GSAW 2026: Scholarly Forum Presentation Abstracts

Session I – Engineering and Health & Life Sciences

10:00am – 11:30am

Engineering

1 - **Md Sadik Awal, “When Shields Fail: Active Electromagnetic Probing in Secure Hardware”**

Problem Statement:
Electromagnetic (EM) shielding is widely used to protect secure hardware from side-channel attacks by suppressing radiated emissions. This protection assumes that reducing observable EM signals prevents attackers from inferring internal computations. However, it is unknown whether shielding also protects against adversaries who actively probe devices rather than passively collecting signals.
Research Objectives:
This work investigates whether execution-dependent information leakage can persist in shielded systems when an attacker injects controlled signals and observes the device's response. We study whether switching activity inside digital circuits produces impedance variations that remain externally measurable despite EM shielding.
Methodology:
We conduct experiments on FPGA- and microcontroller-based platforms enclosed in industry-standard conductive shields. We compare passive EM monitoring with active EM frequency probing. In the active case, external EM signals are directed toward the shielded device, and the reflected responses are analyzed using statistical signal processing, dimensionality reduction, and machine-learning classification.
Results and Conclusions:
Shielding significantly reduces passive EM leakage, causing the device's internal execution states to become difficult to distinguish. In contrast, actively stimulated reflections remain highly separable across workloads and execution conditions, enabling near-perfect classification accuracy across multiple shielding materials. Our findings demonstrate that shielding suppresses radiated emissions but does not eliminate information leakage arising from impedance-dependent reflections.
Contribution and Significance:
This study identifies a previously overlooked physical side channel that bypasses conventional shielding assumptions. The findings challenge the prevailing belief that shielding alone ensures resistance to EM side-channel analysis.
Broader Impacts:
Understanding this leakage mechanism can inform improved hardware defenses, testing methodologies, and certification standards, ultimately strengthening the security of next-generation embedded and computing systems.

2 - **Samantha Blanco, "Suitability of Small Modular Reactors for Resilient Microgrids: A Comparative Literature Review"**

Unexpected events such as system vulnerabilities, transmission system failures, or extreme weather conditions, can disrupt the continuous operation of critical infrastructure including hospitals, data centers, and emergency response facilities. Microgrids have been an answer to back up these infrastructure operations, because they offer immediate response and a sustainable and reliable performance; however common configurations rely on intermittent renewable resources or fossil fuel backup systems that can present limitations in its performance. Small Modular Reactors (SMRs) have been proposed as an alternative, with the opportunity to play a significant role in nowadays energy demands while addressing climate and environmental impact.

This study consists of a comparative review of the literature to evaluate SMRs relative to alternative energy solutions, including diesel generators, natural gas and renewables with storage systems. Peer reviewed journal publications, national laboratory analyses and agency reports are analyzed to evaluate performance across key resilience and deployment criteria, including dispatchability, islanded operation, outage endurance, fuel supply and regulatory complexity.

Renewable-dominant systems provide sustainability benefits, while fossil-based generation systems offer operational flexibility. Both approaches present limitations in prolonged outage scenarios as well as under stringent decarbonization objectives. SMRs may offer advantages in firm generation capacity, long operational capability and low lifecycle emissions, which may enhance their suitability for microgrids serving critical infrastructure. However, challenges related to regulatory approval process, upfront economic investment, and specific deployment constrains remain significant for SMRs. Highlighting the importance of a structured comparative assessment.

By analyzing and synthesizing interdisciplinary findings across nuclear engineering, power systems and energy policy domains, this review provides a comparative assessment of SMR suitability for microgrids applications and outlines the remaining technical, regulatory and economic challenges that shape deployment decisions.

3 - **Md Siam Nur Chowdhury, “Optimizing Firefighters' Routes in Dhaka Using GIS and Dynamic Fire Station Allocation with Temporal Travel Time Analysis: A Study of Mixed-Motorized Traffic”**

Efficient emergency response is a cornerstone of urban resilience, especially in densely populated cities where mixed motorized traffic and unpredictable congestion significantly hinder mobility. Traditional real-time navigation tools, such as Google Maps, often fail under such heterogeneous traffic conditions due to differential vehicle speeds and dynamic congestion, leading to unