS Data Reduction Pipeline v6.0.2, and perform steps such as bad pixel masking, sky subtraction, wavelength calibration, assembling a data cube, telluric correction, mosaicing data cubes together, and aperture extraction to produce a 1D spectrum for each star. Each reduced 1D spectrum was shifted to a common rest velocity using the penalized pixel fitting method (pPXF), such that all the template stars are aligned spectrally. Our template library is a useful resource for any astronomer looking to measure the stellar kinematics in galaxies observed with OSIRIS or any spectrograph with spectral resolution below R ~ 3800.

20. Peculiar Stellar Ages across a Peculiar Galaxy

Liv Moody (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisor: Ray Garner

Using deep, narrowband imaging of the nearby peculiar spiral galaxy NGC 5474, we present stellar age information across its disk and offset bulge. As shown in earlier work on M101, our narrowband filters measure age-sensitive absorption features such as the Balmer lines and the slope of the continuum between the Balmer break and 4000 A break. We separate our study of NGC 5474 into its main disk containing its offset bulge, and the faint outer disk. We show that the main disk is relatively well-mixed in ages, showing no radial age changes, indicative of it being a dwarf galaxy. Meanwhile, the offset bulge is distinct from the main disk, showing only old ages. We explore the ages of the outer disk as a function of angle, showing that it is overall very young with some sides of the galaxy showing recent star formation. We interpret this in the context of the M101-NGC 5474 interaction and the potential extragalactic nature of the offset bulge.

21. Synthesis and Structural Characterization of Bifunctional Naphthalene Derivatives Featuring Antimony and Carbeniums

Abigail Reynholds (Texas A&M University)
Independent Research Project
Research Advisor: Francois Gabbai

With the ongoing efforts toward the synthesis of bifunctional compounds featuring an antimony(V) Lewis acid positioned next to a carbonation. The synthesis of such systems involves multiple steps, as in the case of a derivative elaborated at the upper rim of a naphthalene backbone. Access to the target species involves successive lithiation of the backbone followed by reaction with the corresponding carbon and antimony electrophile. The description of the characterization details obtained, including several crystal structures, allow for the direct observation of the proximity established between the two electrophilic moieties.

22. Click Detect: Immuno-amplification-based Detection of Shiga Toxin 2

Emma Webb (Texas A&M University)
Independent Research Project
Research Advisor: Zhilei Chen

Shiga toxin-producing Escherichia coli (STEC) is among the most common infectious causes of bloody diarrhea and can lead to life-threatening diseases, such as hemolytic uremic syndrome. The pathology of STEC stems primarily from Shiga toxin type 2 (Stx2). Thus, sensitive and reliable detection of the toxin is essential for timely STEC treatment and outbreak control. To address this need, we developed Click Detect, a novel immuno-amplification technique that utilizes click display and a pair of target-specific binders for the sensitive detection of Stx2. One of these binding molecules is immobilized while the other is click displayed and is covalently linked to its coding cDNA. Analogous to a conventional detection via DNA amplification, such as qPCR or LAMP (loop-mediated isothermal amplification). Using Click Detect, we successfully sensed Stx2 in a control buffer with a limit of detection of 100 femtomolar. Similar detection limit was also observed in complex matrices, including lettuce extract and swimming pool water, underscoring the potential of Click Detect as a practical diagnostic method. Overall, we believe that Click Detect is a highly sensitive and versatile method for detecting Stx2 and has great potential as a novel diagnostic platform for diverse antigens.

23. 4-Axis 3D Printing for Improved Mechanical Properties

Justin Chan (The Ohio State University)
Interdisciplinary Research Experiences in Metrology & Inspection
Research Advisor: Jyhwen Wang

3D printing is a popular and low cost choice in manufacturing known for its use in rapid prototyping. A common 3D printing process used is Fused Deposition Modeling (FDM), where thermoplastic material is extruded through a nozzle to build a 3D object layer-by-layer. Most 3D printers have three axes which limit layers to be printed horizontally and may not be the best way to print for certain geometries in terms of strength. This research investigates the use of an additional axis on a 3D printer for printing non planar layer geometries for increased strength. A conventional 3D printer was modified with the additional axis and then custom g-code, the programming language for 3D printers, was created for printing sinusoidal structures. The same structures were printed on both 4-axis and conventional 3D printers and mechanical tests were conducted to compare their strength. By implementing and comparing two different 3D printing techniques, a framework is established for future research on the advantages of 4-axis 3D printing for other complex geometries and advancing 3D printing towards use in finished product manufacturing.

24. Effects of Process Parameters in Creating Micro-Scale Features in Laser Powder Bed Fusion Parts

Blaise Corcia and Alexandra Raimondi (University of Florida)
Interdisciplinary Research Experiences in Metrology & Inspection
Research Advisor: Mathew Kuttolamadom

Compared to other traditional manufacturing processes, laser powder bed fusion (LPBF) has the ability to generate complex part geometries with high precision. In this study, the effects of varying laser power, scan speed, and layer thickness (dominant parameters) were systematically investigated using a design of experiments. Part quality was quantified by measuring porosity and Vickers hardness. Further, feature resolution and dimensional accuracy were evaluated for the machine-material combination to assess its suitability for micro-scale fabrication. For this, the ability to reliably create straight and curved edge features in the XY plane and Z direction was evaluated. Scanning electron microscopy (SEM), optical microscopy, and hardness testing were employed to validate the parts. These findings demonstrate that careful tuning of process parameters in relation to feature size is crucial in deploying a machine-material combination to yield micro-scale features.

26. Understanding UV properties of Host Galaxies of Supernovae

Neshini Sathishkumar (Texas A&M University)
Astronomy
Research Advisor: Peter Brown

We are studying exploding stars, otherwise known as supernovae, in the ultraviolet using the Swift and Hubble Space Telescopes. In particular, we are trying to understand how the properties of host galaxies might correlate with the observed properties of the supernovae they produce. We use Blast (A web service for the automatic, real-time characterization of transient host galaxies) to acquire any missing data, plot galaxy properties like stellar mass and star formation rate, and compute k-corrections on the spectra models of host galaxies. With these, we are able to make corrected magnitude and color plots for the galaxies in the UVOT filters and look for correlations that might link galaxy properties to their respective supernovae. Additionally, by creating 3-color images of Swift supernovae, with image color and zoom scales being consistent throughout, we are looking to compare host galaxies visually. By grouping these galaxies based on supernova type or other properties, we hope to spot visual trends that could hint at deeper physical connections. While our current focus is on Type Ia supernovae, this research could be extended to include other types in the future.

27. Exploring the Proper Motion of the Andromeda Galaxy with Gaia

LaVena Tilger (Texas A&M University)
AggieSTAAR: Aggie Scholarships for Technology Advancements in Astronomical Research
Research Advisor: Louis Strigari

In this project, I explore the three-dimensional motion of the Andromeda Galaxy (M31). Using publicly available data from the Gaia space telescope, I focus on measuring M31's proper motion. My goal is to understand the methods and reasoning presented in the recent lecture and related research. I am working to replicate the source selection process to match previous research samples and gain a better understanding of M31's motion through the cosmos.

28. Ultraviolet Observations of Exploding Stars

Tomas Gomes, Savannah Miller, and Sarah Urbansky (Texas A&M University)
Astronomy
Research Advisor: Peter Brown

We are studying exploding stars -- supernovae-- in the ultraviolet using the Swift and Hubble Space Telescopes. We will describe the Swift UVOT filter system and our efforts to verify the filter transmission curves. Swift UVOT light curves of red giant explosions will be compared within a large Swift sample, with HST spectral observations, and against theoretical model simulations. We are incorporating these data to make more observational templates for comparison with distant supernova explosions for which the light is redshifted and observed at longer wavelengths.

29. Thin Foil Preparation for Excitation Function Measurement of the Medically Desirable 149-Tb

Megha Nagalla (Texas A&M University)
Independent Research Project
Research Advisor: Alan McIntosh

The nuclide 149-Tb has potential for treatment of metastasized cancers. The emission of alpha particles causes localized cell damage and death, while the emission of positrons from the same nuclide allows for imaging during treatment. Since 149-Tb is currently expensive and inefficient to produce, we are exploring new production pathways, starting with the reaction 4-He + 151-Eu. In preparation, I have produced many irradiation targets of europium oxide on aluminum backing from 0.33 to 2.36 mg/cm2 to characterize the molecular deposition process and arrive at a reliable target production technique. I have also made detailed designs, now fabricated, to hold the targets and other components during the cyclotron irradiation of the europium. We anticipate measuring production cross-sections later this year at the TAMU cyclotron institute.

30. Modeling the Behavior of Heavy Ions Incident Upon a Novel Detector

David Keltner (University of Missouri- Kansas City)
Cyclotron Institute REU
Research Advisor: Mike Youngs

Most existing heavy ion detectors are large, power-driven, and lack scalability. We investigate a novel SONOS (Silicon-Oxide-Nitride-Oxide-Silicon) transistor-based detector design that addresses these limitations by offering passive operation, reusability, and potential for miniaturization. SONOS transistors exhibit threshold voltage shifts when irradiated by heavy ions due to charge loss in the floating gate region, making non-volatile flash memory devices composed of SONOS transistors strong candidates for heavy-ion radiation sensing. These devices have demonstrated resilience to permanent damage under irradiation, enabling reliable reuse through standard charge injection processes. In this study, we simulate the effects of heavy-ion radiation on SONOS transistors to deepen the understanding of these interactions. The device is modeled using DEVSIM, a drift-diffusion-based semiconductor simulation tool. The interaction between the floating gate and heavy ions is simulated through GEANT4, a particle transport and interaction toolkit. Device properties are numerically calculated before and after simulated heavy-ion interactions, and changes, such as threshold voltage shifts, are compared to experimental results to assess the reliability of the simulations. The insights gained will inform future experimental testing and the design of future detectors of this form. Results will be presented.

31. Analysis of Toponium Mass Spectra with the T-Matrix Formalism

Oliver Fast (University of North Texas)
Cyclotron Institute REU
Research Advisor: Ralf Rapp

Toponium, the bound state of a top quark and its antiquark, is unique among particle interactions within the quark-gluon plasma (QGP). The top quark has a much larger mass than any other quark, so it typically decays much more quickly than it can hadronize, or form composite particles. Due to this large decay width, it behaves differently to other heavy quark-antiquark bound states, or quarkonia. While other heavy quarks are able to form particles much quicker than the rate at which they decay, the top quark has a decay width which is on a similar order to the binding energy of toponium. Because this behavior is unique among heavy quarks, the study of toponium may lead to insight on the nature of the strong interaction. This work attempts to characterize the mass spectrum of toponium. The propagator of a particle is a probabilistic representation of its location over time. The T-matrix formalism, which was used here, is particularly suited for the implementation of the large top quark decay width into its propagator. The amplitude of the scattering interaction between the toponium system, which results in a peak where the bound state is formed, was determined for a range of input energies.

32. Nuclear Matter Response Functions and Cross Sections in Core-Collapse Supernovae.

Gabriela Escobedo (Illinois Institute of Technology)
Cyclotron Institute REU
Research Advisors: Jeremy Holt and Tingwei Yuan

The behavior of neutrinos in core-collapse supernovae is a key yet poorly understood aspect of modeling these explosive stellar events. Neutrinos compose about ninety-nine percent of the explosion's energy, yet accurately describing how they interact with dense nuclear matter, especially under extreme conditions of temperature, density, and pressure, remains a major challenge. These interactions are governed by the nuclear matter response function, which describes how matter reacts to neutrinos, and directly determines the neutrino cross section, the probability a neutrino will scatter or be absorbed. Our research investigates how this response function evolves across a range of core conditions and how these variations impact cross sections. We are developing computational tools to calculate the response functions and resulting cross sections, which are then used in large-scale supernovae simulations run on high-performance research supercomputers. Our central focus is understanding how theoretical predictions of the cross sections vary with the resolution scale at which the nuclear force is defined. As the nuclear force is not fundamental, but rather a residual interaction emerging from the underlying quark-gluon structure, many-body calculations carry inherent uncertainty from this choice of scale. We address this through modular code design and comparing our results against known physical limits. Preliminary calculations show great variation in response behavior across conditions, supporting our hypothesis that the response function significantly influences neutrino opacity. Our work bridges nuclear theory and astrophysical modeling, and may improve predictions for neutrino signals in detectors like DUNE and Super-Kamiokande, with implications for neutrino physics and dark matter.

33. A Machine Learning Approach to Multi-Directional Neutron Detection

RJ Devlin (Davidson College)
Cyclotron Institute REU
Research Advisor: Grigory Rogachev

The efficient detection of neutrons from fissile nuclear materials is important for security purposes. The neutron source direction is the direction calculated from an active detector to a neutron source placed somewhere outside the detector. A novel method of detecting the direction of fissile Californium 252 neutron sources was developed using TexAT, a time projection chamber built at the Texas A&M Cyclotron Institute. The neutron source direction is identified through a machine learning approach, using the distribution of proton streaks in the active volume generated from neutron-proton elastic scattering events. A Monte-Carlo simulation was developed to simulate TexAT neutron detection. Simulated neutron proton elastic scattering data was saved for the purpose of training the machine learning directional detection algorithm. In addition, experimental data using the TexAT detector will be collected for a variety of neutron source locations to ensure the accuracy of the simulations and directional detection algorithm. The machine learning method will allow for the efficient detection of sources placed in multiple directions by analyzing the distribution of neutron proton scattering events.

34. Role of Meson Excited States in Hybrid Hadronization post Electron-Positron Annihilation

William Lippincott (Northern Arizona University)
Cyclotron Institute REU
Research Advisor: Rainer Fries

Electron-positron (e^+e^-) annihilation creates parton showers that have high enough energies to escape confinement and create hadrons. The process of the partons in the shower turning into hadrons is modeled by Hybrid Hadronization which describes two hadronization processes: fragmentation, which corresponds to the “string” between quarks fragmenting into more smaller strings, and recombination, which corresponds to quarks close together in phase space hadronizing. Using the JETSCAPE (Jet Energy-loss Tomography with a Statistically and Computationally Advanced Program Envelope) framework, a Monte Carlo simulation, this research analyzed the role of excited states and how their presence or lack thereof affects recombination as a form of hadronization in an e^+e^- collision. This project analyzed the energy spectrum for mesons formed from recombination from the same collision. It further analyzed these energy spectra for varying the quantum numbers J, S and L, as well for the varying radially excited quantum states in order to study what effect these quantum numbers have on the recombination energy spectra and recombination as a percentage of all hadronization. The results are shown in the poster.

35. Sample Holder for High Purity Germanium Gamma Ray Detector

Nathan Morales (California State University, Bakersfield)
Cyclotron Institute REU
Research Advisors: Alan McIntosh and Philip Adsley

Terbium 149 (Tb-149) is a promising radioactive isotope for cancer treatments due to its nature as both a positron and alpha particle emitter. This dual decay allows for imaging of tumours using Positron Emission Tomography (PET) and treatment with Targeted Alpha Therapy (TAT) to take place simultaneously. The Tb-149 is transported to the tumour by binding Tb-149 to a biomolecule which attaches to antigen proteins on the surface of cancer cells. A drug is then created which, when injected into the patient, results in a highly localized treatment which results in minimal damage to surrounding cells. In order to explore efficient pathways for the synthesis of the Tb-149 radiopharmaceutical, cross sections for different production pathways have been measured using activation. The focus of this study is to design and create a sample holder for the purpose of safely and efficiently characterizing the efficiency of High Purity Germanium (HPGe) Gamma Ray Detectors using CAD software and 3D printing technology. A better, more robust, measurement stand will allow for reduced uncertainties and better reproducibility for cross section measurements. The resulting efficiency measurements are in good agreement with the expected values, which decrease at a rate proportional to the square of the distance between the detector and the radioactive sample.

36. Characterization of Thin natSn Targets for Nuclear Reaction Experiments

Layla Koon (Pennsylvania Western University)
Cyclotron Institute REU
Research Advisor: Charles Folden III

Targets are materials that are bombarded by an accelerator beam's charged particles to initiate nuclear reactions. The morphology of these targets is studied to determine their impact on the reaction residues produced and the residues' kinetic energy loss. At the Texas A&M University Cyclotron Institute, thin 118Sn targets (250-500 ug/cm2) are bombarded with an 40Ar beam to produce 152Er and 153Er for detector calibration prior to "online" chemistry experiment. To develop a procedure to fabricate 118Sn targets, resistive heating of natSn was utilized at the Advanced Nuclear Target Laboratory for Experimental Research (ANTLER). The fabricated natSn targets' thickness, surface uniformity, and composition were characterized through alpha-particle energy loss measurements, scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and x-ray photoelectron spectroscopy (XPS). The latest results of this work will be presented.

37. The Concentration Distribution of Astatine-211 in Column for Transport

Erin Clark (St. Mary's College of Maryland)
Cyclotron Institute REU
Research Advisor: Mike Youngs

One of several techniques for treating different types of cancers that are currently being developed is targeted alpha therapy. The radioactive isotope astatine-211(211 At) is a candidate for this treatment due to its short half-life and alpha decay mechanism. The isotope is produced at Texas A&M University using the K150 cyclotron and after a chemical separation process can be stored in a cylindrical column but little is known about the distribution of astatine within this column and whether it changes over time. Without this understanding, it is difficult to ensure uniform tests of the isotope in medical trials. This gap in knowledge might lead to waste of the product within the production process. In this experiment, we are working to understand the distribution using 16-element Si photodiode arrays and gafchromic film, both of which can detect the x-rays from the decay. Monte Carlo simulations of several potential distributions were performed and then compared to the experimental results. The results from this study will be shown.

38. Characterization of Ion Bunches using GOLIATH, the Gas-Operated Large Ion bunch and Atomic Trap for He6-CRES

Eva Chalona (University of Southern Mississippi)
Cyclotron Institute REU
Research Advisor: Daniel Melconian

Beta decay, the most prominent form of radioactive decay, is governed by the weak interaction. The He6-CRES goal is to search for physics beyond the standard electroweak model by finding a distortion in the beta energy spectrum using the Cyclotron Radiation Emission Spectroscopy (CRES) technique. Currently, a gaseous source is used, but this brings up a problem of an energy dependent efficiency of beta detection from beta particles that may or may not hit the walls of the chamber. To fix this issue we use ions and confine them to the center of the chamber using a Penning trap; the magnetic field prevents betas from reaching the walls. To load the Penning trap, we require bunches of ions with a small energy and time spread. In order to achieve these requirements, a Radio Frequency Quadrupole (RFQ) is used along with a buffer gas, such as Helium, to bunch and cool the ions. Previous experiments show that most RFQs can create bunches on the order of 10,000 ions per bunch. However, this would mean years of beam time for a successful experiment, but if we can achieve bigger bunches on the order of 1,000,000 ions per bunch, the amount of beam time needed will be less than a week. GOLIATH was designed for this purpose and simulations have shown that it can form these larger bunches. This poster will present GOLIATH, its expected capabilities and our progress in demonstrating its larger bunch sizes using an offline ion source.

39. Testing a Prototype Detector Array on a Chip Using Heavy-Ion Beams

Isabelle Adams (Agnes Scott College)
Cyclotron Institute REU
Research Advisor: Mike Youngs

Many existing radiation detectors are either large, need to be actively powered, or require a significant time delay before the detector can be analyzed. Some detectors have multiple of these drawbacks. This creates a knowledge gap for certain applications, which must be filled by rapid and energy efficient detectors. Previous studies have shown that SONOS transistor flash memory devices are sensitive to heavy ion radiation which creates the possibility of using them as a new small, passive form of detector that can be analyzed reasonably quickly and reused. This project focuses on a prototype chip developed by Cerium Labs to test the effectiveness of the concept. Each chip has capacitors (instead of transistors) with 6 different configurations, which allows for multiple designs to be tested simultaneously. To determine their response to exposure, the chips were exposed to heavy ion radiation in the form of helium-4, nitrogen-14, and argon-40 beams at 15 MeV/u for varying lengths of time. Then the changes of the potential on each capacitor were recorded and analyzed in order to determine the feasibility of each configuration. The results of these systematic studies will be shown.

40. Optimizing Methods to Synthesize Low-Valent Aluminum Species

Brooke Moskovitz (Texas A&M University)
Independent Research Project
Research Advisor: Alison Altman

Low-valent aluminum molecular species are known to be strong 2-electron reducing reagents and unique metalloligands, imparting strong ligand fields. Al-Nacnac (Al{HC[C(Me)NDipp]2} (Dipp = 2,6-iPr2C6H3)) is a stable, low-valent aluminum species that reacts similarly to a carbene with strong reducing properties. The aluminum has a lone pair and empty p-orbital localized on the metal center. This acts as a good sigma donor, but poor pi acceptor. It has been found that Al-Nacnac can cleave organic redox active bonds which can be used in developing higher interest organic molecules. Current Al-Nacnac synthesis proceeds through 2-electron reductive pathways leading to lower yields and difficult reproducibility in their methods. This research focuses on a transmetalation reaction scheme with readily synthesized AlCp* (Cp* = [C5Me5]–) and K-Nacnac. In this study, I explore the addition of Lewis-bases, specifically triphenylphosphine (PPh3), as it facilitates transmetalation by forming stable adducts of the Al-Nacnac and disfavors disproportionation and the formation of side products. To optimize the formation of the Al-Nacnac, parameters such as temperature, concentration, and molar equivalents of PPh3 were adjusted in addition to testing various Lewis bases. The conditions will be adjusted with a goal of higher yields, scalability and reproducibility.

41. Chemical Probing of Variant BoxB RNA library Reveals Structural Determinants of λN Protein Binding

Ava Daly (Texas A&M University)
Independent Research Project
Research Advisor: Lauren Hagler

RNA Binding Proteins (RBPs) are able to recognize and attach themselves to target transcripts through both sequential and structural features. In doing so they can influence gene expression and regulation at various levels. Found in bacteriophage lambdaviurus lambda, the lambda N (λN) protein binds to a conserved RNA stem-loop structure known as the boxB hairpin therefore serving as the model system for studying RNA-protein interactions. The lambda N protein acts as a transcriptional antitermination protein and prevents premature termination of transcription of the attached sequence. This will allow the genes to become resistant to termination and become available for later use in the phages infection cycle. This project investigates how λN binding affinity and specificy are influenced by structural variants within the target boxB stem-loop. These variants were expressed through the creation of an RNA library incorporating mutations such as single-nucleotide substitutions, deletions, additions and stem length modifications. Using chemical probing such as in-vitro DMS-MaPseq, how λN protein binding at increasing concentrations was assessed through changes in structure and DMS reactivity profiles of the bases found within the RNA. This project demonstrates altered protection patterns across specific mutants and how both secondary structure and local sequence composition fluctuate λN recognition and attachment. Additionally, this work builds on the utility of chemical probing to examine the structural determinants of RBP-RNA interactions.

42. Mechanochemical Synthesis of Divalent Lanthanide Iodides

Andy Oliveira (University of Texas at San Antonio)
Center for Mechanical Control of Chemistry (CMCC) REU
Research Advisors: Alison Altman and James Batteas

Lanthanide diiodides (LnI2) are valuable starting material and reductants in synthetic chemistry, with samarium diiodide being used as a powerful single-electron reductant in organic reactions. Beyond reactions, certain lanthanide diiodides have interesting properties, such as gadolinium diiodide which exhibits two-dimensional magnetism and is being explored for applications in high-density data storage and quantum computing technologies. The biggest challenge that comes with these compounds is their synthesis. High sensitivity, lengthy reaction times, instability in solvents, and undesired coordination with solvents are common synthetic problems. Mechanochemical techniques avoid these problems by performing reactions without solvents, in inert atmospheres, and with short reaction times. This study investigates the ability to synthesize and characterize various LnI2 complexes through mechanochemical processes.

A series of lanthanides were reacted with iodine in stoichiometric amounts and were run in both an oscillatory and planetary ball mill under inert atmospheres. Samples were extracted with hexane then annealed, and the resulting powders were characterized through powder X-ray diffraction (PXRD) and scanning electron microscopy (SEM). PXRD patterns showed two polymorphs of SmI2, one high temperature phase with space group Pcab and an orthorhombic structure. The second was an ambient temperature phase with space group P21/a and a monoclinic structure. This reaction suggests that ball milling SmI2 synthesizes both ambient and high temperature crystal structures, emphasizing the potential for synthesizing other unknown LnI2 phases via ball milling. These results demonstrate that ball milling provides a solvent free, ambient temperature, scalable, and rapid route synthesis for various LnI2 complexes.

43. Leveraging Machine Learning to Predict Promising Mechanochemical Reactions

Jonathan Lopez-Hernandez (University of California, Merced)
Center for Mechanical Control of Chemistry (CMCC) REU
Research Advisors: Daniel Tabor and Tzu-Hsuan Chao

This project applies machine learning techniques to accelerate the discovery of new chemical reactions. Computational methods are essential for understanding which reactions are favorable and how molecular components or reaction conditions can be optimized to improve yields or rates. However, traditional approaches are often too computationally demanding to explore the vast chemical space of potential reactions. To address this, we will develop an active learning framework that combines low-cost machine learning models for initial reaction screening with first-principles calculations for validation. Participants will gain experience in computational chemistry, machine learning workflows, and the fundamentals of mechanochemistry. As this is a rapidly evolving area of development in the center, the specific target reactions may vary but could include cyclization, single-bond formation, substitution, and elimination reactions.

44. Studies on Copper Catalyzed Azide-Alkyne Cycloaddition (CuAAC) Reactions by Ball-Milling

Mackenzie Gray (Louisiana Tech University)
Center for Mechanical Control of Chemistry (CMCC) REU
Research Advisor: James Batteas

Mechanochemistry–using force to drive chemical reactions–is a more efficient and sustainable alternative to traditional solution based methods. For mechanochemical reactions, it is important to learn about the effects of milling parameters to better control the reaction outcome, efficiency, and reproducibility as well as gain a deeper understanding of the reaction mechanisms for larger scale industrial applications. Using the copper catalyzed azide-alkyne cycloaddition (CuAAC) reaction we probe the effect of milling atmosphere, copper catalyst, presence of grinding additives, time, and speed on a one-step CuAAC reaction, featuring an in situ generation of the alkyl azide. Our results show that maintaining copper in a +1 oxidation state via atmospheric control is important for optimizing yields. Moreover, we found that the use of silica as a grinding additive cuts the reaction time in half. We further explore the use of ball-milling for syntheses involving CuAAC-derived ketenimine intermediates from sulfonyl azides and terminal alkynes, the first reported mechanochemical synthesis of this reaction.

45. Quantifying Energy Dissipation in Free-Flowing Powders

Ahmad Tantish (Texas Woman's University)
Center for Mechanical Control of Chemistry (CMCC) REU
Research Advisor: Jonathan Felts

Understanding how mechanical energy dissipates in powdered materials is essential for applications ranging from material design to chemical reactivity studies. In this project, we investigate energy dissipation in free-flowing powders under compression and impact conditions using indentation and drop-weight experiments. By analyzing force-deflection curves collected via mechanical testing, we quantify the irreversible energy loss associated with particle rearrangement, friction, and potential reaction mechanisms. Force vs. displacement data were processed using linear interpolation to align and compare results across multiple trials. The area under the loading and unloading curves was used to calculate the total energy input and the recoverable energy, respectively. The difference between these integrals represents the dissipated energy. This study provides a framework for distinguishing between mechanical frictional losses and reaction-driven dissipation in powder systems, and it emphasizes the importance of precise data alignment and repeatability in interpreting energy behavior in granular materials.

46. How the Qβ Coat Protein Recognizes RNA Hairpins: Insights from Chemical Probing

Matt Mansfield (Texas A&M University)
Independent Research Project
Research Advisor: Lauren Hagler

The coat protein of the bacteriophage Qβ has been previously proposed in literature to bind at an acceptable level to any 3 nt hairpin with an 8 nt long stem and an adenine at the +8 position. To test this, we have used chemical probing to characterize the structure of a designed library, using varying ratios of Qβ coat protein with library. By performing DMS-MaPseq measurements with and without the Qβ coat protein, we can decode binding and determine with more certainty what contributes to the coat protein's binding. Ideally, this data should indicate that the Qβ coat protein shows a strong binding preference to any hairpin loop that follows the known secondary structure, which could make it helpful for stabilizing loops that might not be preferential in other circumstances.

47. Expression of Epigenetic Proteins BRD9 and ENL for Phages Display Selection and Crystallization

Jaydaliz Rivera- Rivera (Interamerican University of Puerto Rico)
Sloan Foundation
Research Advisor: Wenshe Liu

Bromodomain-containing protein 9 (BRD9) and Eleven-nineteen leukemia protein (ENL) are crucial epigenetic proteins in our DNA regulation. Since acetylation is the most dynamic protein translational modification is often associated with increased DNA accessibility and transcription. These acetylated histones recruit transcription and remodeling factors, and their deregulation could result in aberrant expression of survival and growth-promoting genes. BRD9 and ENL recognize and read acetylate marks on histones, indicating whether a gene is active or not. The histone-reading function of ENL has been proven essential in the onset and progression of several acute leukemias, suggesting a putative therapeutic window for ENL inhibition. Similarly, BRD9 has become a new hot target for effective tumor treatment methods as it is an essential component of the SWI/SNF chromatin remodeling complex, and a critical target required in acute myeloid leukemia.

My focus during this summer was to overexpress these target proteins by doing transformation of the plasmid and expression. These expressed proteins were then purified using several chromatography methods like Ni-NTA chromatography, FPLC and Size Exclusion Chromatography (SEC). We used pure protein to perform phage display peptide selection campaign to find potent peptide binders for these targets. Furthermore, we synthesized small molecules as BRD9 inhibitors and IC50, which for these molecules was identified by Amplified luminescent proximity homogeneous assay (AlphaScreen assay). However, we also optimized conditions to find the crystallization environment for these proteins using the sitting drop method.

48. Synthesis of Nickel Oxalate Complexes for Catalytic Carboxylation of Alkenes

Yuniel Velez (Interamerican University of Puerto Rico)
Sloan Foundation
Research Advisors: Dave Powers and Phong Thai

The catalytic synthesis of carboxylic acids using carbon dioxide as the carbonyl source necessitates the usage of high-pressure gas and displays low reaction efficiency. We hypothesize a nickel-mediated protocol for the carboxylation of olefins could be realized using oxalate salt as a competent carbonyl precursor. In this regard, an in situ CO2-bound nickel intermediate would be generated via photoactivation of nickel oxalate complexes. In this study, κ2-oxalato nickel catalysts bearing various supporting ligands were synthesized from the reaction between nickel halide complexes and silver oxalate, which afforded both monomeric and dimeric oxalate-bridged species. Alternatively, in situ generation of monomeric nickel species was achieved using ligated nickel triflate and tetraethylammonium oxalate. Research is underway to evaluate the photoactivation and catalytic activity of these nickel oxalate complexes.

49. Synthesis of SuFEx Hubs with Fluorosulfonyl Azide via Strain-Promoted Cycloaddition

Elian Montas (College of the Holy Cross)
Chemistry NSF-REU
Research Advisor: Quentin Michaudel

Click chemistry has revolutionized chemical biology and drug discovery thanks to its hallmark features: bioorthogonality, high yields, broad substrate scope, and straightforward purification. Over the past decade Sulfur(VI) Fluoride Exchange (SuFEx) has emerged as a powerful and modular reaction, offering unique advantages over traditional click methods. The most significant being the ability to form diverse S(VI) bonds through simple S–F exchange with nucleophiles like free amines, alcohols and aryl silyl ethers. However, existing strategies for introducing SuFExable (S(VI)–F) motifs often require nucleophilic (free amine, alcohols) substrates, strong bases, or costly transition metals like palladium or iridium. Inspired by cycloaddition reactions such as CuAAC and SPAAC, we present a novel, metal and base free approach to install S(VI)–F functionalities onto strained cyclic systems using fluorosulfonyl azide as the key reagent. This work begins by detailing the design and rationale behind the reaction, followed by a showcase of structurally diverse strained systems and the SuFEx hubs they enable. Finally, we explore the synthetic utility of these new hubs in constructing biologically relevant molecules, including sulfamides and sulfamates.

50. Mapping How Mutations Shape RNA Folding and Modulate PP7 Capsid Binding Specificity Using DMS-MaPseq

Maya Schauber (Fairfield University)
Chemistry NSF-REU
Research Advisor: Lauren Hagler

Within cells, RNA molecules form complex three-dimensional structures determined by their nucleotide sequence and the surrounding cellular environment. RNA folding is essential for numerous biological functions, including gene regulation and protein synthesis. Many of these processes are regulated by RNA-binding proteins (RBPs) that recognize and bind to specific structures and sequence motifs. Since traditional pulldown assays provide limited information about RNA structure, chemical probing was used to study a designed library of Pseudomonas phage PP7 hairpin mutants. We performed DMS-MaPseq measurements in vitro with and without PP7 capsid protein to investigate how single- and multi-nucleotide mutations affect the structure and binding of the RNA hairpins. We aim to identify and quantify specific structural features that influence RNA folding and capsid recognition.

51. A Metal-First Approach to Ruthenium Pincer Complexes Incorporating Main Group Elements

Mason Bayles (University of Alabama at Birmingham)
Chemistry NSF-REU
Research Advisor: Oleg Ozerov

Nitrogen-containing heterocycles constitute a critically important and structurally diverse class of small molecules. As they comprise approximately 60% of currently approved drugs, the development of efficient syntheses of these compounds remains a vital target for medicinal and organometallic chemists. Despite their importance, site-selective activation and functionalization of C–H bonds within these heterocycles pose significant synthetic challenges. One promising approach to this issue involves the use of pincer-type transition metal complexes containing a Lewis acidic main group element. In this approach, a Lewis acidic directing group captures the Lewis basic heterocycle, followed by regioselective insertion of the ortho C–H bond into the metal center. As such, the synthesis of these pincer complexes has been a central focus of our group. Previous work has demonstrated the effectiveness of these pincer complexes in enabling C–H activation of a broad array of nitrogen-containing heterocycles. However, preparing pincer ligands containing Lewis acidic elements has proven challenging. Consequently, we developed a metal-first synthetic route to pincer complexes. By first generating a phosphinophenol complex and subsequently introducing the desired main group element, we more efficiently synthesized pincer complexes of rhodium and iridium. Naturally, we are interested in extending this methodology to other transition metals. This study showcases the synthesis and characterization of a series of phosphinophenol-containing ruthenium complexes, which serve as viable precursors to PEP-type pincers (E = B, Al, Si, P). The reactivity of these complexes toward various main group reagents is explored to further evaluate their potential in forming these pincers.

52. Aziridination-Assisted Bifunctional Tagging Strategy for Accurate Relative Quantification and Isomer Characterization of Lipids

Stefanía Borges Rivera (University of Puerto Rico at Cayey)
Chemistry NSF-REU
Research Advisors: Xin Yan and Erin Hirtzel

Lipids are promising disease biomarkers, as changes in the lipidome can indicate the progress of certain diseases. Mass spectrometry (MS) has emerged as a useful tool for lipidomic studies due to its sensitivity and specificity. However, it is challenging to quantify lipids because of their diverse structures and isomers. Despite its strengths, MS cannot provide carbon-carbon double (C=C) bond isomer resolution and accurate relative quantification alone. In this study, a bifunctional tagging strategy was developed to allow both relative quantification and structural characterization of lipid isomers. Previous work in our group utilized rhodium-catalyzed aziridination to introduce isobaric mass tags (IMTs) to C=C bonds to accurately quantify lipids. IMTs are a tandem mass spectrometry (MS2) approach to quantification, where multiple samples can be quantified under a single analysis. Building on this work, this reaction allowed the incorporation of a target site for an amine-reactive radical-inducing reagent that could be used for radical-directed dissociation (RDD), an MS2 technique that provides structurally informative fragmentation. The RDD reagent was isotopically labeled so that it could function as an IMT as well. This project focused on establishing the IMT functionality of this isobarically-labeled RDD reagent. Separate samples were tagged with differently labeled IMTs and then combined for a single analysis. Because the tags are isobaric, they appeared as a single MS1 peak, while MS2 reporter ions enabled accurate relative quantification. RDD was initiated in MS3 to differentiate between lipid isomers. This bifunctional tag provides both relative quantification and structural characterization within one experiment, functioning as an IMT and an RDD reagent.

53. Exploring N-Aminopyridinium Reagents for Cross-Electrophile C(sp^3)−N Coupling

Carmen Sánchez Delgado (University of Puerto Rico at Cayey)
Chemistry NSF-REU
Research Advisor: David Powers

Cross-electrophile coupling involves transition metal–catalyzed bond formation between two bench-stable and widely abundant electrophilic partners without the need for pre-formed organometallic reagents. Although this method is widely developed for C−C coupling chemistry, the application of the same in C−N bond formation is rare. Recently, a base-free nickel-catalyzed cross-electrophile coupling between aryl halides and N-aminopyridinium salts has been developed in the Powers laboratory, enabling efficient C–N bond formation to synthesize aryl alkyl amines. Expanding on the scope, this research aims to develop a method for metal-catalyzed cross-electrophile alkyl C(sp^3)−N bond, specifically targeting the more challenging tertiary C(sp^3)−N bonds, which are often inaccessible by traditional methods due to the steric hindrance of bulky alkyl groups and undesired side reactions or rearrangements.

54. Leveraging Sulfamide Chemistry for Novel Diazirine Formation

Emmanuel Cruz (University of Puerto Rico at Cayey)
Chemistry Summer Research Scholars Program
Research Advisor: Quentin Michaudel

Diazirines are a versatile organic molecule with diverse applications, including pyrazole synthesis, labeling and hyperpolarization, metal-catalyzed cross-coupling, and as a precursor for other reactive species. Because the ring is small in nature, it is very strained, making it susceptible to rearranging into its diazo isomer–a similar structure to diazirines–or to release the dinitrogen molecule altogether, leaving a carbene behind. Carbenes are highly reactive molecules, which makes them useful in organic synthesis for their use as crosslinking agents and reactants in the synthesis of alkenes, cyclopropanes, and even polymers. It is because of this ease of access to relatively elusive molecules that diazirines are of interest when it comes to their formation. Unexpectedly though, the scope of their syntheses is considerably limited. Presently, there are only 2 known ways to make them: via a ketone or similar isomer and through the Graham reaction via an amidine. Both methods, however, are commonly lengthy multi-step reactions which utilize toxic chemicals such as liquid ammonia, chromic acid, and carbon tetrachloride. This project aims to develop a third synthetic pathway for diazirines by first accessing highly unprecedented cyclic sulfamides, then eliminating the sulfonyl group can be eliminated via aza-Ramberg–Backlünd chemistry, thus generating the desired heterocycle. Promising preliminary results show that synthesis up to the cyclic intermediate was achieved from an amine intermediate. Future works highlighting the challenging purification and subsequent –SO2– elimination will also be discussed.

55. Spatial 2'-Hydroxyl Acylation Reversible Crosslinking (SHARC) Mediated Identification of in vivo Heterochiral RNA–RNA Interactions

Vance Couturier (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisor: Jonathan Sczepanski

Mirror image RNA (L-RNA) is the synthetic enantiomer of naturally occurring D-RNA. With similar physical and chemical behavior to its native analog, L-RNA is particularly attractive for use in therapeutic and diagnostic applications, as its bioorthogonality prevents its degradation by cellular nucleases and is believed to limit off-target interactions. Though canonical Watson–Crick base pairing does not occur between heterochiral RNAs, L-RNA aptamers have the capacity to render disease-causing targets inactive in vivo through tertiary recognition motifs. While L- aptamers have been identified in vitro through systematic evolution of ligands via exponential enrichment (SELEX), the interactions of L-RNAs across the human transcriptome have not been rigorously characterized. This project seeks to identify sequences within the transcriptome that are most susceptible to interaction with L-RNAs using spatial 2'-hydroxyl acylation reversible crosslinking (SHARC) to isolate bound targets in vivo. L-r(GA)20, which caused exon skipping events in vivo, was selected as an L-oligonucleotide (ON) for initial investigation. First, D-RNA library rLib.1036 was generated from a DNA library with known affinity for L-r(GA)20. Subsequently, the

SHARC reagent dipicolinic acid imidazole (DPI) was used to confirm the viability of heterochiral RNA–RNA crosslinking via agarose gel electrophoresis. DPI and diglycolic acid imidazole's (DGI) crosslinking efficiencies were then compared. DPI was shown to have a higher crosslinking efficiency than DGI and will be used to crosslink L-r(GA)20 with total RNA isolate in vitro. Additional studies will then be performed in vivo using biotinylated L-ONs to characterize their interactions with the transcriptome.

56. Design and Development of Phosphine Urea Ligands for Enantioconvergent Cross-Coupling Reactions

Emma Conrey (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisor: Andy Thomas

Cross-coupling reactions are prevalent in both industry and academia for the past fifty years. One of the most common reactions used for carbon-carbon bond formation is the Negishi cross-coupling. This reaction consists of a palladium or nickel catalyst, an organozinc reagent, and an organohalide. This coupling is particularly prevalent in pharmaceutical synthesis due to its high compatibility with most functional groups, and it allows for a greater diversity and complexity of substituents on drug molecules following synthesis. While there is an abundance of instances where a racemic electrophile can be cross-coupled with a nucleophile, there are only a few instances where racemic organozinc nucleophiles can be cross-coupled asymmetrically. These instances involve coordinating groups on the electrophile for the enantioenriched product to be obtained with high enantiomeric ratios. The aim of this research is to produce a chiral arylphosphine ligand that will be used in cross-coupling a racemic nucleophile with an electrophile. These ligands will contain a Lewis-basic urea backbone that serves as an electron donor to facilitate covalent bond formation with a metal.

57. Metal-Free C–N Bond Formation Using N-Aminopyridiniums via EDA Complexes

Isaac Deavenport (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisors: David Powers and Cali Kucifer

Electron donor-acceptor (EDA) complexes are assembled by non-covalent interactions between an electron donor and electron acceptor. Photoexcitation of EDA complexes can trigger a single-electron-transfer (SET) and generate radical intermediates under mild conditions. It is proposed that N-aminopyridinium salts can take part as electron acceptor to undergo photoinduced-SET, followed by cleavage of the N–N bond to afford N-centered radicals. Using Cs2CO3 as an electron donor, various protected N-aminopyridiniums have been shown to undergo depyridylation to yield N-centered radicals which was trapped by (U+03B1),(U+03B2)-unsaturated ketones. Further efforts are being made to make this C–N bond formation procedure modular, using appropriate N-aminopyridinium salts and radical acceptors resulting in various amines to be obtained.

58. Photochemically Driven PCO Group Transfer to Olefins via Ni(II)-Based Precursors

Guilherme Ragi Berto (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisor: David Powers

Phosphorous-containing motifs are central to many bioactive compounds, agrochemicals, and ancillary ligands, yet direct strategies for incorporating phosphorous into non-activated organic substrates remain limited. We recently reported synthesis, characterization and the reactivity of a well-defined (PNP)Ni-PCO complex. Cryogenic photolysis of the complex undergoes CO extrusion which results a reactive [Ni]–P species which we formulate as a triplet metallophosphinidene based on a combination of cryogenic spectroscopy and computational results. In the absence of substrate, the reactive metallophosphinidine undergoes rapid P-P coupling to afford a diphosphorous-bridged dinickel complex. The observation of formal [2+2] cycloaddition between two equivalents of (PNP)Ni-PCO in the formation of the dimer inspired us to consider the analogy between alkenes and metallophosphaketenes in the cycloaddition with olefinic partners. Here we report the first example of photochemically driven phosphorous group transfer via a reactive (PNP)Ni-PCO complex. We observed in correct reaction conditions, instead of [Ni]-P dimerizing, (PNP)Ni-PCO could undergo [2+2] cycloaddition with suitable unsaturated organic substrates to afford four-membered ring phosphacycles. Further, subsequent treatment with TMS-PCO effects cleavage of the [Ni]-P bond, enabling group transfer and regeneration of the starting (PNP)Ni-PCO complex. Ultimately, this work establishes a rare phosphorous-group transfer manifold and provides mechanistic insights into the cycloaddition.

59. Lanthanide Iodides Across Oxidation Extremes: Solid-State and High-Pressure Approaches to LnI_2 and LnI_4 Compounds

Megan Minassian (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisor: Alison Altman

Lanthanides exhibit sharp optical features due to f–f transitions within their contracted 4f orbitals, making them ideal for applications such as bioimaging, display technologies, and optical sensors. These transitions are largely unaffected by the surrounding chemical environment, ensuring consistent luminescence. Because the 4f orbitals in lanthanides are contracted—due to increased nuclear charge, poor shielding, and relativistic effects—oxidation typically involves the removal of electrons from the higher-energy 5d and 6s orbitals. As a result, the +3 oxidation state is most common, while +2 and +4 compounds are much rarer. This work aims to synthesize metastable Ln(II) and Ln(IV) iodide compounds and explore how oxidation state influences their luminescent properties. State-of-the-art high-pressure techniques will be used to access these metastable states—specifically targeting the synthesis of terbium tetraiodide (TbI_4), and exploring the 4f → 5d transitions in neodymium diiodide (NdI_2). This work will be essential for uncovering the oxidation state–dependent luminescent properties of LnI_x systems, while also laying the foundation for bulk synthesis of these compounds using the high-pressure multi-anvil press at Brookhaven National Laboratory's National Synchrotron Light Source II (NSLS-II).

60. Accessing Chemically Recyclable Poly(Squarate Ester) via Ring-Opening Metathesis Polymerization

Liam Taylor (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisor: Quentin Michaudel

In recent years, environmental concerns have risen about conventional polymer materials due to their make–use–dispose product cycle and resulting accumulation in landfills and nature. These concerns have led to a significant push to synthesize new polymers as alternatives or replacements with built-in degradation or reuse pathways. This research aims to create a polymer with a closed-loop degradation pathway: a mechanically robust material that can be depolymerized into compounds which can be directly reassembled into its monomer. Subsequent polymerizations of recycled material should be mechanically identical to the original, pristine polymer. The polymer is being synthesized via ring-opening metathesis polymerization (ROMP) of a squarate ester derived from the cyclization of squaric acid with a diol. Future efforts will be focused on materials analysis of the polymer, as well as comparison between pristine and recycled material.

61. Yeast-Based Screening of Protein Variants for Binding Site Characterization

Davis Beauvais (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisors: Arthur Laganowsky and Michael Lynn

Almost every lifeform has some form of potassium channel which is why it is important that we understand the structure and function of these proteins. K+ channels are responsible for maintenance of the resting membrane potential and are involved in numerous biological functions. Dysfunction of K+ channels underlies several human pathologies and even some cancers. Understanding the gating mechanisms of these channels provides a foundation for downstream applications in drug discovery and therapeutic treatments. E. coli is a useful expression system for growing simple proteins with no post-translational modifications, but when expressing more complex eukaryotic proteins like K+ channels, yeast can be a powerful step up. Pichia pastoris is a methylotrophic yeast that we use in this project to screen for expression of membrane proteins. A large part of our work is optimizing protein purification using native mass spectrometry. We then investigate lipids and metal ions that may be important to a protein’s function, using mass spectrometry and crystallography. Purity of samples is critical to native mass spectrometry experiments because each reagent added to the instrument will add complexity to the spectrum, making interpretation more difficult. These studies are intended to clarify how specific interactions control the gating mechanisms of potassium channels.

62. Insights Into the Effect of Charged Phospholipid Headgroups on Valinomycin Incorporation in Model Lipid Monolayers

Anabela Meier (Texas A&M University)
Chemistry Summer Research Scholars Program
Research Advisors: Saranya Pullanchery and Amrita Chakraborty

Phospholipid bilayer, which forms the fundamental structure of cell membranes, acts as a natural barrier requiring specific membrane transporters to facilitate the movement of polar solutes, ions, glucose, amino acids, and other molecules. This has sparked significant interest in the development of artificial ion transporters, particularly for disease diagnosis. Investigation of the mechanism and efficiency of these ionophores often requires them to be incorporated into phospholipid (mono- or bi) layers by either (a) premixing them in solution phase, or (b) injecting the former into an aqueous subphase underneath a pure lipid monolayer. However, the extent of ionophore incorporation, and how their conformation in the mixed monolayer are affected by the charge of lipid headgroups are unknown. In this study, we use Valinomycin — a cyclic peptide known for selective potassium ion transport across lipid membranes — to examine these effects. We employ a Langmuir trough to study the surface properties of mixed monolayers of Valinomycin with cationic, anionic, and zwitterionic headgroups. Additionally, we compare the change in mean molecular area upon introducing K + into the subphase when Valinomycin was premixed vs injected in case of differently charged lipids, thereby proposing the relative efficiency of these two popularly adapted methods.

63. When Solvers Shape Ecosystems: A Race for Ecological Realism in Numerical Predator Prey Models

Sreeram Shankar (College Station High School)
Independent Research Project
Research Advisor: Sharath Girimaji

Numerical solvers are often treated as background tools in ecological modeling, but they can fundamentally alter the outcome of a simulation. This is especially true in realistic modeling, where accuracy and predictive power are crucial for understanding environmental systems. In this project, I compared 14 fixed-step solvers—ranging from simple methods like Euler to complex ones like RK8, BDF2, and Adams-Bashforth 4—across seven time step sizes, from 1 year to 1 day. Using real-world moose and wolf population data from Isle Royale, I created a high-fidelity reference model using the Lotka-Volterra predator-prey differential equations with an adaptive DOP853 solver. Each solver was evaluated on multiple ecological metrics: accuracy to real data, fidelity to the high-resolution model, population conservation drift, peak alignment, and statistical correlation. Surprisingly, Euler's method consistently ranked among the top performers, achieving the best overall accuracy at both the coarsest and finest time steps. Other solvers, such as BDF2 and AB4, displayed sharp transitions—failing completely at one resolution and becoming top-ranked at the next. These findings challenge the assumption that higher-

order methods always produce better results. Like in Formula One racing, where a simple, well-tuned car can outperform a more powerful one under the right conditions, Euler's method excelled due to its stability, rhythm alignment, and robustness. Solver choice, therefore, is not just a technical detail—it shapes the ecosystem you simulate.

64. Modeling Biofilm Growth and Detachment Under Varying Hydrodynamic and Nutrient Conditions in Tropical Freshwater Systems

Abelino Garcia (College of the Sequoias)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisor: Yinuo Noah Yao

Biofilm is a protective layer formed by complex microbial communities that adheres to surfaces in aquatic environments. These communities play a significant role in ecological, engineering, and medical contexts. However, predicting biofilm growth is challenging due to the complex interactions between local hydrodynamics and substrate conditions. This study aims to predict biofilm growth and detachment in tropical freshwater systems under varying substrate and hydrodynamic conditions. We hypothesize that substrate availability is the dominant factor for biofilm growth and detachment at a stagnant or low flow environment, whereas local hydrodynamics will become the primary factor under high-flow environments. To test the hypothesis, we collected 12 water samples from a tropical pond within a primary growth forest in Costa Rica with six of the samples collected after heavy rainfall and six after minimal rainfall. The samples will be analyzed for ammonium and phosphate concentrations and used as the reference case for Computational Fluid Dynamics (CFD) simulations in OpenFOAM. Substrate conditions (e.g. ammonium and phosphate concentrations) and flow conditions (e.g., velocity) will be varied in the simulations to quantify their impacts on biofilm growth and detachment. By combining field measurements with using CFD simulations, this research advances understanding of the physical and chemical factors governing biofilm formation in natural aquatic systems.

65. Uncovering the Impact of Leaf Cutter Ants Nesting Activity on Soil Biogeochemical Properties in a Tropical Forest Plantation

Bailey Castaneda (University of Arizona)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisor: Felipe Aburto Guerreo

This study evaluates the spatial distribution of total organic carbon (TOC), total nitrogen (TN), clay, sand, available and soluble nutrients contents within bioturbated soils by Atta cephalotes (leaf cutter ants). We compare soil characteristics between areas of high ant activity to those without apparent activity. The

nest of focus was located in a 20 year-old Hyeronima plantation on a tropical andisol near San Isidro de Peñas Blancas, Costa Rica. A rectangular grid was established across a 3 m2 surface. A 2.5 m x 1 m trench was excavated across the nest covering areas with apparent bioturbation. A 15 cm x 15 cm grid was marked along the exposed soil profile. A total of 104 samples were collected from the surface and soil profile. A soil mosaic was made, demonstrating differing qualities in and around the leaf cutter ant nest, depicting the entirety of the nest profile. The collected samples were analyzed by Near Infrared Spectroscopy (NIR) and soil chemical properties predicted (e.g., TOC, TN, etc.) using the open-source machine learning model trained using the Open Soil Spectral Library (OSSL). This data visualizes spatial distribution of soil properties across the bioturbated area including both non-mound and mound areas. We predict higher organic carbon and nutrient elements (e.g., nitrogen) near areas with higher ant bioturbation due to increased organic inputs near the nest. This study illustrates how leaf cutter ants modify the spatial distribution of soil biogeochemical properties and determine the impact of soil engineers on their environment's structure.

66. Soil Aggregation Effects on Water Movement and Nutrient Dynamics Across Costa Rican Land Uses

Kayla Mitchell (University of Washington Tacoma)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisors: Julie Howe and Peyton Smith

Healthy soil depends on many factors including soil aggregation, the process by which individual soil particles bind together to form clusters. Stable aggregates regulate water movement and nutrient retention, affecting agriculture and water resources. This project sought to identify the impact of aggregation on water and nutrient movement through soil across three sites in the Peñas Blancas region of Costa Rica: papaya farm (Carica papaya), a managed plantation (Hieronyma alchorneoides, known as Pilòn trees), and native forest. Four paired randomized samples were collected from each site. Pairs were divided into intact soil and soil sieved to pass 2-mm. Both were equalized by dry mass to fill a soil core liner (7.5 cm diameter x 15 cm depth). Water flow, aggregation, and nutrients were compared in the intact and sieved treatments site and among sites. Water tests included infiltration, and hydraulic conductivity. Aggregates were evaluated by stability and size. Nutrients (nitrate, ammonium, and phosphate) were evaluated in leachate and with added nutrient solutions in column experiments. Soil at managed sites and sieved soil had slower infiltration and hydraulic conductivity, and less stable aggregates, than native or intact soil. Results suggest that aggregation plays an important role in maintaining water movement through the soil and preventing loss of nutrients from the system, which is critical during the rainy season. Understanding the dynamics between soil aggregation, water, and nutrients improves management practices leading to efficient crop production and natural resource preservation, especially in tropical areas where studies on this interaction are limited.

67. Sulfide Oxidation of Sediments in the Aguas Zarcas River Reduces Dissolved Inorganic Carbon Loads from Silicate Weathering

Mehreen Rahman (Virginia Tech)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisor: Peter Knappett

In the carbon cycle, weathering of silicate minerals converts soil CO2 into dissolved inorganic carbon (DIC). The DIC is transported via groundwater to rivers, and into oceans. That DIC is converted to carbonate for marine organisms. After they die, the carbon is stored in their shells for millenia. In the rainforests of Costa Rica, plentiful rainfall, plant matter and basalt-rich volcanic rock generate abundant bicarbonate. However, DIC fluxes can be reduced from acid-producing minerals (like sulfides) in this tropical environment.

This study's primary objective is to determine the geochemical sources and hydrological processes that generate acidity in the Aguas Zarcas River of northern Costa Rica. This acidic river may acidify the bicarbonate back into CO2, re-releasing it into the atmosphere. To achieve this objective, we installed 5 shallow wells (1 m depth) and two drive-point piezometers (30 cm) in a 22 m long transect along the floodplain and riverbed. pH, alkalinity, silica, and sulfate concentrations were measured, including the mass flux of sulfuric acid.

We observed that sulfate and acidity are generated from the aquifer sediments, with no bicarbonate in the adjacent floodplain. Sulfate concentrations were abnormally high, with an average concentration of 800 mg/L and a maximum of 2888 mg/L. Floodplain aquifer pH was low (4.74) compared to the river (5.22). Yet, much of the expected concentrations of hydrogen and dissolved silica in the volcanically-derived riverbank aquifer are missing; major cation and anion concentrations and geochemical modeling will determine which chemical reactions are responsible.

68. Mineralogical and Chemical Patterns in Volcanic Soils Across Elevation Gradients in Costa Rica

Cassandra Montano Arellano (University of Arizona)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisors: Youjun Deng and Chia-Wei Lin

This study investigates the mineralogical and chemical composition of volcanic soils across an elevation gradient in Costa Rica, with additional comparisons between distinct land uses: a Payment for Ecosystem Services (PES) plantation and a native forest. Four soil profiles were sampled along the Radio Cima–Pocosol road located 1.46 km south-west to Texas A&M Soltis Center, each at five depths to 0.5 meters. Complementary profiles were collected from the plantation and forest sites. Analyses included bulk density, pH (in RO water, KCl, and NaF), electrical conductivity (EC), particle size distribution, and scanning electron microscopy (SEM) of the deepest horizons. Chemical extractions using ammonium oxalate and dithionite-citrate-bicarbonate (DCB) were conducted to quantify non-crystalline Al and total Fe, respectively. Preliminary pH results averaged 6.37 in RO water, 5.03 in KCl, and 11.04 in NaF, suggesting the presence of amorphous minerals such as allophane and imogolite. We hypothesize that oxalate-extractable Al and Fe will be highest in mid-elevation profiles, reflecting optimal conditions for non-crystalline mineral formation, while DCB-extractable Fe will increase with depth and in older, less disturbed soils. This research enhances understanding of how elevation and land use influence soil mineralogy in tropical volcanic landscapes. Findings have implications for soil fertility, carbon sequestration, and land management strategies in montane ecosystems.

69. Using Simulated Rainfall on Large Leaves Growing in Neotropical Climates to Determine Convergent or Divergent Water Flow Paths Among Tree Species

Pedro Mendoza-Zamora (Washington State University)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisor: Georgianne Moore

Humid tropical regions support an abundance of tree species with large leaves. These broad leaves play critical roles in thermoregulation, light interception, and rainfall redistribution. This study aimed to quantify how large leaves influence rainfall partitioning into throughfall, stemflow, and intercepted precipitation to better understand how these species alter water flow paths that converge or diverge on the leaf surface. We focused on stemflow from the leaf petiole directed toward the trunk. A rainfall simulator provided uniform rain on and around freshly collected leaves, which were suspended by their petioles at fixed angles. A curtain behind each leaf blocked external water, ensuring that only water running down the petiole was measured as stemflow. A grid of containers spaced 15x15-cm was placed on the ground, with containers directly underneath estimated interception and throughfall, while containers outside the leaf margins measured baseline rainfall. Species of interest included the Heliconia sp. and Cecropia sp., two large-leaf plants from the Costa Rican rainforest. Cecropia showed very little stemflow and tended to orient their leaves to shed water away from their stems, demonstrating divergent flow paths. The smooth, waxy leaves of Heliconia had intermediate stemflow, suggesting that rapid flow rates help keep leaves dry between rain events. In comparison, previous work on the coastal Sabal palmetto palm growing in Georgia, USA, showed that stemflow increased exponentially at steeper angles, capturing up to 0.25-m2 leaf area down the petiole, indicating convergent flow paths that may help flush excess salts from their root zone during storms.

70. Evaluation of Tropical Soil Aggregate Structure Across Various Land Uses and Its Influence on Hydrological Properties

Vicktoria Holdaway (Oklahoma State University)
Costa Rica REU: Ecohydrology of Tropical Forests
Research Advisor: Salvatore Calabrese

Soil aggregate structure plays a key role in determining hydrological processes such as infiltration. Well-developed and stable aggregates tend to increase macroporosity, increasing a soil's saturated hydraulic conductivity. Land use can alter the natural formation of aggregates, impacting soil hydrological and biogeochemical processes. Hydrobiogeochemical indicators that quantify aggregate structure are often overlooked in ecohydrological models. This project aims to understand how aggregate structure and stability of tropical soils in Costa Rica are affected by different land uses and how these structural differences influence hydrological properties. Intact soil cores were compared to homogenized soil cores within three land uses, including a tropical montane native forest, a Costa Rican Payments for Environmental Services Program (PES) tree plantation, and a papaya cropland outside of San Isidro de Penas Blancas. Aggregate structure was measured using bulk density, soil fractionation, particle density, and soil texture. Soil carbon content was measured using visible and near-infrared spectroscopy. Saturated hydraulic conductivity was measured using falling-head methods. In situ infiltration rates were measured using a measured-volume infiltration test. We hypothesize that the native forest will show the most well developed structure with higher aggregate stability and higher saturated hydraulic conductivity and infiltration rate. The PES tree plantation is expected to follow, whereas the papaya cropland will have the least favorable aggregate structure and lower saturated hydraulic conductivity and infiltration rate. By connecting soil structure to soil functions, this research can lead to improved ecohydrological model predictions and land management.

71. The Effects of Chemically Embalmed Carrion on Fire Ant Foraging

Flo Streeter (University of Texas at San Antonio)
Broadening Participation in Entomology – REEU Program
Research Advisor: Anjel Helms

Fire ants are omnivorous decomposers known to consume carrion both above and below ground. Embalming fluids are a mix of formaldehyde and other chemicals such as methanol. These chemicals are used to preserve human cadavers before burial. If the cadavers are not properly encased, there is a high likelihood that a widespread decomposer such as fire ants may encounter the remains. While there have been studies on the introduction of preserved lab specimens to decomposers, there is a dearth of research into the effects on decomposers when presented embalming fluids intended for human remains. This study examines how chemically embalmed carrion affects fire ant foraging behavior and survival. We expect ants to avoid foraging on embalmed carrion, while actively consuming control carrion. Red imported fire ant (Solenopsis Invicta) workers and brood were collected from colonies near College

Station, TX. Fire ant workers and brood were placed into each of eight plastic experiment boxes and provided with water and a sugar-water solution. One group of pinky mice (n=4) were injected with an embalming solution, and the other group were non-injected controls (n=4). One pinky mouse was placed in each experiment box and covered with compacted soil. Ants from each treatment were observed for a total of 3 days, with observations made on the weight change of the pinky mouse, and numbers of ants remaining in the soil. Findings from this study provide insights into fire ant foraging on embalmed remains with applications for forensic science.

72. Investigating the Role of Arbuscular Mycorrhizal Fungi (AMF) in Squash Plant Tolerance to Water Stress and Resistance to Aphid Herbivory

David Hernandez (San Antonio)
Broadening Participation in Entomology – REEU Program
Research Advisors: Anjel Helms and Dimitra Papantoniou

Symbiosis with arbuscular mycorrhizal fungi (AMF) can provide host plants with several benefits including improved nutrient (primarily phosphorous) and water uptake, tolerance to abiotic stresses (i.e. scarcity of water), and increased defense against biotic stresses (i.e. insect herbivory). In natural environments, plants commonly experience both abiotic and biotic stresses simultaneously. In this study, we investigated how AMF-inoculation affects squash plant tolerance to water stress and resistance to aphid herbivory. We hypothesized that AMF would support plant growth and photosynthesis despite lower water availability. Moreover, we expected reduced aphid performance on AMF-inoculated plants that were either water-deprived or received sufficient water and that AMF inoculation would help plants compensate for aphid damage by helping the plants to regrow, even under water stress. To evaluate how AMF affects squash plant tolerance to water stress, we inoculated zucchini (Cucurbita pepo) plants with AMF and subjected them to either water stress or sufficient watering. We then measured plant growth traits of the AMF-inoculated and control plants under both watering conditions, including above- and below-ground biomass, plant height, root expansion, and photosynthesis. In a separate experiment to determine how AMF affects squash resistance to aphids with water stress or sufficient watering, we applied melon aphids (Aphis gossypii) to AMF-inoculated and control plants under both watering conditions. We then measured aphid performance (i.e., number of aphids) and resulting plant biomass. This study will provide insights on the potential of AMF use in sustainable agriculture to protect plants against abiotic and biotic stresses.

73. The Effect of Vairimorpha (Nosema) ceranae on Honey Bee Queen Behavior (Apis mellifera)

Haley Olvera (University of Texas Rio Grande Valley)
Broadening Participation in Entomology – REEU Program
Research Advisors: Juliana Rangel and Tonya Shepherd

The Western honey bee, Apis mellifera, plays an important role in ecosystem stability and human health, pollinating approximately 80% of flowering plants and providing one-third of our food supply. Honey bee health is threatened by the microsporidian parasite Vairimorpha (Nosema) ceranae. N. ceranae propagates within the midgut tissue of affected bees which can lead to early onset age polyethism, shortened lifespan, and overall stress to the colony. While N. ceranae's effect on bee health and behavior has been well studied in workers, not much is known about its effect on queen bee biology.

This study evaluated N. ceranae's impact on queen bee behavior by measuring egg-laying, movement, and retinue size before and after infection. We hypothesized that after infection, egg-laying and movement would increase while retinue size would decrease. Six observation colonies with individual queens were established. Pre-infection observations occurred over five days, after which the queens were inoculated with a sucrose solution containing N. ceranae spores, and the same behavioral data was collected. While data analysis is still ongoing, initial results suggest an increase in movement and egg-laying, as well as a decrease in retinue size. This work helps us better understand the effect of N. ceranae infection on queen honey bee biology.

74. Comparison of SARS-CoV-2 Prevalence in White-Tailed Deer Populations of Texas

Gabriel Esguerra (University of Texas Rio Grande Valley)
Broadening Participation in Entomology – REEU Program
Research Advisor: Gabriel Hamer

Wild white-tailed deer (Odocoileus virginianus) are now being recognized as potential carriers of SARS-CoV-2 because of their high population density, social behavior, and frequent contact with human environments. Therefore, white-tailed deer (WTD) may play a role in maintaining and spreading the virus, which raises concern not only for other animals but also for humans. While infections have been detected in WTD across parts of the United States, Texas data remain limited. To fill the gap of WTD infections in Texas, over 10,000 WTD retropharyngeal lymph node (RLN) samples from Texas A&M Veterinary Medical Diagnostic Laboratory (TVMDL) have been given to us for analysis. TVMDL tests WTD samples for Chronic Wasting Disease, and if negative, their samples are sent to us for SARS-CoV-2 testing. The RLN samples collected from TVMDL range from 2021 to 2024 and were tested using reverse-transcriptase qPCR (RT-qPCR) for the presence of SARS-CoV-2 RNA. Each record included harvest location, season, age, sex, cause of death, and Ct values for positive results. We identified 44 positive samples out of ~3,000 tested, collected across multiple years, with several found in both 2021 and 2023. Positive cases were more frequently observed in males and spanned multiple ecoregions, including the Cross Timbers and Prairies and the Blackland Prairies. Ct values varied among WTD samples, with some showing relatively higher viral loads. The results provide a better understanding of how SARS-CoV-2 circulates in free-ranging WTD populations in Texas and emphasize the importance of continued wildlife surveillance for emerging infectious diseases.

75. Splicing and Gene Editing Studies in Aedes aegypti

Javier Gonzalez (University of Texas Rio Grande Valley)
Broadening Participation in Entomology – REEU Program
Research Advisor: Zachary Adelman

Advancing genetic manipulation in Aedes aegypti is critical for understanding mosquito physiology and developing vector control strategies. This study integrates two investigative efforts targeting gene function and expression regulation in Ae. aegypti. First, we assessed exogenous intron splicing within the Nix open reading frame (ORF), the male-determining locus, to engineer male-linked transgene expression. Utilizing an rpL10 intron known to splice efficiently in mosquito cells, we constructed plasmids bearing a 3xp3-DsRed marker within the intron and inserted them at multiple sites within Nix. Following transfection into A20 cells, Western blot analysis evaluated protein expression and intron excision fidelity.

Second, we employed CRISPR-Cas9-mediated knockouts of two candidate wing morphology regulators, Curly and its suppressor ortholog HPX5, to characterize phenotypic consequences in adult mosquitoes. Guide RNA plasmids targeting these loci were microinjected into embryos, with wing structures evaluated post-emergence. This approach explores the genetic underpinnings of wing development and complements molecular characterization of gene expression. Together, these projects enhance our understanding of intron-mediated transgene delivery and phenotype modulation in Ae. aegypti, underscoring the utility of combined molecular and developmental genetic tools in vector biology.

76. Comparing SARS-CoV-2 Detection Among White-Tailed Deer in Texas Ranches

Andrea Rodriguez (University of Texas Rio Grande Valley)
Broadening Participation in Entomology – REEU Program
Research Advisor: Gabriel Hamer

SARS-CoV-2, has been detected in a variety of animal species, including white-tailed deer (Odocoileus virginianus). This raises concerns about the potential role of deer as wildlife reservoirs and the risk of spillback transmission to humans. This study investigates the prevalence of SARS-CoV-2 in captive white-tailed deer across multiple ranches in Texas. From January 2023 to May 2025, approximately 2,100 oral and nasal swab samples were collected from various Texas ranches and tested for viral RNA using reverse transcription by quantitative PCR (RT-qPCR). This method allows for the identification of active or recent infections. In addition to RT-qPCR results, SARS-CoV-2 was tested using plaque reduction neutralization test (PRNT-50), which allows us to detect antibodies from previous exposure. In addition, we categorized infection rates by ranches, county, age, and sex to better understand patterns of viral distribution across diverse settings. We analyzed detection rates across 22 ranches and found that the variation in infection risk was influenced by differences in management practices and environmental conditions. Specifically, ranches with higher deer density and limited physical separation had higher rates of SARS-CoV-2 positivity, suggesting that crowding may facilitate viral transmission. In contrast, lower infection rates were observed in ranches that implemented stricter handling protocols, such as routine health screenings and quarantine procedures. These findings enhance ongoing wildlife surveillance efforts and offer valuable insight into how the virus may persist. Overall, informing future SARS-CoV-2 virus prevention strategies for both captive deer and public health.

77. Predation Between Chrysomya rufifacies and Cochliomyia macellaria

Sarah Rodriguez (University of Texas Rio Grande Valley)
Broadening Participation in Entomology – REEU Program
Research Advisors: Aaron Tarone and Ashleigh Haughey

This study investigates the predatory interactions between Chrysomya rufifacies and Cochliomyia macellaria, focusing on how prey density influences facultative predation by third-instar Ch. rufifacies. Building upon prior work by Hunter West, which examined predation in one-on-one larval interactions, this research expands the scope to include multiple prey densities, one, three, and five Co. macellaria larvae per trial, to better understand the intensity and frequency of predation under ecologically relevant conditions. We hypothesize that Ch. rufifacies will exhibit higher predation rates at low prey densities and that predation intensity will decrease as prey numbers increase. The study also explores whether the extent of prey consumption influences the survival of Ch. rufifacies larvae to pupation and eclosion, as well as potential sex-based differences in predatory behavior. Predation intensity is assessed using a modified scale capturing degrees of tissue consumption. The results are expected to clarify the ecological dynamics of facultative predation between these species and improve forensic entomology practices by accounting for interspecific interactions that affect larval development.

78. Native Bee Gut Microbiomes in the College Station/Bryan Texas Area

Zoe BeDell (Texas A&M University)
Broadening Participation in Entomology – REEU Program
Research Advisor: Erick Motta

Investigating the diversity and composition of microbiomes associated with native bees is essential for understanding their health and resilience, particularly considering their widespread population declines. Bee gut microbiomes vary across species and are shaped by factors such as nest provisions, diet, and modes of transmission. However, eusocial and solitary bees have differing microbiomes. In general, solitary bees acquired their gut microbiomes primarily from environmental sources, including food and nest provisions, whereas eusocial bee maintain more stable microbiomes through social interactions within the caste. This study focuses on characterizing the gut microbiomes of native bees (Hymenoptera: Apoidea) collected in the College Station/Bryan area of. Bees were caught through sweep netting excursions conducted during spring and summer 2025 and were kept alive during this process for dissection. Dissections were performed to isolate whole guts for DNA extraction, followed by microbiome analysis using 16S rRNA amplicon sequencing to assess microbiome composition and relative abundance, and quantitative PCR to estimate absolute abundance. A total of 92 gut microbiomes were characterized within the families of Apidae, Halictidae, and Megachilidae, providing insights into the microbiome diversity across the main families of native bee species present in this area. Identification of bee specimens were confirmed through taxonomic keys and Texas A&M's reference collection.

79. Disruption of Plant Immune Responses by Candidate Salivary Effectors of the Potato Psyllid

Carmen Aguilar (University of Texas at San Antonio)
Broadening Participation in Entomology – REEU Program
Research Advisors: Cecilia Tamborindeguy and Azucena Mendoza

The potato psyllid, Bactericera cockerelli, transmits 'Candidatus Liberibacter solanacearum' to solanaceous plants in the United States. This study investigates the effect of ten candidate psyllid secreted salivary proteins (effectors) on plant defenses. Effectors are secreted salivary proteins that disrupt the plant immune responses and allow insects to feed. These candidate effectors have been cloned into Agrobacterium tumefaciens and, through infiltration, expressed in N. benthamiana leaves. We evaluated whether the candidates could disrupt the hypersensitive response (HR) in N. benthamiana by co-infiltration of A. tumefaciens carrying the effector with A. tumefaciens carrying PrfD1416V, a known inducer of cell death. Furthermore, we also explore whether the effectors interfere with the reactive oxygen species (ROS) and calcium (Ca^{2+}) signaling in N. benthamiana by performing ROS and Ca^{2+} assays. A list of effectors that suppress plant defenses will be identified. The results are expected to narrow down candidate effectors and provide a better understanding of the feeding mechanism used by phloem-feeding insects.

80. Uncovering the Hidden Virome: Surveillance of Insect-Specific Viruses in Aedes Mosquitoes Across Developmental Stages

Sam Guerra (University of Texas at San Antonio)
Broadening Participation in Entomology – REEU Program
Research Advisors: Tereza Magalhaes and Xiao Liang

Insect-specific viruses (ISVs) are a group of viruses that naturally infect mosquitoes without replication to other vertebrates. These viruses have garnered increasing attention due to their potential role in influencing the transmission dynamics of human-pathogenic arboviruses. This study focuses on the detection and comparison of ISVs between Aedes aegypti and Aedes albopictus mosquitoes, using a combination of viral RNA extraction, reverse transcription, and PCR. We employed a pan-virus PCR approach to detect a range of alphaviruses and flaviviruses in both species, using Madariaga virus. Our preliminary experiments revealed a stark difference in viral replication: while Aedes aegypti supported robust replication of Madariaga virus, Aedes albopictus exhibited a dramatic decrease in viral replication after approximately four days post-infection. This finding suggests species-specific differences in viral susceptibility and replication potential, highlighting the need for further investigation into the ecological and epidemiological implications of ISVs in mosquito populations. The results of this study could provide critical insights into the role of ISVs in mosquito-virus interactions and their potential impact on the transmission of human pathogens.

81. Assessing the use of Fecal Spore Load as a Proxy for Host Spore Burden (Nosema ceranae) in European Honey Bees (Apis mellifera)

Mae Law (Texas A&M University)
Independent Research Project
Research Advisors: Juliana Rangel and Tonya Shepherd

Western honey bees (Apis mellifera) are an essential eusocial pollinator of major agricultural crops around the world and provide approximately 90% of commercial pollination in agriculture globally. The microsporidium Varimoprhia (Nosema) ceranae is an obligate intracellular pathogen in honey bees that poses a risk to their gut metabolism and colony productivity. Traditional approaches to assessing the health of honey bees involve the extraction of the ventriculus from euthanized bees. The aim of this study is to evaluate a more sustainable method of health assessments by comparing growth curves of N. ceranae spore load in honey bee fecal matter and the corresponding spore burden in the host gut. Simultaneously, we will be able to identify when Nosema spore counts peak during the course of the infection. Eighteen groups of five teneral adult bees were individually infected with spores. The bees were observed over 14 days post-infection, and sampled at different time points. Approximately every two days post-infection, we defecated fifteen bees by sedating them and pressing on their abdomen to collect fecal. Their corresponding abdomen was isolated and homogenized on the same day. All samples, including one control group, underwent DNA extraction and qPCR to quantify the results. Results are currently being collected and undergoing analysis. With more sustainable and non-destructive protocols, future avenues for assessing bee pathogens and performing longitudinal studies open for researchers.

AFTERNOON SESSION

2:00 PM – 4:00 PM

1. All-in-One Device for Measuring Tissue Oxygenation, Temperature, and Providing Feedback with Red Light Therapy

Izma Akbar (New York University)
Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) REU
Research Advisors: Amir Zavareh and John Hanks

Post-surgical flap monitoring is critical for detecting early signs of tissue ischemia and improving graft outcomes. This research presents the development of a wearable patch that integrates continuous-wave near-infrared spectroscopy (CW-NIRS) and second-derivative spectral analysis to noninvasively monitor tissue oxygen saturation (StO_2) in real time. The system employs four discrete wavelengths (660, 730, 810, and 870 nm) to differentiate oxy- and deoxyhemoglobin concentrations. In addition to diagnostics, the patch delivers low-level red light therapy (LLLT) at therapeutic wavelengths to enhance microcirculation and tissue regeneration. The device also incorporates temperature sensing, creating a closed-loop feedback system that informs therapeutic delivery based on physiological needs. This dual-function platform aims to reduce flap failure rates by enabling early detection and intervention, offering a low-cost, noninvasive, and patient-friendly solution for post-operative care.

2. Point-of-Care Electrochemical Biosensor to Detect BNP Levels for Heart Failure Diagnosis

Rishee Shah (Texas A&M University)
Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) REU
Research Advisor: Hatice Koydemir

B-type natriuretic peptide(BNP) is released from the ventricles of the heart when it is overloaded with blood volume and/or pressure. BNP functions to reduce this load on the heart by dilating blood vessels and reducing the volume of blood. This biomarker is the standard for testing when diagnosing heart failure, as elevated BNP levels indicate the heart is being overworked. Currently, this testing is mainly available in a hospital setting. Our research is focused on making this test more affordable and widely available outside of a hospital. We functionalized electrochemical sensors to achieve the right sensitivity and selectivity to allow efficient binding of BNP biomarkers to the electrodes. This generated an electrical signal that was measured and translated into a BNP concentration level. The functionalization process included electrochemical cleaning, gold deposition, surface characterization, formation of a self-assembled monolayer, and antibody attachment. The electrochemical techniques we utilized to modify the surface of the electrodes and measure results were cyclic voltammetry, differential pulse voltammetry, and amperometry. While we are still optimizing the functionalization process, our results demonstrate promising sensitivity and selectivity for BNP biomarkers, bringing us closer to a point-of-care diagnostic device.

3. Developing Semi-Interpenetrating Network Polyampholyte Hydrogels to Further the Development of Subcutaneous Glucose Biosensors

Sofia Morais (University of North Carolina at Chapel Hill)
Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) REU
Research Advisor: Melissa Grunlan

Retention of emerging near-IR (NIR) optical glucose sensing assays and diminished biofouling could enable the construction of a wrist injectable glucose biosensor with improved longevity. The Grunlan lab created a cylindrical "self-cleaning" double network (DN) hydrogel membrane that undergoes cyclic swelling/deswelling, minimizing cellular adhesion. These DN hydrogel membranes are comprised of a thermoresponsive monomer, N-isopropylacrylamide (NIPAAm), and [-] 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS). An optical glucose-sensing liquid assay can then be injected into the central cavity of the hydrogel rod. Successful retention of the assay requires the ends of the rod to be sealed. Electrostatic attraction could enable adhesion by leveraging the anionic moieties present in the DN hydrogel. This work seeks to develop adhesive hydrogel caps made from a charged semi-interpenetrating polyampholyte (sIPN-PA) comprised of a crosslinked polyampholyte network and a non-chemically crosslinked polyelectrolyte (either [+] poly(diallyldimethylammonium chloride) (PDADMAC) or [-] poly(sodium 4-styrenesulfonate) (PNaSS)). Initial studies utilized commercially available polyelectrolytes (PEs) with different degrees of polymerization (DPn); however, a similar DPn is crucial to adequately compare the material properties of the hydrogels. In this work, we synthesized both [+] PDADMAC and [-] PNaSS via reversible addition-fragmentation chain-transfer RAFT polymerization, employing time, temperature, and concentration to tune the DPn. Chemical structure and DPn were confirmed via gel permeation chromatography (GPC), proton NMR spectroscopy (1H-NMR), UV-Vis spectroscopy, and Fourier transform infrared (FTIR) spectroscopy. Future work will focus on the incorporation of the developed PE into an sIPN-PA hydrogel and subsequent material characterization (e.g., compressive properties, tensile properties, and adhesive strength).

4. Developing Methods for the Integration of Single-Analyte Sensors Into a Hollow Fiber

Isabela Recendez (Texas A&M University)
Precise Advanced Technologies and Health Systems for Underserved Populations (PATHS-UP) REU
Research Advisor: Mike McShane

Chronic diseases like diabetes significantly affect quality of life and are among the leading causes of death in the United States. Current monitoring devices, such as Continuous Glucose Monitors (CGMs), support diabetes management; however, they focus on a single biomarker — glucose— limiting their ability to capture a broader metabolic picture. Recent biosensor research aims to address this limitation by developing a barcode sensor, using hydrogel compartments embedded with sensing components to simultaneously monitor multiple analytes such as glucose, oxygen, and amino acids. This offers a more holistic assessment of patient health, offering the potential to improve early detection, disease prevention, and personalized treatment strategies. This study aims to support that vision by testing the integration of single-analyte sensors in two hollow fiber membranes— a narrow, opaque KrosFlo tube and a wider, transparent silicone drainage tube— to evaluate their sustainability for potential subcutaneous implantation. Both commercially available membranes were modified to improve hydrophilicity and facilitate analyte diffusion. Glucose- and amino acid-responsive microparticles, both of which are phosphorescent, were embedded in each membrane type and tested independently using a customized benchtop testing system designed to capture phosphorescence lifetime readings. These readings enabled a comparative analysis of sensor performance across configurations. This work aimed to establish a reproducible protocol for embedding and evaluating single-analyte sensors into a hollow fiber membrane, with the additional objective of informing future strategies for the development and packaging of implantable, multi-analyte biosensing systems.

5. Pulse of Evolution: Heart Rate Adaptation in Astyanax Larvae

Joshua Rowland (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Alex Keene

Astyanax mexicanus, a teleost fish with both surface-dwelling and multiple independently evolved cave-dwelling populations, offers a unique model for studying evolutionary changes in cardiac physiology. The stark ecological differences between these morphs, particularly in terms of light, oxygen, and resource availability, make this species an ideal model for exploring how the environment influences heart development and function. Our study investigates baseline heart rate in larvae from one surface (Rio Choy) and three cave morphs (Pachón, Tinaja, and Molino) to identify intrinsic differences in cardiac regulation. By measuring heart rate at defined time points during early development, we aim to determine whether evolutionary pressures have shaped physiological responses in cavefish. Future directions include introducing mild stressors (e.g., Sleep Deprivation) to examine heart rate plasticity and potential differences in physiological responsiveness among populations. This work provides insight into how cardiac traits adapt to extreme environments and informs broader questions of heart function, plasticity, and evolution in vertebrates.

6. The Role of Neural Activity in Stress-Induced Muscle Remodeling

Athena Ramirez (Texas A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisors: Brigitte LeBoeuf and Rene Garcia

All living organisms have evolved mechanisms to sense and respond to stress. In humans, the heart remodels its muscle in response to stressors like heart attacks, a process that often becomes pathological. Despite treatment advances, cardiovascular diseases remain the leading cause of death worldwide. However, the impact of neural activity on muscle remodeling has been largely overlooked, and the extent to which neural signals regulate this process remains unclear. C. elegans serves as an excellent model to

study this relationship due to its transparency, similar neurons and signaling pathways to humans, and ability to perform regulated muscle remodeling in males nearing adulthood. This specifically occurs in anal depressor muscles, used for defecation in larval males, which disassemble and remodel for mating behaviors. Anal depressor remodeling during stress could be controlled cell intrinsically or extrinsically. Originally, the theory was that neuronal activity did not impact muscle remodeling, since muscle-intrinsic signaling was known to regulate remodeling under normal circumstances. Mutations in the stress-response transcription factor atfs-1 leave males unable to completely remodel their anal depressors when stressed.. Surprisingly, expressing atfs-1 in GABAergic neurons in atfs-1(lf) mutants increased remodeling defects. This indicates that rescuing atfs-1 in GABAergic neurons negatively impacts muscle remodeling. This unexpected result prompted further investigation of atfs-1 expressions in other neuronal subtypes, including cholinergic neurons, as well as all neurons, and their effects on anal depressor remodeling. Using bleach as a stressor, we observed the effects across these neural subsets. Our findings highlight the need to further explore the role of neural activity in muscle remodeling.

7. Exploring the Effect of Mating System Variation On Genome Evolution in Solanaceae

Philip Ugochukwu (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Heath Blackmon

Chromosome number variation is a major aspect of genome evolution, yet its relationship to reproductive strategy is not fully understood. In Solanaceae, species vary both in chromosome number and mating system. For example, these species can be either self-compatible (SC) and self-incompatible (SI). Broadly, SC means that the plant can fertilize and reproduce with itself while SI means that the plant is unable to reproduce with itself. Our research investigates whether shifts in chromosome number are correlated with SC status across the Solanaceae family. We compiled chromosome numbers, phylogenies, and compatibility data from published databases and research publications. Using R-based comparative phylogenetic methods, we plan to test for correlations between chromosome number variation and SC status across species within Solanaceae. Although our research results are still ongoing, we aim to increase our understanding of mating system variation on genome evolution in Solanaceae and angiosperms as a whole.

8. Elucidation of Genes Involved in the ElyC-Mediated Regulation Pathway

Hailee Coleman (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Asha Rao

The rise in antibiotic resistance among Gram-negative bacteria, especially Enterobacterales, poses a serious global health threat. Recent research has focused on the outer membrane which has led to the discovery of new antimicrobials targeting essential pathways that form this barrier. A deeper understanding of outer membrane biogenesis is crucial for further progress. Enterobacterial common antigen (ECA) is a conserved carbohydrate antigen in Enterobacterales that plays a role in acid and bile salt resistance and pathogenesis, existing in three forms: lipopolysaccharide-linked (LPS), cyclic (CYC), and phosphoglyceride-linked (PG). In this study, we investigate genes potentially involved in the ElyC-mediated regulation pathway of ECA PG: specifically, we analyze deletions of ybeX, ydgA, ytfF, hemY, and ycfP–5 genes seen to have positive interactions with elyc.To determine if these genes have similar genetic interactions as elyc, we built double knockout strains of these genes with elyC and waaL, performed linkage disruption analyses, and calculated their cotransduction frequencies. Our results contribute to a deeper understanding of outer membrane biogenesis and genetic regulation of ECA in Enterobacterales. By identifying genes with important roles in the ElyC-mediated ECA-PG pathway, this research supports the development of targeted strategies to combat rising antibiotic resistance in Gram-negative bacteria.

9. Evaluating Proliferation and Migration in Triple-Negative Breast Cancer Using MTT and Scratch Assays

Jacob Orange (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisors: Tapasree Sarkar and Olajumoke Ogunlusi

Breast cancer ranks as the second most prevalent cancer amongst women worldwide, with Triple-Negative Breast Cancer (TNBC) representing a particularly aggressive subtype characterized by the absence of estrogen, progesterone, and HER2 receptors. Due to its rapid progression and constant evolution, understanding the behavior of TNBC is essential to develop effective therapies. In this study, we aim to investigate the proliferation and migration potential of TNBC cells, specifically MDA-MD231, using two techniques: proliferation (MTT) assay & motility (scratch) assay. The MTT assays' function is to measure cellular viability and proliferation following the treatments of two novel drugs, while the scratch assays' function is to assess cell migration and wound-healing capacity. We expect the TNBC cells to exhibit high levels of both proliferation and migration, coherent with their aggressive phenotype. Moreover, we expect these anti-cancer novel drugs to inhibit cellular proliferation and cellular division that would help stop tumor growth and survival. These findings can ultimately contribute to a better understanding of TNBC pathophysiology and support the development of targeted treatments aimed at limiting tumor growth and metastasis.

10. Unveiling the role of ABC transporters A1 and A7

Mackenzie Ross (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisors: Matt Moulton and Seun Bamisaye

This study leverages Drosophila melanogaster as a model organism to elucidate the functional consequences of genetic variants linked to Alzheimer's disease (AD) pathology. The Moulton lab investigates the functional impacts of disease variants on key biological processes, including glial lipid droplet (LD) formation and neurodegeneration by introducing AD risk genes into the fly genome. ATP-binding cassette (ABC) transporters, particularly ABCA1 and ABCA7, play critical, evolutionarily conserved roles in lipid homeostasis and neuroprotection. In neurodegenerative disorders such as AD, oxidative stress and protein aggregation disrupt neuronal-glial interactions, with lipid metabolism dysfunction emerging as a central pathological feature. We propose that impaired glial LD formation, driven by loss of ABCA1/7 function, contributes to neuronal vulnerability and progression of neurodegeneration in AD. To investigate this, we utilize Drosophila melanogaster models and the GAL4-UAS system to replace the fly orthologs of ABCA1/7, Eato and ldd, with human ABCA1 and ABCA7 respectively. We demonstrate that human ABCA1/7 can functionally replace Eato and ldd by promoting glial LD formation. Additionally, we assess the functional consequences of introducing disease-associated variants in these genes on glial LD formation and neurodegeneration. These efforts provide mechanistic insight into the underlying consequences of risk variants in disease.

11. Identification of Toxoplasma gondii Excretory Proteins Responsible for HIF-1α Stabilization

Jadyn Mckinney (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Lamba Sangare

Toxoplasma gondii (T. gondii) is an obligate intracellular parasite capable of infecting nearly all warm-blooded animals. Approximately one-third of the global population is infected, with immunocompromised individuals, pregnant women, and children being particularly vulnerable. To ensure its replication and survival within host cells, T. gondii secretes effector proteins that modulate host pathways. Prior studies have shown that the parasite can stabilize hypoxia-inducible factor 1-alpha (HIF-1α) in host cells, even in the absence of invasion. We hypothesize that parasite-derived excretory proteins mediate this stabilization. In this study, we identified 10 candidate proteins potentially involved in this process. Two candidate genes, Tg251550 and Tg222850, were endogenously tagged with an HA epitope to investigate their localization within the parasite. This was done using a ligation independent cloning method with a pLIC-D-HA plasmid with the HA sequence. The genes of interest were inserted into the plasmid. The plasmid with the inserted genes of interest will be transfected into a ΔKu80 parasite using electroporation. Immunoflurorescence Assay (IFA) will be performed to detect the localization of the genes of interest. We expect the tagged proteins to be localized in the cytosol of the parasite. Next experiments after confirmation of the cytosolic localization aim to determine their potential role in HIF-1α stabilization in host cells.

12. Using HiC to Improve Draft Assemblies: de novo Chromosome-level Assembly of Oochoristica javaensis to Advance Population Genomic Studies in Parasitic Tapeworms

Yanni McCray (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Charles Criscione

Understanding host-parasite interactions from the parasite's perspective is critical for uncovering mechanisms of virulence, adaptation, and genome evolution. Parasite genomic studies have revealed genes involved in interacting with and modulating host immunity. However, these studies have largely focused on microparasites (e.g., viruses, bacteria), due in part to limited genomic resources for macroparasites such as helminths. When available, helminth genomes are often highly fragmented, hindered by challenges in sequencing organisms with minimal tissue. To address this limitation, a high-quality genome assembly was developed for Oochoristica javaensis, a cestode (tapeworm) parasitizing the invasive gecko Hemidactylus turcicus, widespread across the southern United States. An initial assembly of O. javaensis consisted of 14 nuclear scaffolds and a mitochondrial genome, but its fragmentation limited accurate gene annotation and variant analysis. To improve contiguity and resolution, Hi-C chromatin conformation capture data were incorporated using the YaHS scaffolding pipeline. This produced a significantly enhanced assembly comprising 9 nuclear scaffolds and one mitochondrial scaffold, likely reflecting chromosome-level resolution. Benchmarking universal single-copy orthologs (BUSCO) analysis indicated 85.9% completeness against the Eukaryota database and 66.8% against the Metazoa database, comparable to other high-quality helminth genomes. This resource offers a valuable foundation for investigating the genetic underpinnings of parasite virulence, transmission, and adaptation to both host and environmental pressures. Moreover, the dual invasiveness of O. javaensis and its gecko host presents a promising model for studying host-parasite co-invasion and evolutionary dynamics.

13. The Impact of Autism Spectrum Disorder on Oral Hygiene Practices and Preventative Dental Care Use Among U.S. Children Aged 6–17

Jimena Vega (St. Edward's University)
Biomedical Informatics and Behavioral Sciences (BIBS) Summer Research Program
Research Advisors: Sawsawn Salih and Peggy Timothe

Children with Autism Spectrum Disorder (ASD) often face unique challenges that affect their oral health, including difficulties with sensory processing, communication, and habit formation. While the link between ASD and oral hygiene barriers is well recognized, these disparities are less studied, limiting how effectively dental public health efforts can support this population. This study investigates how having ASD, compared to not having ASD, influences preventative dental care behaviors among U.S. children aged 6–17 years. Specifically, it examines differences in the frequency of routine dental visits, daily oral hygiene practices like brushing and flossing, and the level of caregiver involvement. A cross-sectional analysis was conducted using nationally representative data from the National Survey of Children's Health

(NSCH). Children were grouped by ASD status and compared using chi-square tests of independence to evaluate differences across key oral health behavior indicators. Findings indicate that children with ASD are significantly less likely to receive preventive dental care ($\chi^2 = 379.9$, p < 0.001) and general dental visits ($\chi^2 = 394.41$, p < 0.001), and are more likely to require caregiver help with oral hygiene ($\chi^2 = 596.33$, p < 0.001). Tooth condition also varied significantly by ASD status ($\chi^2 = 45.94$, p < 0.001). These results highlight persistent disparities in oral health behaviors and access to care for children with ASD. Addressing these gaps through inclusive, adaptive strategies tailored to the needs of neurodiverse individuals is critical to ensuring equitable and more inclusive dental care, and to improving outcomes for this underserved group.

14. A Comparative Analysis of Bayesian Additive Regression Trees (BART) and Gradient Boosting Models (GBM) Against Linear Mixed Effects Risk Models

Sukhmani Nanda (University of Texas at Dallas)
Biomedical Informatics and Behavioral Sciences (BIBS) Summer Research Program
Research Advisors: Debdeep Pati and Peggy Timothe

Tooth loss is a critical marker of oral health deterioration, linked to systemic health issues. Current clinician-based risk assessments often lack the precision needed for long-term predictions, limiting timely intervention. This study investigates if advanced algorithmic models, Bayesian Additive Regression Trees (BART) and Gradient Boosting Models (GBM), can more accurately forecast tooth loss compared to linear mixed effects risk models traditionally used by clinicians. We hypothesize that BART and GBM will outperform conventional approaches by leveraging complex, nonlinear patterns and interactions in patient data. We'll use a large, retrospective dataset from 2013-2014 National Health and Nutrition Examination Survey (NHANES), containing comprehensive periodontal, behavioral, and demographic data from adult patients over time consisting of 14,556 participants. Both BART and GBM models will be trained on a portion of the NHANES data and rigorously validated on independent hold-out sets. Model performance will be measured using AUC, sensitivity, specificity, and calibration. We anticipate BART and GBM can demonstrate significantly improved accuracy and consistency in forecasting tooth loss. These models are also expected to offer insights into under-recognized risk factors, advancing precision dentistry. This study aims to show the utility of machine learning in enhancing tooth loss prediction. Successful integration of these models could support earlier, more personalized dental interventions and improve long-term oral health outcomes for at-risk populations.

15. Identifying Dental Care Access Differences in Texas for People with Physical Disabilities: A Cluster-Based Spatial Analysis

Sushruti Vasireddy (University of Texas at Austin)
Biomedical Informatics and Behavioral Sciences (BIBS) Summer Research Program
Research Advisors: Alan Dabney and Peggy Timothe

Access to dental care remains a critical public health issue for physically disabled populations who often face compounded mobility and transportation barriers. This study identifies dental care access deserts across all 254 Texas counties by developing a composite index integrating ambulatory disability prevalence, household vehicle unavailability, and Dental Health Professional Shortage Area (DHPSA) designations using 2023 American Community Survey (ACS) 5-Year Estimates. To ensure robustness, we also included confounding factors such as poverty rate, population density, urban-rural classification, and household vehicle access.

All analyses were conducted in R Studio, including data cleaning, standardization, and cluster analysis. Variables were standardized at the county level, and hierarchical cluster analysis was used to group counties with overlapping barriers. Counties falling into the highest-burden clusters were designated as dental care access deserts. Heat maps were generated using R's spatial visualization packages to visually highlight these access differences across the state.

These insights aim to guide targeted interventions—such as mobile dental units, community outreach, and transportation assistance programs—to reduce barriers and improve oral health care for physically disabled Texans.

16. The Association Between Concussions and Risk Factors for Bruxism in Adolescents

Harsha Mangalagiri (Texas A&M University)
Biomedical Informatics and Behavioral Sciences (BIBS) Summer Research Program
Research Advisors: Raghad Obeidat and Peggy Timothe

Introduction: Concussions, a form of mild traumatic brain injury (mTBI), are common among adolescents, especially those involved in sports and recreational activities. While their cognitive and emotional effects are well-documented, less is known about how concussions may influence risk factors associated with oral health conditions such as bruxism. Bruxism—a repetitive jaw-muscle activity involving teeth grinding and clenching—has been linked to heightened stress, anxiety, emotional dysregulation, and inconsistent sleep patterns, all of which may arise following a concussion.

Methods: We conducted a secondary data analysis using the National Survey of Children's Health (NSCH) 2022–2023 combined dataset, focusing on adolescents aged 12–17 years. Key variables included parent-reported concussion history and risk factors for bruxism, such as mental health indicators (anxiety, depression), emotional and behavioral difficulties, and sleep-related behaviors (e.g., bedtime consistency and average sleep duration). Chi-square tests and logistic regression models were performed in R to examine associations between concussion history and these risk factors, adjusting for potential confounders such as adverse childhood experiences (ACEs), ADHD, autism, and sociodemographic factors (age, sex, race/ethnicity, and socioeconomic status).

Results: We will report the prevalence of concussions in this population and describe associations between concussion history and the likelihood of risk factors commonly linked to bruxism. Exploratory analyses will assess how these risk factors may co-occur and contribute to elevated bruxism susceptibility.

Conclusion: By identifying associations between concussion and risk factors for bruxism, this study may provide insight into potential pathways linking neurological injury to oral health outcomes. These findings can inform clinical practice by encouraging screening for bruxism-related risk factors in adolescents with concussion history and supporting interventions focused on emotional regulation, sleep, and stress management.

17. Maxillary Retromolar Distalization Limits for Subjects with Different Growth Patterns, Gender, and Growth Status

Wiley Liou (Rice University)
College of Dentistry Summer Undergraduate Research Program
Research Advisor: Shivam Mehta

Molar distalization is a conservative orthodontic approach to Class II correction that increases arch length by moving posterior teeth distally, reducing crowding and overjet while minimizing extractions. Distalization is limited by the maxillary tuberosity, a posterior bony structure in the retromolar space; inadequate bone volume here can lead to root-cortex contact and increase the risk of periodontal damage, dehiscence, or resorption. This study quantitatively analyzes the retromolar region in subjects with different skeletal pattern, sex, and growth status using Cone-Beam Computed Tomography scans (CBCTs). 651 CBCTs were evaluated for nongrowing and growing males and females categorized with a hyperdivergent, hypodivergent or normodivergent pattern. Retromolar distance was measured on the left and right maxilla at the alveolar crest and three heights above the cementoenamel junction (CEJ): 3, 6, and 9 mm. Males had significantly more retromolar space at the alveolar crest (p=0.08), 6mm (p<0.001), and 9mm (p=0.001), though there was no significant difference between males and females at 3mm (p=0.58). Retromolar distance was significantly higher in non-growing individuals compared to growing individuals at all levels (p<0.001). Hypodivergent and hyperdivergent facial patterns had significantly more retromolar space than normodivergent patients at the alveolar crest (p=0.018), with space becoming progressively greater across all profiles further from the alveolar crest.

18. Von Frey Filament Testing in a Rodent Pain Model as Part of Developing a Behavior-Based Orofacial Pain Assay

Sai Konda (Emory University)
College of Dentistry Summer Undergraduate Research Program
Research Advisors: Phillip Kramer and Mikhail Umorin

Chronic orofacial pain affects millions of patients, with approximately 21.7 % of the U.S. population reporting pain in the orofacial region. Despite this high prevalence, treatment options remain limited. Progress in developing safer, more effective treatments is constrained by the difficulty of reliably modeling and measuring pain in preclinical studies. Establishing objective methods to assess pain in animal models is essential for advancing our understanding of pain neurocircuitry and evaluating therapeutic strategies. This study compares traditional methods of pain assessment to novel AI-based assessment models to address the challenge of reliability in pain measurement.

Orofacial pain in rats was induced using two methods: (1) ligature surgery and (2) varicella zoster virus (VZV) injection. Mechanical sensitivity was measured at baseline (pre-surgery/injection) and at 7, 14, and 21 days post-injection or surgery using von Frey filament testing of the whisker pad region.

Rats that underwent ligature surgery or received VZV injections demonstrated increased mechanical sensitivity over time, evidenced by lower withdrawal thresholds to von Frey filament application, consistent with the development of mechanical allodynia characteristic of chronic pain states.

Von Frey filament testing provides a reliable baseline method for assessing mechanical sensitivity in rat models of orofacial pain. This standard method can be compared to AI-based measurement of spontaneous pain behaviors to improve the overall reliability of pain assessment in preclinical research. Our AI-based pain assay is currently undergoing validation for different methods for behavior quantification in both rats and mice.

19. AI-Based Detection of Spontaneous Pain Behaviors in a Rodent Pain Model

Zoe Tow (Johnson & Wales University)
College of Dentistry Summer Undergraduate Research Program
Research Advisors: Phillip Kramer and Mikhail Umorin

Chronic orofacial pain affects approximately 11.8 million adults in the United States. Animal pain models are traditionally used to study pain, but the objective pain measurement in animal models remains a significant challenge. Currently, pain measurement relies on reflexive responses to invasive stimuli that interferes with natural behavior and introduce confounding variables. We developed an artificial intelligence (AI)–based system to assess spontaneous pain behaviors in undisturbed rodents, with the goal of enabling more accurate, scalable, and non-invasive methods of pain measurement.

Video recordings were collected from two experimental pain models and pharmacological treatment groups. Nose, eyes, ears, lower jaw, front paws, hind paws, base of tail, and tail tip were labeled on approximately 8,000 videos frames. DeepLabCut was used to train a ResNet-101 convolutional neural network to estimate body part positions frame-by-frame in video recordings. 3D coordinates were obtained from six cameras using Anipose. Additional body parts were added later to capture behavior in greater detail.

The trained model produced 3D coordinates for each labeled body part across all frames. The coordinates were then analyzed to identify shifts in posture and movement patterns as potential pain-specific indicators. Several pain-specific behaviors have been identified in preliminary analyses.

Preliminary findings suggest we can reliably identify pain-specific behavior without interfering with natural activity. This framework offers a more objective and fine-grained method for behavioral pain analysis. Our AI-based pain assay is currently being validated for different behavior quantification methods in both rats and mice.

20. Investigating the Role of Butyrate-Producing Gut Bacteria, Ruminococcus, in Modulating Comorbid Painful Temporomandibular Disorders and Opioid-Induced Hyperalgesia in Mice

Tyler Phan (University of Massachusetts Amherst)
College of Dentistry Summer Undergraduate Research Program
Research Advisors: Feng Tao and Joshua Crawford

Temporomandibular disorders (TMDs) affect millions of people and are often characterized by persistent facial pain. Patients with TMDs report symptoms such as jaw pain, difficulty eating, and even headaches. Opioids, such as fentanyl, are common drugs used to treat TMD pain, but their usefulness is limited by the severe side effects that come with them. Opioid-induced hyperalgesia (OIH), a condition where opioid treatment switches from reducing pain to causing pain, is one of those side effects. Recent studies suggest a role for the gut microbiome in modulating OIH and TMD pain through the production of short-chain fatty acids (SCFAs). We hypothesized that restoring levels of butyrate, a SCFA produced in the colon, through Ruminococcus treatment can reduce TMD pain and increase the effectiveness of fentanyl treatment by mitigating OIH. In this study, we investigated the effects of Ruminococcus, SCFA-producing gut bacteria that mainly releases butyrate, on TMD pain and OIH as well as their comorbidity in 19 male 7–8-week-old C57/BL6J mice. A 5-day forced mouth-opening (FMO) model to induce TMD pain or sham control was performed, followed by 4 days of fentanyl or saline injection concurrent with Ruminococcus or vehicle treatment. We assessed pain behaviors through von Frey testing, the Mouse Grimace Scale, and open field testing to examine the motor function of mice. We conducted all of the behavioral tests during the treatment and up to 10 days following the last treatments. Fecal butyrate levels were also measured using an Enzyme-Linked Immunosorbent Assay (ELISA). Our preliminary findings indicate that restoring butyrate levels with Ruminococcus treatment can delay the development of OIH and reduce TMD pain, thereby increasing the effectiveness of fentanyl in treating TMD pain. These findings provide insight into the gut-brain axis in the comorbid TMD pain and OIH, which suggests that gut microbiome and SCFAs could be targeted to develop a new microbiome-based therapy for such pain conditions.

21. Improving Preeclampsia Outcomes: A Literature Review on Prevention, Screening, and Patient-Centered Care

Meghan Hash (Texas A&M University)
Independent Research Project
Research Advisor: Chelsey Rosen

Preeclampsia remains a leading cause of maternal and perinatal morbidity and mortality worldwide. It is characterized by the sudden onset of high blood pressure accompanied by signs of damage to other organ systems, most often the kidneys, typically occurring around 20 weeks of gestation. This literature review explores 12 articles published within the past five years discussing strategies for improving the prevention, screening, and management of preeclampsia through patient education, clinical protocols, and health care system interventions. It supports the efficacy of low-dose aspirin, calcium, vitamin D, and lifestyle changes in reducing pre-eclampsia risk. Additionally, it reveals that quality improvement and clinical implementation projects confirm the feasibility of integrating prevention measures. This includes implementing first-trimester screening and aspirin prophylaxis into routine prenatal care and proves them to be especially beneficial when paired with provider education and EMR tools. However, this literature review highlights that most patients diagnosed with preeclampsia report feeling overwhelmed, uninvolved, out of control, and confused throughout their treatment and labor experience. It highlights disparities in patient knowledge, involvement in care, and emotional outcomes, which remain prominent and understudied. By identifying current practice and patient experiences with preeclampsia, this review seeks to highlight the gaps in research and the need for more awareness of such a critical topic.

22. Literature Review on Factors Affecting Maternal Self-Efficacy and Depression

Sadie Rollston (Texas A&M University)
Nursing Undergraduate Honors Program
Research Advisor: Robin Page

Postpartum and maternal mental health plays a leading role in the wellbeing of both the family unit and the mother herself, yet risk factors which predispose a woman to conditions like depression are largely overlooked. Possible mediators for the development of these conditions include self-efficacy, maternal role adaptation, and maternal-child bonding. This review discusses specific risk factors associated with maternal self-efficacy and depression, as well as how the two mediate one another. A variety of articles were pulled within seven years (with a focus on five years) to identify common factors which impact maternal mental health. Key search terms included but were not limited to maternal self-efficacy, maternal depression, role attainment, stress, and trauma. Primary factors which increase a mother's risk of low maternal self-efficacy include having experienced variable forms of trauma and stress, which can be mitigated by adequate support and access to community resources. High maternal self-efficacy may even offer a protective effect against depression. By studying the literature around interactions between a mother's lived environments, as well as her confidence, we can understand how and when to intervene to provide the best possible outcomes.

23. The Impact of Gamification-Based Education on Blood Glucose Management in Diabetes: A Systematic Review of Reviews

Miguel Leal (Texas A&M University)
Nursing Undergraduate Honors Program
Research Advisor: Ya-Ching Huang

Introduction: Diabetes is the eighth-leading cause of death in the U.S. and poor blood glucose (BG) management is associated with serious long-term complications. Effective diabetes self-management requires both knowledge and skills. While educational interventions have been shown to improve health outcomes among individuals with diabetes, evidence regarding the effectiveness of gamification—defined as the use of game-like elements in non-game contexts—on BG control remains inconsistent.

Objective: To summarize and critically evaluate systematic reviews that examined BG outcomes in individuals with diabetes who received education via gamification-based interventions.

Methods: A systematic literature search was conducted for reviews published until March 2025. Studies were screened using Covidence by two independent reviewers; disagreements were resolved by a third. Inclusion criteria were: (1) publication in English; (2) gamification as the primary intervention; (3) BG or A1C as primary outcomes. Studies were excluded if they involved gestational diabetes exclusively, used gamification alongside other interventions, or were classified as grey literature. The methodological quality of each review will be assessed using the AMSTAR 2 tool.

Results: Of 141 articles screened, 39 were included in the full text review. Eight papers were included in a final review. Data analysis is currently in progress. Preliminary findings show that gamification interventions are correlated with a decrease in HbA1c and BG levels amongst both diabetes type 1 and diabetes type 2 patients.

Conclusion: This systematic review will provide a clearer understanding of whether gamification-based education can effectively improve BG outcomes in people with diabetes and guide future intervention design.

24. How Parenting Styles Affect OCD Symptom Severity

Anushka Ganoo (Texas A&M University)
Independent Research Project
Research Advisors: John Hettema and Shaunna Clark

This study explores the role of parental care and overprotection as they relate to obsessive-compulsive disorder symptom severity within Hispanic/Latino populations, an unrepresented community in obsessive-compulsive disorder research. Current research links care to lower obsessive-compulsive disorder severity and overprotection to higher severity. Hispanic/Latino communities emphasize cultural values of familism, which emphasizes family be prioritized over self. These values may uniquely shape parenting styles and obsessive-compulsive disorder development. We aim to investigate the relationship between parental bonding and obsessive-compulsive disorder symptom severity in Hispanic/Latino individuals and help address the current gaps in obsessive-compulsive disorder literature.

Students of Latino origin from Texas A&M University completed an online survey regarding environmental factors and mental health outcomes. The survey included items from the Parental Bonding Instrument and the Baylor Obsessive- Compulsive Inventory. Our analysis used 547 student responses (155 males and 392 females). Mean scores for paternal overprotection, paternal care, maternal overprotection and maternal care were calculated in addition to sum scores for current obsessive-compulsive disorder symptom severity. Negative binomial regression model was used to predict symptom severity based on each parental bonding variable in univariate and multivariate models.

Paternal and maternal overprotection were significant positive predictors of symptom severity ($\beta = 0.215$ and 0.175, respectively), while paternal and maternal care were significant negative predictors ($\beta = -0.122$ and -0.104, respectively). The multivariate model revealed paternal overprotection as the sole significant variable.

Parental overprotection was associated with more severe symptoms, while care was associated with less severe symptoms. Findings suggest that overprotection, especially from fathers, may contribute to obsessive-compulsive disorder severity, while care may act as a protective factor. Future research should explore underlying mechanisms and causal relationships between parental bonding and obsessive-compulsive disorder symptoms.

25. Translational Measurement During Viral Infection Under G3BP Inhibitor Treatment Using Puromycin

Donald Rawls (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates (GREAT) Program
Research Advisor: Jared Bard

The prevalence of viral infections has become an urgent global health concern, with the Chikungunya Virus epidemic emphasizing how rapidly viruses can evolve, spread, and impact human life. Unlike many viruses that resolve quickly, Chikungunya can cause prolonged, debilitating joint pain lasting months to years, severely affecting quality of life and burdening healthcare systems highlighting its potential as a persistent and underestimated public health threat. One critical area of interest is how viruses hijack the host's protein synthesis systems to reproduce. Under stress conditions, cells form protective structures called stress granules (SGs), which temporarily pause protein translation to conserve energy and resources. A key component of SG formation is the protein G3BP1, which helps regulate translation initiation. However, many viruses have developed mechanisms to disrupt G3BP1 activity to keep host translation machinery active for viral protein product. This project aims to investigate how viral infection impacts host translational activity when G3BP1 is inhibited. Using G3I which is an inhibitor that disrupts G3BP1 function, throughout this project, we will study how protein synthesis is altered in infected cells.

26. Identification of Macrophage Polarization States in the Injured Mouse Spinal Cord 7 days Post Injury

Kala Dumas (Prairie View A&M University)
Genome Research Experiences to Attract Talented Undergraduates Program (GREAT)
Research Advisor: Dylan McCreedy

Background: Macrophage polarization is a key aspect of immune regulation following spinal cord injury (SCI), with M1 and M2 subtypes mediating pro-inflammatory and reparative responses, respectively. Neutrophils, as the first immune cells to infiltrate the injured spinal cord, play a pivotal role in shaping the inflammatory environment and influencing subsequent macrophage responses.

Method: We assessed the impact of neutrophil depletion on macrophage polarization. The tissues were from a prior study from the lab wherein mice were divided into neutrophil-depleted group treated with anti-Ly6G antibody and a control group. Animals were euthanized at 7 days post-SCI, and spinal cords were processed for immunofluorescence analysis. Sections were incubated with primary antibodies against F4/80 (macrophage marker), CD86 (M1 marker) and arginase (M2 marker). After secondary antibody incubation and mounting, images were captured using Nikon Eclipse upright microscope. Quantification of macrophage populations was performed using a MATLAB code. Independent, blinded researchers manually traced regions of interest, and F4/80+ cells co-labeled with arginase or CD86 were quantified.

Result: Quantitative analysis revealed no significant differences in the proportions of M1 or M2 macrophages between sexes or between the neutrophil-depleted (anti-Ly6G) and control groups. However, our sample size was limited, and it remains possible that sex differences in macrophage polarization could emerge with higher statistical power in future studies.

Conclusion: The results suggest that, under the tested conditions, neutrophil depletion via anti-Ly6G does not differentially affect macrophage polarization or reveal sex-specific differences in macrophage populations. Future studies with larger cohorts will be important to fully elucidate the potential influence of sex and neutrophil-macrophage interactions on post-injury immune responses.

27. Exploring the Association Between Toothaches and Adverse Childhood Experiences (ACEs) among Low-Income Children

Christopher Gonzalez (Berea College)
Biomedical Informatics and Behavioral Sciences (BIBS) Summer Research Program
Research Advisor: Peggy Timothe

Adverse childhood experiences (ACEs) are potentially traumatic events that occur before the age of 18—such as parental incarceration, exposure to domestic or neighborhood violence, or economic hardship. These experiences are linked to a wide range of poor health outcomes throughout life, including disruptions in mental, oral, and physical health. Children from low-income households are more likely to experience multiple ACEs and face compounding challenges such as higher rates of stress-related conditions and limited access to care. Dental decay is common among children and highly prevalent among low-income children. Toothaches in children are often associated with underlying conditions such as dental decay, particularly when access to timely dental care is delayed. Using data from the 2022–2023 National Survey of Children's Health (n = 105,138), we focus on children aged 1–17 living in households below 200% of the federal poverty level. Key variables include ACE exposure (10 indicators), demographic variables, and parent-reported oral health problems. We will conduct descriptive analysis to explore ACEs and toothaches among vulnerable populations of children. We hypothesize that children exposed to multiple ACEs are at even greater risk of experiencing toothaches compared to those with no ACEs. However, we also anticipate that there are many limitations to our study, including structural and behavioral barriers—including provider shortages and long wait times—that may limit this effect. Results will inform public health policy by emphasizing the need to integrate oral health and trauma-informed care.

Acknowledgment: Supported by NIH Grant No. 1R25LM014219-01 (BIBS Program)

28. Development of a Breath Analyzer for Disease Diagnosis

Savannah Bean, Alex Chaiken, Jesus Marroquin, Jiwoo Nam, and Jayani Singh (Texas A&M University)
Aggie Research Program
Research Advisor: Robert Carpenter

In today's healthcare system, rapid point-of-care testing is essential but often compromised by patient discomfort, diagnostic accuracy, environmental sustainability, and unfriendly price. Based on the field interviews with medical professionals, our team identified critical concerns surrounding current single-use diagnostic kits. They tend to be invasive, which is not easy to use for children and uncooperative patients, contribute significantly to plastic waste, and are prone to false results compared to laboratory-based testing, which can take days to get the results back. To address these challenges, our interdisciplinary team is developing a multiplexed breath-based diagnostic device that is non-invasive, environmentally sustainable, and cost-effective. The device collects exhaled breath condensate by filtering out saliva and other debris from a patient's breath and other possible external gas. Using breathonomic nanosensors, we aim to identify disease biomarkers and diagnose. Because the device reads the molecular fingerprints for all materials in the sample, it can identify markers of pathogens that are previously undiscovered. The resulting data will be processed and interpreted using a machine learning model that improves over time with real-world data integration. Our goal is to condense this technology into a portable and accessible device that can deliver accurate diagnostics beyond traditional clinical settings. With applications in underserved and remote areas, this solution aims to expand access to quality diagnostics, reduce medical waste, reduce diagnostic test fees, and enhance the patient experience through painless testing.

30. Aha! Moments in Memory Retrieval

Lilly Juarez (Texas A&M University)
Independent Research Project
Research Advisor: Steven Smith

Aha! moments are sudden bursts of insight common in problem-solving tasks and generative ideation. We explored whether sudden insights also occur during memory retrieval. Our study focused on the cognitive mechanisms involved when individuals engage in recall. Specifically, we examined whether aha! moments occur after an incidental encoding task and the frequency with which aha! moments are produced. Participants first completed an incidental encoding task in which they were presented with overarching categories and asked to rate how well items fit within specific subcategories. Then, they were asked to recall the subcategory name and items within a category and identify whether they experienced an aha! moment when they remembered an item. It was hypothesized that incidental encoding followed by a recall test should evoke aha! moments in participants and that the frequency of aha! moments will be greater when a person switches between subcategories than when trying to recall them from the same one. We analyzed recall patterns by categorizing each reported aha! moment based on when it occurred during the person's recall test. The following classification system was used: 1st (first item/category recalled), same (same subcategory as previous item), new (start of a new category), revisit (transition from one subcategory to a previously recalled subcategory), or false (incorrectly recalled item/category). Preliminary findings suggest that incidental encoding can lead to aha! moments, and that aha! memories are more likely to be observed when a person switches subcategories during their recall test.

31. Reducing Recidivism Through Psychology: A Literature Review of Prison-Based Interventions Since 2000

Juan Davila (Texas A&M University)
Independent Research Project
Research Advisor: Kristy Cuthbert

Reducing criminal recidivism is crucial for public safety and the successful rehabilitation of incarcerated individuals. This literature review assesses the effectiveness of psychological interventions employed in prison settings to reduce reoffending rates and improve mental health outcomes after release. We analyzed peer-reviewed, randomized controlled studies published since 2000 that evaluated psychological interventions, including cognitive-behavioral therapy (CBT), dialectical behavior therapy (DBT), and psychoeducation, focusing on recidivism among incarcerated adults. Studies exclusively involving juveniles, conducted outside the United States, or lacking follow-up assessments post-release were excluded. The data sources for this review included PubMed, APA PsycNet, and SpringerLink. A total of 27 studies met the criteria, encompassing 9,002 participants from various correctional systems in the United States. CBT-based interventions emerged as the most studied and generally most effective, with around 70% of the studies showing statistically significant reductions in recidivism rates or improvements in mental health for treatment groups compared to controls. Program success was particularly evident when

interventions were intensive, well-structured, and delivered by trained professionals. However, results varied based on the specific population and program fidelity. Despite promising findings, several limitations were identified, such as challenges with data collection, inconsistent follow-up timelines, and limited data beyond one year post-intervention. This review highlights the types of interventions most associated with positive outcomes and the contextual factors that shape their effectiveness. Findings underscore the need for improved program delivery methods, standardized follow-up timelines, and broader replication of interventions across underrepresented regions and populations.

32. Effect of Cell Arrangement on Vaccinia Virus Replication

Timothy Stout (Texas A&M University)
Independent Research Project
Research Advisor: Feng Zhao

Viral infections are a serious threat to human health and are among the leading causes of death. This has been exemplified by outbreaks such of SARS-CoV-2, mpox virus, Zika virus, Ebola virus, and H1N1 influenza during the past 15 years. Observing how viruses infect host cells and spread is critical to understanding and managing viral diseases, including vaccine development. Currently, the conventional cell culture in a petri dish lacks the sophisticated architecture present in human tissues, and animal models are costly and do not fully replicate human physiology. To better represent the complexity of tissue architecture, polydimethylsiloxane (PDMS) scaffolds were constructed with varying patterns to mimic different tissue architectures. How viruses respond to physical microenvironmental cues remains largely unexplored, making the varying microarchitecture in the substrates a useful tool for studying viral response to varying environments. Human dermal fibroblasts (hDF) were seeded on the scaffolds in aligned, interwoven, random, and chevron patterns. The cultures were infected with Vaccinia virus (VACV) and their replication was measured on different architectures using the Gaussia luciferase assay. The Gaussia luciferase activities were shown to not have significant differences across the different architectures, suggesting that the viral replication may bypass physical microenvironmental cues.

33. Hyperandrogenemia Related Liver Disease in Females Demonstrates a U-Shaped Dose-Response Pattern

Sarah Hurt (Texas A&M University)
Independent Research Project
Research Advisor: Annie Newell-Fugate

Hyperandrogenemia in polycystic ovary syndrome (PCOS) is associated with insulin resistance and hepatic steatosis. Elevated liver enzymes and hepatic steatosis are common in obese PCOS patients. These findings suggest that hyperandrogenism drives liver pathology in women, but the mechanism is unknown. This study assessed the effect of moderate (i.e. PCOS) and virilizing serum testosterone levels on hepatic structure and function in female pigs. Sexually mature female pigs had testosterone enanthate silastic

implants (TE; 0g, 0.56g, 1.12g, or 2.24g; n=1-2 pigs/dose) placed in subcutaneous adipose tissue. Fasting blood samples for serum testosterone, liver enzymes, and plasma lipids were collected every three days for 36 days. Liver tissue sections were analyzed for liver collagen and glycogen content. Serum total testosterone was 3.3-fold higher in 0.56g TE pigs, 7.4-fold higher in 1.12g TE pigs, and 18.4-fold higher in 2.24g TE pigs than in control pigs. Glycogen was severely depleted in the 1.12g TE liver, whereas it was only mildly decreased in the 2.24g TE liver. Moreover, 1.12 g TE pigs were insulin-resistant compared to control pigs. Hepatic steatosis occurred in the 0.56g TE and 2.24g TE but not in the 1.12g TE liver. Plasma cholesterol increased in the 1.12g TE and 2.24g TE pigs, whereas triglycerides increased in the 1.12g TE but decreased in the 0.56g and 2.24g TE pigs. Liver fibrosis was most severe, and serum ALT was increased in the 1.12g TE and 2.24g TE pigs. Therefore, liver pathology severity does not necessarily correspond with the degree of hyperandrogenemia in females.

34. Quantification of Fecal Bile Acids During the Postnatal Period in Cats

Maddie Perez (Texas A&M University)
Independent Research Project
Research Advisor: Jan Suchodolski

Bile acids (BA) aid in fat digestion, metabolic signaling and cholesterol regulation. Gastrointestinal (GI) diseases, one of the leading causes of mortality in kittens, can impact fecal BA concentrations. Therefore, it is important to establish healthy reference values for kittens in the postnatal period. The aim of this study was to quantify fecal BA in healthy kittens from 5-20 weeks of age. Fecal BA were quantified using a validated liquid chromatography-mass spectrometry assay. Feces were obtained from healthy kittens (n = 110) aged 5 to 20 weeks and grouped based on age, and from young sexually mature cats (6-7 months; n=14). Differences between age groups were assessed using Kruskal-Wallis tests. The concentrations of 12oxo-lithocholic acid and 3oxo-deoxycholic acid were lower in the 5-6, 7-8, 9-10, and 13-14 weeks age groups in comparison to the 6-7 month age group (p < 0.05), suggesting reduced bacterial conversion of deoxycholic acid into oxo-BA products. The percent of BA without a C7 hydroxyl or C7 keto group was lower in the 5-6, 9-10, and 13-14 weeks age groups than the 6-7 month group (p < 0.05), possibly indicative of less bacterial bai gene activity in younger cats. Our results suggest that BA profiles in kittens older than 5 weeks resemble those of sexually mature cats. This mirrors a previous study done on puppies where they had increased secondary bile acids prior to weaning. Further research on younger kittens will need to be done to better understand early postnatal development.

35. Extracellular Matrix Morphology and Cellular Mechanobiology on Interwoven versus Interwoven-Aligned PDMS Scaffolds

Jeffrey Ock (Texas A&M University)
Independent Research Project
Research Advisor: Feng Zhao

Chronic wounds due to burns, diabetes, or trauma are notoriously difficult to treat due to their complex pathology. Current treatments struggle to resolve chronic inflammation and are prone to fibrotic response. The extracellular matrix (ECM) provides crucial support to wound healing via structural support and biochemical cues. Applying variation to the polydimethylsiloxane (PDMS) scaffolds used in the growth of this dermal ECM allows for a customizable ECM that can be optimized for reduced inflammation and fibrosis. Aligned ECM has been shown to produce differences in morphology as has interwoven ECM (iECM) with reference to a flat (random) scaffold. A novel scaffolding pattern, interwoven-aligned ECM (iaECM), was developed to observe the morphological and mechanobiological differences emergent from a combination of an aligned and interwoven pattern (with reference to iECM). Throughout this study the aiECM was shown to produce a more compact and anisotropic ECM, with deviations in nucleic and cytoplasmic structure from iECM. Further study revealed key differences in ECM deposition later observed with immunofluorescent (IF) staining of key ECM proteins, providing reasonable suspicion of differentiation as well. While differentiation was later disproved with further IF analysis, slight differences in actin expression were observed. The findings thus far suggest differences in microarchitecture in PDMS scaffolds can modulate fibroblast mechanobiology, ECM deposition/morphology, and nuclear morphology. These insights may further inform the design of more analogous and specialized dermal ECM with the goal of reducing inflammation and fibrotic pathology.

36. Semantic Data Interoperability Technologies Across Life Cycle of Process Plant Projects

Avinash Kakarala (Texas A&M University)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisors: David Jeong and Ashrant Aryal

Piping and Instrumentation Diagrams (P&IDs) are fundamental engineering documents utilized throughout the design, operation, and maintenance phases of process plants. However, data interoperability challenges persist, particularly due to the prevalent use of non-digital P&IDs. Variations in symbols, notations, and legends across different facilities result in costly and inefficient data exchange processes, even though standards such as Data Exchange for the Process Industry (DEXPI) have been developed to mitigate these issues. Digitizing P&IDs and ensuring interoperability are thus critical objectives for enhancing data consistency and reducing information handling costs within the process industry. This study proposes an automated framework for converting paper-based P&IDs into structured Knowledge Graphs (KGs). A KG, characterized by nodes representing entities and edges depicting relationships, provides a robust mechanism for modeling complex semantic information inherent in process plants, including equipment, instrumentation, piping, and their interconnections. Leveraging the

capabilities of multi-modal large language models (LLMs), the proposed methodology extracts relevant data from scanned P&IDs and systematically maps this information into a KG-based digital representation. This approach not only preserves the fidelity of the original diagrams but also significantly improves data interoperability and accessibility, facilitating more efficient engineering and operational decision-making.

37. Energy Retrofit Strategies for U.S. Single-Family Houses Using an Automated Framework

Heidi Thiele (Oregon State University)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisor: Ashrant Aryal

Buildings account for approximately 40% of total energy consumption and 35% of carbon emissions in the United States. Among them, 78% of residential and 75% of commercial buildings were built before the year 2000. These older buildings are responsible for over 75% of the total energy use in the sector, highlighting the urgent need for energy retrofitting of them. However, the effectiveness of retrofit strategies varies widely based on building characteristics and local climates. Many existing retrofit studies rely on simplified assumptions or generic strategies and lack detailed, climate-sensitive analyses. Without such comprehensive evaluations, it is difficult to develop broadly applicable retrofit guidelines or identify the trade-offs between different strategies. Therefore, a systematic comparison of retrofit measures across climates and building configurations is still missing. This project aims to conduct a detailed, climate-specific analysis of retrofit strategies for single- family homes in the U.S., using a previously developed automated retrofit decision-making framework. The study will apply the framework across all 16 U.S. climate zones to identify the most cost-effective and energy-saving strategies for each region. The goal is to not only to discover optimal solutions at each location but also to analyze patterns, regional differences, and trade-offs between Energy Conservation Measures (ECMs) across locations. This research will provide insights that can inform general retrofit guidelines and strategic decision-making at the national level.

38. VISIT-MR: Virtual, Intelligent, and Scalable Immersive Site Training through Mixed Reality in AEC Education

Aushmeet Singh (Texas A&M University)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisor: Gilles Albeaino

Site visits are essential in Architecture, Engineering, and Construction (AEC) education, offering hands-on experience that connects theory to practice. However, traditional site visits face challenges, including logistical constraints, large group sizes, and site-specific limitations. Mixed reality (MR)-based site visits offer an alternative, but existing approaches often rely on rigid, predefined content with limited adaptability to varying needs and student backgrounds. To address these limitations, this research proposes VISIT-MR, an MR-based site visit protocol featuring an AI chatbot that adapts to users' learning progress and enables seamless transitions between AR and VR. A pilot study was conducted to evaluate the feasibility and user experience of VISIT-MR through an electrical system site visit. Users' perceived workload, system usability, and sense of presence were measured using questionnaires and compared against validated benchmarks from prior research. The findings will inform future refinements and comparative studies to evaluate VISIT-MR's educational efficacy. This study presents a novel, adaptive MR protocol to enhance AEC education and support other experiential learning domains.

39. Use of Conversational AI to Enhance Cultural Competency in Construction Education

Michael Redelick (Virginia Tech)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisor: Minerva Bonilla

The construction industry is highly diverse, with minorities comprising 40% of the workforce, 30% of whom are Latino/Hispanics. Despite this representation, about 27% of construction-related fatalities are experienced by this demographic group. This issue is caused by cultural barriers and misunderstandings that prevent a cohesive work environment. To address this concern, this research explores how cultural competency skills can aid in navigating complex interpersonal dynamics on job sites, using a conversational AI avatar to simulate real-world construction scenarios in a training environment. Undergraduate construction science students engaged with a virtual Hispanic construction worker in simulated conflict scenarios. These interactions were designed to reflect real-world cultural dynamics and assessed students across four cultural competency dimensions: knowledge, understanding, desire, and encounters. Post-simulation evaluations used Likert-scale surveys to measure usability, scenario relevance, and self-reflection. Dialogue transcripts were analyzed to assess student growth and the AI's effectiveness. The findings suggest that conversational AI can enhance intercultural learning and soft skills development in construction education, offering an innovative framework for training purposes.

40. Simulation of Repetitive Work & Kaizen and its Application to Drywall Installation in Commercial Construction Projects

Hannah Montelongo (Texas A&M Higher Education Center at Mcallen)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisors: Zofia Rybkowski and David Jeong

The US construction industry is experiencing a shortage of workers, in which drywall labor makes up 55%-75% of the total cost of a project. This research aims to identify potential ways to scientifically increase the productivity of drywall workers and, in turn, assist the construction industry in accomplishing more despite a dwindling supply of on-site labor. The study examines how repetitive actions and kaizen (continuous improvement) can increase worker efficacy to accomplish more in less time. Historically, pioneers such as Frederick W. Taylor and Frank and Lillian Gilbreth used stopwatches and clocks to scientifically measure and increase worker productivity via time-motion studies that examine the human motions required for specific tasks. Since then, time-motion studies have primarily been applied to the manufacturing industry. A simple peg board game, played in multiple rounds, was developed by General Motors and Ralph M. Barnes, and a 1946 film is available on the internet. That said, while the peg-board simulation is relatively well known by students of business and manufacturing, it has yet to be widely introduced to those within the construction industry. This research aims to introduce the implications of repetitive movement & kaizen to participants using the peg-board simulation game by creating an “aha moment” for participants and then applying lessons learned to repetitive tasks on construction sites, such as the installation of drywall on large commercial projects. The research methodology includes construction site visits to observe workers installing drywall with their personal tools, and then introducing new sets of tools and time-motion processes to potentially increase installation productivity. Preliminary results thus far suggest that the peg-board game is effective in increasing productivity of repetitive tasks, and it is hypothesized that the kaizen concepts demonstrated are likely applicable to drywall installation processes.

41. Impacts of Socio-Technical Barriers on Decentralized Wastewater Management in Rural Alabama’s Black Belt

Giselle Morocho Aguilar (Stony Brook University)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisors: Amal Bakchan and Esma Birisci

The rural Alabama Black Belt region—named for its dark, fertile soil—is characterized by persistent poverty, low population density, and limited infrastructure investment. Communities in this region frequently encounter severe challenges in accessing adequate wastewater management services, notably the prevalent use of “straight piping”, resulting in raw sewage discharge that compromises public and environmental health. Although recent initiatives have promoted cost-effective decentralized wastewater treatment systems (DWTS), effective management strategies for these systems remain underdeveloped. Responsible management entities (RMEs), tasked with the sustainable operation and maintenance of

DWTS, face substantial operational difficulties due to geographic remoteness, constrained financial resources, limited workforce capacity, and socio-technical complexities unique to limited-resource rural settings. This study aims to assess the impact of RME's structural and operational factors on the socio-technical barriers encountered in decentralized wastewater management. Specifically, the objective is twofold: (1) to identify key socio-technical barriers and their potential determinants through a comprehensive literature review; and (2) to empirically evaluate these relationships. Utilizing 100 survey responses from RMEs operating across 27 states in the U.S., the study develops an ordinal logistic regression model that assesses the effect of seven independent variables related to system design and operational flexibility on eleven identified socio-technical barriers. Empirical findings illuminate the specific organizational and operational characteristics of RMEs that significantly impact DWTS management, thereby addressing critical knowledge gaps in responsible management research. Additionally, the study identifies actionable leverage points, enabling RMEs to strategically target improvements that directly address prevalent structural and operational challenges in limited-resource rural communities.

42. Advanced Sensing Technologies for Preventing Construction Workers' Work-Related Musculoskeletal Disorders (WMSDs)

Archit Avhale (Texas A&M University) and Isaiah Thomas (Tuskegee Institute)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisors: Namgyun Kim and Jaehoon Lee

This 10-week research program is designed to explore how inertial measurement unit (IMU) sensors can detect construction workers' risk of work-related musculoskeletal disorders (WMSDs). For my first task, I will engage in comprehensive literature reviews to understand the prevalence and causes of WMSDs in construction, focusing particularly on how prolonged physical exertion without adequate rest significantly contributes to these disorders. Leveraging widely accessible wearable devices such as smartwatches and health trackers, which typically utilize lower-sampling-rate IMU sensors, the student will analyze whether these everyday technologies can effectively detect WMSD-related activities. The project includes practical data analysis exercises and a simple experiment, in which I will collect and evaluate sensor data to assess the potential of consumer-grade IMUs for monitoring and mitigating construction workers' health risks in real-time. This hands-on approach aims to provide valuable insights into integrating wearable sensing technology within occupational health management practices.

Next, I will design and conduct an experiment to detect specific construction activities known to increase the risk of carpal tunnel syndrome, such as overhead work and hammering. I will first begin by identifying and selecting representative tasks from typical construction scenarios, then develop protocols for capturing relevant motion data using wearable devices equipped with IMU sensors. During the experiment, participants will simulate these activities under controlled conditions while the student records sensor data. I will then subsequently analyze this data to determine whether lower-sampling-rate IMU sensors, as found in common smartwatches or health trackers, can reliably distinguish between different activities and effectively detect motions associated with an increased risk of carpal tunnel syndrome. Through this practical exercise, I will use it to gain direct experience in experimental design, data acquisition, and data interpretation, thereby enhancing my skills in applying wearable technology to occupational health and safety research.

Finally, In the next stage of the project, I will conduct a comparative experiment to evaluate the effectiveness of lower-sampling-rate IMU sensors by comparing their data with pre-collected data from higher-sampling-rate IMU sensors provided by the mentor. Through careful analysis, I will determine the relative accuracy, sensitivity, and reliability of lower-sampling-rate sensors in capturing critical movements associated with carpal tunnel risks. This comparative approach aims to clarify whether consumer-grade sensors can effectively detect movements relevant to occupational health monitoring, providing practical insights into the feasibility of integrating affordable wearable technologies into construction safety management practices.

43. Assessment of Test Methods for Freeze-Thaw Performance of Concrete Material for Additive Construction by Extrusion

Natalia Quesada Marshall (University of California, Berkeley)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisor: Julie Hartell

The freeze–thaw resistance of concrete is well established and is commonly evaluated using standardized methods such as ASTM C666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing. These tests, however, were primarily developed for assessing the durability of transportation infrastructure and do not adequately reflect the evolving needs of the construction industry; especially the growth in residential construction and the use of additive construction by extrusion (ACE). The goal of this study is to develop and evaluate a standardized methodology for assessing the freeze–thaw performance of ACE. Recent literature shows that ACE is especially vulnerable to freeze–thaw damage due to its inherent microscopic heterogeneity and anisotropy, which lead to higher interfacial porosity, weaker interlayer bonding, and irregular pore morphology and distribution. Furthermore, it is assumed that factors such as printing parameters, geometry, and applied coatings will significantly influence performance. These variables are taken into consideration to avoid rejecting viable material designs or approving materials compromised by suboptimal printing. The project is divided into four phases. Phase 1 focuses on selecting the appropriate test method; Figure 1 presents data captured from two different tests. Phase 2 identifies protocols for sample preparation and specimen fabrication. Phase 3 defines a temperature profile and freeze–thaw exposure regimen. Phase 4 establishes testing procedures and acceptance guidelines. Preliminary findings for two different exposure types are presented and analyzed using statistical methods such as coefficient of variation, t-tests, F-tests, Tukey's test and ANOVA to compare outcomes and assess the sensitivity of each testing method. Additionally, petrographic analysis is conducted to validate damage initiation and progression supporting quantitative findings. Research findings will aid in the advancement of standardization suited for this material application. Ultimately, the development of such standardized protocols will support the broader adoption of ACE by enhancing durability, reducing costs, and increasing confidence in its application across the construction industry.

44. Physical Fatigue Monitoring of Construction Workers Using Edge-Based Machine Learning and Wearable Sensors

Arnia Goode (Columbia University)
Construction Science REU "Smart & Sustainable Construction in the Digital Era"
Research Advisors: Chuma Nnaji and Ashrant Aryal

Fatigue is a major concern in the construction industry, as it contributes to reduced productivity, lower work quality, and a heightened risk of accidents. Traditional methods of assessing physical fatigue, such as surveys and questionnaires, are often impractical and unsuitable for real-time monitoring on active construction sites. This research project proposes a smart fatigue monitoring system that combines hardware (Polar H10 heart rate sensor) with software (a mobile application) to classify fatigue levels in real time. A machine learning-based multilayer perceptron model was developed and trained using both objective data, such as heart rate variability (HRV) and user demographics (age, weight, height, etc.), and subjective data, including self-reported fatigue ratings using the Rating of Fatigue scale. Once developed, the model was deployed on an edge device (i.e., a mobile app), which collects real-time heart rate data and processes it to predict the user's fatigue level continuously. When the system detects a high fatigue level, it triggers a vibration alert on the worker's mobile device, prompting timely intervention. This integrated solution provides a practical and efficient approach to real-time fatigue monitoring, offering a responsive tool to enhance safety and productivity in construction environments.

45. Detection of Smears in Spray Cards Using Machine Learning and Computer Vision

Arun Muthukumar (College Station High School)
Independent Research Project
Research Advisors: Scott Nolte and Navjot Singh

Understanding herbicide spray pattern (i.e. droplet size distribution) is essential for optimizing application parameters to maximize spray coverage on the target and minimize herbicide drift. The spray patterns are typically captured using spray cards which are then analyzed to detect spherical droplets. However, wind and other factors can cause droplet smears on spray cards, leading to inaccuracies in determining spray patterns. In this study, a custom machine learning pipeline was developed using YOLOv11, which was implemented with CSPDarknet and PANet architectures to detect and quantify droplet smears on spray cards. The spray cards used for model training, validation, and testing were obtained from a herbicide spray deposition study conducted earlier. Roboflow was used to annotate and augment smears on spray cards, and the model was created and tested using Python. To overcome the training dataset limitation and increase the diversity of the data, the images were cropped into 9 equal squares per raw image to increase the image numbers. A total of 411 images were allotted for training the model, while 116 were utilized for validation and 57 for testing. The best model provided a precision of 83% (number of correctly predicted detections) and a recall of 80% (number of actual smears detected), indicating reliable model performance. Here we demonstrate the use of a machine-learning model for effectively detecting the smears in spray cards and estimating associated error rates. This model helps researchers improve the accuracy of spray pattern analysis and make robust management decisions regarding herbicide spray optimization.

46. The Effect of Ventilation on Bacterial Cells with Deleted Membrane Channels

Marshall Meyer (Iowa State University)
Biological and Agricultural Engineering Independent Research Project
Research Advisor: Maria King

Modern-day hospitals have a requirement of 6 air changes per hour (ACH) in rooms to control the spread of airborne bacteria by the use of vents in hospital rooms, which pull out air into HEPA filters installed in an HVAC system. However, recent studies have shown that HVAC systems are not able to completely filter out all microbes, causing small populations of bacteria to survive and develop antibiotic resistance in response to aerosolization. The goal of this research is to use a gram-negative bacterium, Escherichia coli, with different membrane channel deletions to better understand which conditions of aerosolization will upregulate the expression of related genes and trigger antibiotic resistance and which antibiotics become ineffective as a result of the developing resistance in E. coli. To test if the gram-negative bacterial aerosols would develop antibiotic resistance when exposed to airflow, E. coli cells were resuspended in 10% phosphate buffer saline and aerosolized using a 6-jet Collison Nebulizer. The airborne E. coli cells were exposed for increasing periods (5 min - 45 min) to ventilation airflow in a testing chamber, equipped with a propeller to model the air circulation with a velocity similar to the airflow in an HVAC system. After different durations, the cells were collected from the testing chamber into a wetted wall cyclone (WWC) sampler to plate the samples and observe the effect of air flow on antibiotic resistance. Increased exposure to ventilation airflow resulted in the development of resistance to cell wall inhibitor antibiotic Ampicillin.

47. Activated Cold Plasma: Applications in Heavy Metal Water Purification and Cotton Seed Germination

Aloyo Paul (Agnes Scott College)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisor: Janie Moore

Atmospheric cold plasma (ACP) has emerged as a promising tool in agriculture for enhancing seed
Atmospheric cold plasma (ACP) has emerged as a promising tool in agriculture for enhancing seed germination, plant growth, and water decontamination. While most studies focus on food crops, this study investigates ACP's functionality in promoting cotton seed germination and reducing concentrations of lead (Pb^{2+}) and cadmium (Cd^{2+}) in water.

For the first phase cotton seeds were soaked for 10 minutes in either distilled water (control) or treated with ACP at 70 kV for 5 minutes and soaked in plasma activated water (PAW) before warm germination at 28°C. Germination rates were recorded daily. Seedlings were then transferred to a hydroponic system and given nutrients. A subset of plants continued receiving PAW, while the control group was irrigated with distilled water.

In the second phase water samples were spiked with 100 ppb concentrations of Pb^{2+} and Cd^{2+}. These samples were treated with ACP at 70 kV for 3, 5, and 7 minutes. Pre- and post-treatment concentrations were quantified using inductively coupled plasma mass spectrometry (ICP-MS).

By integrating ACP into seed treatment and water purification, the research explores its effectiveness in improving plant development and reducing metal in irrigation sources. Findings may support broader applications of ACP in agricultural settings where water quality and crop resilience are critical challenges.germination and plant growth. While most studies focus on the germination of plants for human consumption, this study investigates the effects of plasma-activated water (PAW) and ACP on linted cotton seed germination. Cotton seeds were soaked for 10 minutes in either distilled water (control) or treated with ACP (70 kW for 5 minutes) and PAW before warm germination. Germination rates were recorded daily. Following germination, seedlings were transferred to a hydroponic system and given nutrients. A subset of plants continued receiving PAW, while the control group was irrigated with distilled water. Preliminary results indicate that seeds treated with PAW demonstrated little to no change compared to the control group. In some instances the control group performed better than the cotton seeds that were treated with ACP before germination. These findings suggest subjecting cotton seeds to ACP treatment at 70 Kw for 5 minutes could have adverse effects on cotton seed germination. Further research must be carried out to optimize plasma treatment parameters.

48. Harnessing Atmospheric Cold Plasma for Kernel Sanitization

Marijoe Vogtembing (Roanoke College)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisor: Janie Moore

Atmospheric cold plasma (ACP) is gaining attention as a non-thermal, chemical-free technology with broad potential in agricultural applications. This study explores the use of ACP treatment on maize kernels to assess its effectiveness in reducing microbial and fungal contamination. Maize kernels were exposed to ACP under controlled conditions, and post-treatment analysis focused on evaluating changes in microbial and fungal load through aflatoxin analysis measuring CFU/ml. Significant reductions in both bacterial and fungal colony-forming units were observed on treated kernels compared to untreated controls, indicating ACP's potential as an effective surface decontamination tool. To further investigate the effects of ACP on kernels surface chemistry, Fourier-transform infrared spectroscopy (FTIR) was performed as an analytical method. This technique helps identify potential chemical modifications induced by reactive gas species, enhancing understanding of how ACP interacts with biological surfaces at the molecular level. By minimizing pathogen presence on kernels prior to planting or storage, ACP may contribute to improved crop health and yield. This approach offers a sustainable, scalable solution with promising applications in processing, post-harvest treatment, and food safety protocols. As agriculture moves toward greener, more efficient technologies, atmospheric cold plasma could become a vital tool for enhancing product quality and reducing dependence on synthetic agrochemicals.

49. Efficiency of Activated Food Waste Biochar in Removing Long-Chain Organic Contaminants from Wastewater

Emilio Jimenez (Texas A&M University)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisors: Janie Moore and Sergio Capareda

This study evaluated the performance of biochar derived from food waste for removing long-chain organic pollutants from wastewater. The food waste was pyrolyzed and then biochar was activated with atmospheric cold plasma, steam, and alkali treatments. Food scraps and by-products were selected as an accessible, low-cost feedstock, and transformed into biochar through controlled pyrolysis. Activation processes entailed an increase in porosity, the introduction of functional surface groups, and expansion of overall surface area. Each activated biochar variant was tested against representative long-chain contaminants (Methylene Blue), and performance was analyzed using adsorption kinetics, equilibrium isotherms, and removal efficiency. Using the steam activation, 97.93 ± 0.07% of methylene blue could be absorbed by the biochar when activated with steam for 7 minutes at 40 psi. Results demonstrated notable differences in kinetic behavior and adsorption capacity across activation methods, demonstrating that adequately engineered food waste biochar offers strong potential as a sustainable, low-cost alternative for advanced water treatment applications.

50. Textural Analysis of Different Protein Balls with Emphasis on Atmospheric Cold Plasma-Treated Cricket Protein

Drew Streckwald (University of Illinois Urbana-Champaign)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisor: Elena Castell-Perez

This study aimed to compare the texture qualities of various proteins, with implications in product development, characterization, and food innovation, while highlighting how atmospheric cold plasma treatment may alter the texture of the cricket protein ball. Texture plays an important role in consumers' perception of food products. This research aims to assess textural qualities such as hardness, cohesiveness, adhesiveness, springiness, and chewiness of protein balls. We conducted a double compression test using a TX Food Texture Analyzer, with the objective to assess with the effect of atmospheric cold plasma for 7 minutes at 70 kV on cricket protein balls. Untreated cricket protein balls served as controls. Whey, plant-based pea, and egg white protein powders served as commercially available controls. Although each protein ball was made using the same ingredients, the portions for each type of protein ball differed slightly.

51. Activated Corn Waste-Derived Biochar Enabled Efficient Removal of Organic Pollutants from Aqueous Solutions

Ayanah McCabe (North Carolina Agricultural and Technical State University)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisors: Sergio Capareda and Mohammad Habib

Agricultural residues such as corn stover present a sustainable feedstock for biochar production, offering the dual benefit of waste valorization and environmental remediation. In this study, corn waste was converted to biochar through pyrolysis, then subjected to activation treatments including steam, cold plasma, and alkali methods. The resulting biochars were characterized for surface area, porosity, and adsorption capacity to evaluate their suitability for pollutant removal.

To assess performance, adsorption tests were conducted using methylene blue — a 0.001% aqueous solution — as a model organic pollutant. The effectiveness of each activation method was evaluated by analyzing adsorption kinetics, isotherms, and removal efficiency. Adsorption rates of 95% and higher across multiple tests, indicating strong affinity and high removal efficiency. These results underscore the potential of activated corn waste-derived biochar as a cost-effective and environmentally sustainable adsorbent for treating dye-based organic pollutants in wastewater.

52. Effect of Blanching and Drying Conditions on the Functional Properties of Black Soldier Fly Larvae Protein

Maria Quireza (Texas A&M University)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisors: Janie Moorea and Rosana Moreira

This study investigates the effects of blanching, air-drying conditions, and atmospheric cold plasma (ACP) treatment on the functional and microbial properties of black soldier fly larvae (BSFL) protein. As demand grows for sustainable protein sources, BSFL offers a promising solution due to its high nutritional value and low environmental impact. The research focuses on how processing conditions influence key functional characteristics such as turbidity and gel formation, and evaluates the antimicrobial potential of ACP treatment.

Frozen BSFL samples were blanched, dried at various temperatures (30°C to 50°C) and air flow rates (0.5–1.5 m/s), then defatted using a hexane-isopropanol solution. Proteins were extracted at pH 10, centrifuged, and freeze-dried. Turbidity was assessed by UV-Vis spectrophotometry at 400 nm. Gelation properties were analyzed rheologically by monitoring the transition from viscous to gel state during thermal ramping, with storage modulus (G′) and loss modulus (G″) used to evaluate gel strength and temperature.

For microbial analysis, ACP treatment was applied to BSFL samples placed in gas-filled plastic bags and exposed to plasma at 80 kHz for up to 8 minutes. Treated samples were incubated for 18–24 hours before colony counts were performed.

The results showed that higher drying temperatures led to greater turbidity and increased gelation temperature, indicating enhanced protein aggregation and altered functionality. ACP treatment significantly reduced microbial counts, with the 8-minute treatment proving most effective.

Overall, the study demonstrates that both thermal (drying temperature) and non-thermal (ACP) treatments critically influence the quality of BSFL protein. These findings support the development of safe, functional insect-based ingredients for use in food systems and contribute to ongoing efforts to promote sustainable, alternative protein sources.

53. Effect of Atmospheric Cold Plasma (ACP) on the Nutritional Composition and Physical Characteristics of Cricket Protein Compared to Whey, Egg-White, and Plant-Based Proteins

Sara Nunez (Texas A&M University)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisors: Elena Castell-Perez and Rosana Moreira

As global demand for protein-based foods increases, insect-derived proteins such as cricket powder offer promising alternatives to reduce the environmental impact of conventional sources. This study evaluates the effect of Atmospheric Cold Plasma (ACP) on the nutritional composition and physical characteristics of cricket protein compared to whey, egg-white, and plant-based proteins. Cricket powder was treated using ACP at 7-minutes and 70 kV. The aim is to determine the effect of ACP on the formulation, processability and shelf-life. Properties including bulk and tapped density, water activity, color and texture profile analysis were measured for the raw materials and protein balls. The nutritional composition was analyzed, with a focus on macronutrients such as protein, fat, and carbohydrates. Ingredient selection and formulation were carefully designed to balance nutritional value with desirable taste and visual appeal, supporting the development of consumer-acceptable products.

54. Expression, Purification, and Quantification of Relative Activity of Polycaprolactone(PCL) Degrading Enzymes Expressed in E. coli

Ethan Do (Texas A&M University)
CURB REU
Research Advisors: Qing Sun and Siddhant Gulati

The global accumulation of synthetic plastics, particularly polycaprolactone (PCL) from the biomedical industry, poses a serious environmental threat due to their resistance to natural degradation. This study aims to evaluate the enzymatic degradation of PCL using two enzymes, Lipase A (LipA) and Lipase B (LipB). Both enzymes, previously shown to exhibit PCL-degrading activity in Bacillus subtilis, were cloned into plasmids and transformed into E. coli for recombinant protein expression. After protein expression, both LipA and LipB were purified by His-tag purification, and their concentrations were quantified. Degradation assays were performed by incubating PCL pellets with the enzyme under varying temperatures (37°C and 42°C) and buffer volumes (50–260 µL), for both enzymes LipA and LipB. The

reactions were carried out in a 100 mM Tris-HCl buffer at pH 8.0 for up to 168 hours. Initial experiments showed negligible PCL degradation with lower buffer volumes, but increased reaction volumes considerably improved degradation, particularly in LipB-treated samples, as determined by visual analysis and activity assay measurements at 48-hour and 168-hour timepoints. This ongoing study demonstrates that enzymatic degradation of PCL using LipA and LipB expressed in E. coli is feasible, though enzyme activity is sensitive to incubation conditions, especially reaction volume and temperature. Further optimization of reaction conditions and substrate properties is required to achieve complete PCL degradation. The findings contribute to the development of scalable, biologically driven solutions for plastic waste management and lay the groundwork for future enzyme engineering efforts targeting complete biodegradation of plastics.

55. Techno Economic Analysis Data Analytics Tool

Emilio Lugo Gutierrez (Duke University)
CURB REU
Research Advisors: Chengcheng Fei, Yayun (Birdy) Chen, and Mengqiao Liu

Techno-economic analyses (TEAs) are an essential step of evaluating the economic and technical feasibility of new production pathways. However, most TEAs are scattered around in different journals, slowing down large-scale data analysis. Therefore, we have created a local application to streamline TEAs of renewable energy products. Specifically, the interface unifies data acquisition and input; contains an interactive cost estimation of production pathways; as well as static information of existing products, processes, and necessary equipment. This is all while having a reference search engine that allows for an instant gateway to the literature. The interface building process first began with large scale data collection and standardization into the following categories: chemical/product, process, equipment, TEAs, and references. After the initial data collection, a Python 3.12 application was built with sqlite3 for the database and Tkinter for the interface, enabling it to run locally on all operating systems. Custom functions allow users to be as granular with capital (CAPEX) and operational (OPEX) costs as they need to be, while enabling them to tweak parameters to see how those costs are affected. The interface so far has compiled 30+ TEAs, with an engine to add more. This has drastically improved analysis of these production pathways, while also enabling the ability to add more to the database. By unifying different data sources into one standardized, interactive interface, the interface is expected to shorten data-gathering cycles and enable high-throughput design-space exploration for renewable-energy technologies.

56. ACP Impact on Cricket Protein Powder Functional Properties

Natalie Borrero Ramírez (University of Puerto Rico at Mayagüez)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisor: Elena Castell

With growing interest in sustainable and time-efficient non-thermal processing techniques, atmospheric cold plasma (ACP) offers a promising approach for enhancing insect-based proteins. Insects, such as crickets, emit fewer greenhouse gases and require less land compared to traditional protein sources. This study investigated the effects of ACP treatment on the processability of cricket powder, using a 7-minute exposure at 70 kV. Properties such as moisture content, particle size, bulk density, Hausner ratio, and Carr Index (CI) were evaluated to understand how ACP influences the powder's flowability, stability, and suitability for processing. To contextualize the performance of cricket powder, both treated and untreated samples were compared to plant-based and egg white protein powders. Understanding these changes is key to improving the functional potential of insect proteins in food applications. This work contributes to the exploration of sustainable protein sources and supports the potential of ACP as a useful tool for improving novel protein ingredients.

57. Atmospheric Cold Plasma Treatment on Corn Stover

Noël Ndalamba (Catonsville)
Food/Feed Safety and Renewable Energy Summer Hands On (FRESH) REEU
Research Advisor: Janie Moore

Corn waste such as cobbs, husks, and stalks, have great potential to be a stable source of renewable energy. This is mainly due to its availably, and abundance in the carbohydrate cellulose and hemicellulose. However, when it comes to its preservation, scientists run into various issues. One of these issues, which is the one that will be addressed in this project, is the microbial build up on the corn stover. This appears to be an obstacle because as the microorganisms grows on the biomass, they feed onto it, leading to dry matter loss and the breaking of the carbohydrate bonds. This research aims at addressing this issue by using Atmospheric Cold Plasma (ACP) treatment on biomass of different moisture content. ACP treatment uses ionized gas to interact with the biomass being treated and disable microbial build up. Using ACP on the corn stover, we hope to address microbial problems. However, we are also anticipating the ionized gas to react with the carbohydrates, changing the chemical composition of the biomass. In order to monitor these changes, we will also use Fourier Transform Infrared Spectroscopy (FTIR). FTIR will allow us to see where the chemical bonds change and give us a better picture of how ACP treatment affects the corn waste. During the beginning stages of the research, we hope to see a decrease in microbial build and minimal change in the chemical structure of corn stover.

58. Thin Film Thickness Analysis using White Light Reflectance Spectroscopy (WLRS)

Xavier Figueroa and Daniel Jeong (Texas A&M University)
Semiconductor Research Experience and Education Project (RESCU-SM)
Research Advisors: Cha Bum Lee and Dae Seok Chai

Thin films are crucial components in modern electronics, optics, and materials science, where precise control of their thickness is often critical to device performance. Accurate deposition of the film can have a significant impact on the quality and performance of the device. Metrology includes processes conducted to measure thickness, enabling better quality control in fabrication. These traditional methods include tools such as ellipsometry and profilometry, yet different processes come with tradeoffs in that they can be complex or limited by geometry. More importantly, the methods can be destructive, destroying the sample in the process. White Light Reflectance Spectroscopy (WLRS) presents an alternative to previous methods, highlighting its non-destructive nature on the wafer, offering an optical alternative for thin film characterization. Through analysis of spectral images generated from broadband light and simulation of the wafer under different refractive indices, WLRS can accurately determine film thickness.

59. Towards Resilient Cyber-Physical Power Systems: Simulating and Classifying Anomalies

Edwin Xiao (University of Illinois Urbana-Champaign)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Katherine Davis

Cyber-physical smart grid systems face increasing threats from sophisticated data-driven attacks that exploit the reliance on data for digital control of the physical system. This work presents a rudimentary framework that integrates data fusion, feature extraction, and statistical analysis to detect anomalies and classify various types of attack in smart grid environments. Using synchronized phasor measurement unit (PMU) data from the IEEE 39-bus system, we apply a suite of twelve attack models—including traditional false data injection, replay-based, and adversarial perturbations—and extract time-series features such as temporal deviations, statistical deltas, and replay signatures. A simple rule-based classifier leverages these features to distinguish attack vectors with high interpretability. The approach demonstrates the usefulness of fused data analytics in improving attack detection and resilience in critical infrastructure systems.

60. Modernizing CNC Control: A Cyber-Physical Testbed for Intelligent, Secure, and Adaptive Manufacturing

Pranav Sundar (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Satish Bukkapatnam

As the smart manufacturing industry modernizes, ensuring operational flexibility and cybersecurity assurance has become increasingly vital, particularly for machine tool controllers (MTCs), the backbone of modern manufacturing processes; however, the proprietary nature of most commercial Computer Numerical Control (CNC) systems hinders customization, access to real-time data, and the ability to improve cybersecurity measures. This research addresses these by converting a conventional open-loop CNC (Langmuir MR-1) from a partially closed architecture into a closed-loop, open-architecture cyber-physical testbed. By integrating GRBL firmware via serial communication, it enables direct communication to the command-line interface (CLI), real-time monitoring, and closed-loop feedback via side-channel monitoring-based set point control. To support high-resolution data acquisition and visual feedback, the machine is instrumented with multimodal sensors—accelerometer, acoustic emission sensor, optical camera, and structured light source—allowing for an understanding of the machine and process dynamics. Building on this, targeted firmware modifications will be implemented to emulate cyberattacks while providing a controlled environment to assess system vulnerabilities. The system will support detection, recovery, and mitigation—key aspects of cybersecurity resilience—while maintaining real-time closed-loop control. Initial experiments demonstrated robust real-time data acquisition at approximately 15 Hz with AprilTag-based tracking, achieving detection rates between 80-100%. Under ideal conditions, the system achieved a positional error of 3-7 mm, which is within the lower range of visual pose estimation systems used in robotics. Despite occasional degradation, the CNC maintained accurate closed-loop control and consistently detected abnormal behavior. Ultimately, the modified CNC will allow for reliable real-time monitoring and closed-loop control, even under simulated cyberattacks. This configuration will support anomaly detection through visual feedback, and offers a practical testbed for advancing research in cyber-physical resilience, intelligent control, and secure manufacturing systems.

61. Investigation of an AI-Based Robust Threat Detection Framework for Multi-UAS Agents Using Reinforcement Learning

Paige Warren (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisors: John Valasek and Payton Clem

This research investigates the use of artificial intelligence in autonomous multi-agent robust threat detection in a hostile environment. It expands upon previous work that developed a Reinforcement Learning (RL) Soft Actor Critic framework specific to a quadcopter Unmanned Air System (UAS) tracking hostile, evasive maneuvering ground vehicle targets. The simulation training environment of this RL software was improved by updating the intelligent agent from a quadcopter to a hexacopter UAS, called

the Lunatic. In order to update the agent the mass properties and inertias, state-space dynamical model, and the flight operating limits had to be re-calculated and integrated into the code while keeping the original quadcopter as an optional agent. This update was a step towards the use of AI in multi-agent problems because it successfully integrated a different UAS agent into the environment of the common RL software. Simulations were then run extensively through the StableBaselines3 software package on the High Powered Research Computer (HPRC) to test the updated software and tune the reward function. The learning curve plots produced from preliminary training gave insight into how fast the agent learned the optimal path to maximize the reward function. The final learning curves and plots of the agent in training showed that the software was successfully adapted to be stable, realistic, and had “infinite” tracking (which was a 30 minutes tracking time). The results presented in this paper shows that successfully tuning the reward function for an RL agent facilitates reaching an optimal policy for the problem being investigated.

62. Multilingual Molecules: AI Agents for Cross-Domain Learning in Proteins and Biomedical Texts

Kov Satlykov (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Yang Shen

Understanding proteins—central to nearly all biological processes—requires interpreting both their intrinsic biochemical "language" and the vast body of biomedical knowledge written in human language. Bridging these two domains presents a unique opportunity for artificial intelligence (AI), particularly large language models (LLMs), to advance protein understanding and biomedical discovery. In this project, we explore how large-scale pretrained models can be used to learn across these modalities. We first benchmarked unimodal protein language models, such as ESM2 and ESM-C, using zero-shot inference and few-shot supervised learning to predict protein mutation effects. Embeddings from these models were used to train a multilayer perceptron (MLP), which was evaluated on several datasets. Building on this foundation, we investigated instruction-tuned large language models (LLMs), particularly LLaMA-based architectures fine-tuned on protein-specific natural texts such as Open Protein Instructions (OPI). Our goal is to assess their ability to perform more complex tasks—such as functional annotation and pathogenicity prediction—by integrating protein sequence representations (protein "language") into large language models trained on human biomedical texts. This research aims to evaluate the generalization capacity of fine-tuned LLMs and extend their application to essential tasks in biomedical research.

63. Determination of Return Trajectories from Cislunar Regions to Low-Earth Orbit

Leron Gundlur (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Srinivas Rao Vadali

There has been great interest in the 21st century for the return of humans to the Moon and the establishment of a more permanent presence on the lunar surface. With the hope for increased human activity on and around the Moon comes the question of crew safety. With more flights, the chance of an emergency arising and the need for a crew to immediately return to Earth increases. To ensure crew safety in emergencies it is necessary to be able to compute return trajectories from anywhere in the cislunar region to low-Earth orbit. This paper presents a method for determining trajectories from the cislunar region to low Earth orbit while minimizing delta v with a given time constraint. This is done utilizing numerical optimization techniques. Any two points in the Earth-Moon system can be chosen in the circular restricted 3-body frame along with a fixed time-of-flight to produce a trajectory. Constraints of parameters such as delta v or time-of-flight of the trajectory can also be imposed to reflect entry interface constraints.

64. Efficacy Screening of Oxaliplatin in Dormant and Non-Dormant Colorectal Cancer Spheroids

Brinlee Goggans (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Shreya Raghavan

Metastatic colorectal cancer (mCRC) is a prevalent disease associated with high mortality. Disseminated CRC cells can enter a dormant state characterized by reversible cell cycle arrest and reduced metabolic activity. Dormancy can be modeled by culturing CRC cells in 3D spheroid arrays under low-serum media and low-dose chemotherapy. Spheroid area measurements over time enable validation of dormancy induction by comparing growth rates between dormant and control spheroids. Cross-sectional area quantifications of dormant and control spheroids treated with various doses of oxaliplatin can be used to evaluate the cellular response to oxaliplatin treatment, providing insight into the role of dormancy in chemotherapy resistance.

Preliminary data confirmed successful dormancy induction: dormant spheroids exhibited an approximately 8-fold increase in area over eight days, compared to a 24-fold increase in control spheroids. When treated with oxaliplatin, dormant spheroids showed minimal changes in growth, whereas control spheroids experienced a marked reduction in cross-sectional area, indicating both reduced proliferation and significant cell death. This contrast highlights the chemoresistance associated with dormancy, which is believed to contribute to long-term cancer persistence and relapse. Ongoing analysis aims to quantify growth rate changes across treatment groups to better characterize these dynamics.

By investigating how dormancy affects tumor growth and response to chemotherapy, this study contributes to a growing body of research focused on understanding the mechanisms that underlie cancer cell dormancy and treatment resistance. These findings may inform more effective therapeutic strategies targeting dormant tumor cell populations in mCRC and other cancers.

65. Impedance Characterization and Flaw Detection of Silicon Bonded Wafers Using EIS

Celine Cho and Miguel-Angel Lopez (Texas A&M University)
Semiconductor Research Experience and Education Project (RESCU-SM)
Research Advisors: Cha Bum Lee and Dae Seok Chai

The increasing need for non-destructive evaluation of silicon bonded wafers highlights the importance of understanding how bonding conditions and defects affect electrical behavior. This research aims to characterize the impedance behavior of silicon bonded wafers under varying bonding conditions and in the presence of intentional defects using a non-destructive technique, Electrochemical Impedance Spectroscopy (EIS). The objective is to evaluate how bonding quality and defect introduction influence key electrical properties, such as resistance, capacitance, and inductance, as reflected in Nyquist plots. By analyzing these impedance characteristics, the research seeks to identify measurable correlations between bonding layer integrity and impedance response, thereby supporting the development of reliable, non-destructive methods for assessing interface quality in silicon wafer bonding.

66. Evaluation of CPA-Induced Cytotoxicity in HepG2 and U937 Cells

Bhavika Kaparthi (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Elaheh Rahbar and Matthew Powell-Palm

Cryoprotectant agents (CPAs) are crucial to preserve biological viability and functionality during cryopreservation; however, there are growing concerns about cytotoxicity from prolonged CPA exposure affecting metabolic function. The objective of this study is to assess the acute and delayed effects of CPA-induced cytotoxicity in HepG2s (hepatocarcinoma cell line) and U937s (monocyte cell line). We measured cytotoxicity via lactate dehydrogenase (LDH), live/dead, and urea assays. HepG2 and U937 cells were seeded in a 96-well plate (10,000 cells/well), exposed to 14 CPAs (n=5/CPA) at 1.5mol% for 45 minutes at 37°C, then assayed immediately or 24 hours post-exposure. In HepG2s, there was significant cytotoxicity acutely detected with Triethanolamine and Tetrahydrofurfuryl Alcohol exposure. However, cytotoxicity decreased 24 hours later, displaying cell recovery. The greatest improvement in cytotoxicity was observed with 2-Methyl-1,3-Propanediol (80% decrease in LDH) 24 hours post-exposure. U937s recovered similarly, up to 89% improvement post-Diethylene Glycol exposure. Overall, U937s had a better recovery post-CPA exposure compared to HepG2s (73% vs. 58%). With regards to hepatic functionality, HepG2s displayed a significant increase in urea production (e.g., 10% in HepG2s treated with Propylene Glycol, and 39% with Butylene Glycol). Based on these results, we were able to demonstrate significant cell recovery post-CPA

exposure at 37°C in HepG2s and U937s. This cell-based approach to screening CPA-induced toxicity shows promise as a potential high-throughput mechanism to evaluate new CPAs on specific cell types. Future work is needed to evaluate the CPA-induced toxicity at lower temperatures and longer durations.

67. Implementing Triangle Centrality with YGM

Dan Choi (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Roger Pearce

Triangle Centrality is a graph metric that quantifies the importance of a node based on its participation in triangles - a set of three mutually connected nodes. While the original Triangle Centrality algorithm was developed for shared-memory systems, this work presents a distributed implementation using YGM, an asynchronous distributed computing library designed for scalability and high throughput. My algorithm assumes an undirected input graph, which is converted into a degree-ordered graph to prevent triangle overcounting. Graph nodes and edges are partitioned across ranks using ygm::map, and each rank asynchronously communicates with other ranks to detect triangles and increment its local triangle count. After assigning the number of triangles to all nodes, I apply Burkhardt's formulation to computer triangle centrality in a similar manner of triangle counting. A few test cases are performed to validate its correctness, and extensive weak and strong scaling tests are also performed to evaluate the algorithm's scalability and performance.

68. Hardware Fuzzing for Secure Open-Source RISC-V Core Validation

Jayden Koh (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisors: Jeyavijayan Rajendran and Chen Chen

As the RISC-V instruction set architecture (ISA) continues to gain traction in both academic and industrial domains, a growing number of open-source RISC-V processor implementations have emerged. While these new RISC-V processors are developing the open-source hardware ecosystem, they are also presenting the security industry with new opportunities. This work analyzes the hardware design of several popular cores, including RSD, XiangShan, and CVA6, using novel hardware fuzzing techniques to identify and triage functional vulnerabilities. Our findings underscore the need for the integration of a variety of rigorous validation pipelines to ensure adherence to ISA standards. The vulnerabilities found in open-source processors will be reported to their respective authorities to enable the secure and transparent development of open-source hardware products for commercial and system-critical applications.

69. Multimodal Molecules: Foundation Models for Protein Understanding Across Biological Tasks

Maxwell Zhou (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Yang Shen

Proteins, the workhorse molecules of life, are composed of linear amino acid sequences that fold into complex three-dimensional structures. This allows them to be represented as multimodal data—spanning sequences (text) and structures (image, graph and geometry). With the rapid advancement of artificial intelligence (AI), particularly in multimodal foundation models, there is growing potential to transform how we understand and predict protein behavior across diverse biological tasks.

In this project, we explored the integration of multimodal protein representations to improve mutation effect prediction. We benchmarked existing unimodal models, including ESM2 and ESM-IF, using zero-shot inference and few-shot supervised learning on ProteinGym datasets, such as deep mutational scanning (DMS) and clinical benchmarks. Building on this foundation, we developed a multimodal deep learning model that integrates sequence and structural embeddings from ESM2 and ESM-IF to predict mutation scores. Our approach leverages and aims to generalize across tasks beyond mutation effect prediction (such as cross-species protein-protein interaction), contributing toward the development of robust, multimodal protein foundation models.

70. PELT: Plagiarism Evasion via LLM-Based Transformations of C++ Code

Venkat Nallam (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Jeyavijayan Rajendran

Large Language Models (LLMs) continue to become increasingly accessible and capable in performing complex text- based tasks, including code generation. This development has resulted in widespread integration within many industries along with massive popularity among everyday users, such as students. Furthermore, this ease of access has elicited concern for misuse in academic settings, including plagiarism in text-based tasks, such as programming assignments. This can include leveraging LLMs to rewrite existing programs (i.e., C++) with the goal of evading current plagiarism detectors. Given the scale and prevalence of this risk, it is imperative to evaluate the capabilities of state-of-the-art (SOTA) LLMs and strategies utilized to evade plagiarism detection.

Therefore in this work, we propose the first LLM-based framework capable of rewriting C++ programming assignments to successfully evade detection by multiple SOTA plagiarism detection tools, while maintaining functionality to result in a passing, and often high (90+) grade on the assignment. This framework contains solutions to mitigate challenges associated with functionality degradation, ensure adaptability to likely plagiarism scenarios, and mitigate context window limitations, resulting in an automated and end-to-end framework. We perform an extensive evaluation across two SOTA accessible LLMs, and assess their capabilities across a curated dataset of over 5000 real-world, student-submitted submissions across 7 unique assignments.

71. Performance Analysis of Privacy-Preserving Techniques in Federated Learning

Brice Ockman (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Garth Crosby

Federated learning allows for collaboration between decentralized data to help tackle complex machine learning tasks, Privacy Enhancing Technologies (PETs) offer some potential solutions, so we conducted a comparative analysis between three PETs; Differential Privacy (DP) using Opacus, Secure Aggregation (SA) using Flower, and Homomorphic Encryption (HE) using Tenseal. To standardize our testing we used the same Convolutional Neural Network and MNIST digit classification with 10 non-IID clients to train each model. Each PET was then implemented and tested independently against a Federated Averaging (FedAvg) baseline, with performance measured across computational efficiency, convergence speed. SA demonstrated balanced performance characteristics with moderate computational overhead while maintaining excellent convergence speed, while DP exhibited high computational efficiency with minimal additional overhead but showed reduced convergence speed due to noise injection requirements, with accuracy decreasing depending on privacy budget parameters in non-IID scenarios. HE presented significant computational challenges with overhead slower than plaintext processing, substantial communication costs due to large ciphertext sizes but providing the strongest cryptographic guarantees.

72. Restoration and Improvement of a CERT Frame

Thomas Wismar (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Hong Liang

This research focused primarily on the restoration of a CorTest Test System for Slow Cycle Corrosion Fatigue, Constant Extension Rate, and Electrochemical Studies (C.E.R.T.), and secondly on the addition of a vibratory apparatus to the system. To restore the original system, all of the original equipment was calibrated and tested. The significant modules of the original system include the motor apparatus, responsible for applying loads to a test specimen; the linear variable displacement transducer (LVDT), which measures the total “stretch” of the sample; and the load cell, which records the amount of force applied to the sample. The LVDT and load cell came uncalibrated and with exposed wires which needed to be mapped to their respective pin outputs. It was found through the original user’s manual that both the LVDT and load cell were intended to be supplied with a 10VDC input. Outputs were then measured for each system for calibration, with varying displacements for the LVDT and loads for the load cell. Because the load cell has a capacity of 6000lb, special loading equipment was needed to apply significant force for the calibration. Both the LVDT and load cell were found to be in working order and had R^2 > 0.999 for response curves. A 10VDC PSU was attached to both pieces and the outputs were connected to a DAQ, enabling digital processing in LabVIEW. When considering the motor, the intended extension rate ranges from 10-5 to 10-7 in/sec, which was found to be insufficient for the intended test purposes. Because the rate is too slow, manual loading will be applied to specimens for future testing, until a new load mechanism is acquired. The vibration module was designed by the student to apply up to approximately

1,000lbf to the test specimen at variable frequency. The final module design utilizes a combination of electromagnetic force, which has the advantage of varying frequency without necessarily varying magnitude, as well as a hydraulic system to amplify the vibrational force applied. Assembly of the module remains to be completed, with testing to follow.

74. A Benchmark for Quantum Chemistry Relaxations via Machine Learning Interatomic Potentials

Zach Krueger (Texas A&M University)
Independent Research Project
Research Advisor: Shuiwang Ji

Computational quantum chemistry plays a great role in drug discovery, chemical synthesis, and materials science. While Density Functional Theory (DFT) offers high accuracy, it is computationally expensive. Machine Learning Interatomic Potentials (MLIPs) have shown great promise in replacing DFT calculations. MLIPs leverage deep learning to accurately approximate Potential Energy Surfaces (PES) while maintaining efficient computation and scalability. However, training MLIPs require large datasets with accurate force and energy labels. PubChemQCR is the largest publicly available dataset of DFT-based molecular dynamics simulations containing over 3.5 million trajectories and over 300 million molecular conformations. PubChemQCR includes not only the ground truth relaxed geometry, but also the critical intermediate steps along the relaxation path. To provide baselines for future work, 9 common MLIPs were benchmarked on our dataset. Models were compared based on their force and energy prediction accuracy as well as metrics reflecting the success of their molecular relaxation.

75. Physically Grounded Correction of Transmission Line Parameters in Synthetic Grids: A Multiverse Approach

Abdoulaye Diop (Texas A&M University)
Undergraduate Summer Research REU Program (S-REU)
Research Advisor: Jonathan Snodgrass

The accuracy and realism of synthetic electric power grids are crucial for ensuring their value in research, education, and operational planning. A persistent challenge in these models is the alignment between assigned thermal (MVA) ratings and the underlying physical and electrical parameters of transmission lines. This paper introduces a dual-path methodology for reconciling these discrepancies by integrating real-world transmission tower geometries and conductor configurations into the synthetic grid design process. This method is tested on the 2025 Texas 2000 bus synthetic grid as well as other reliable cases. In the first approach, MVA limits are treated as fixed constraints, and line parameters—resistance (R), reactance (X), and susceptance (B)—are back-calculated using a physically feasible selection of conductors, bundle counts, and tower spacings. In the second approach, the given R, X, and B parameters are considered accurate, and a physically consistent MVA limit is derived from optimized tower and

conductor configurations. For each path, a rigorous iterative framework is applied to explore feasible combinations of ACSR conductors and phase arrangements, using DC power flow and analytical formulas grounded in transmission line theory. The result is a set of transmission line models that are both thermally and electrically credible, improving the fidelity of synthetic grids and enabling more meaningful simulation of overloads, upgrades, and contingency scenarios. This methodology provides a scalable foundation for future synthetic grid design, validation, and planning studies.

76. Vision-Based Autonomous Railway Fault Detection UAV

Mustafa Eltayeb (Texas A&M University)
Texas Summer Research Experience (TSRE) from Qatar
Research Advisor: Moble Benedict

Undetected railway faults can lead to dangerous and costly accidents. This project explores the use of a camera-equipped drone that can automatically follow railway tracks and help identify problems early. The drone is controlled by a small onboard computer and a flight controller. A custom program reads the video feed, determines how the drone should move, and adjusts its flight in real time. All flight and video data are saved for later analysis. This system offers a more affordable and flexible alternative to traditional railway inspection methods, with the potential to improve safety and efficiency. Future work might include integration of Machine Learning(ML) so that the drone may autonomously find and flag faults at a specific location along the railway track.

77. Investigating the Common Ion Effect for Brine Mining

Railee Fernandez (Texas A&M University at Qatar)
Texas Summer Research Experience (TSRE) from Qatar
Research Advisor: Hamidreza Samouei

The selective precipitation of dissolved salts from concentrated brine solutions plays a critical role in desalination, water reuse, and the extraction of valuable minerals. In brine mining, understanding the thermodynamic behavior of salts in the presence of other ions is essential for efficient resource recovery. This study explores how common salts, sodium chloride (NaCl), potassium chloride (KCl), and ammonium chloride (NH4Cl), react when calcium chloride (CaCl2) is added, a situation relevant to brine mining and water treatment. We conducted eight experiments in which varying amounts of calcium were added to salt solutions, using calcium-to-salt mass ratios such as 3.5 grams of calcium to 3 grams of salt and up to 7 grams of calcium to 3 grams of salt. Instead of relying on electrical conductivity, which can be inaccurate in mixtures, we used a gravimetric method that directly measures how much solid salt precipitates out of solution. We also used X-ray diffraction (XRD) to identify which salts formed crystals. In every case, NaCl formed the most solid, followed by KCl, then NH4Cl. One test using magnesium chloride (MgCl2) instead of the usual salts showed no precipitation at all. These results help explain how salts behave in high-ion environments and show how simple measurement tools can give clearer results in complex water systems. This work supports better strategies for recovering valuable minerals from brine and managing waste more effectively.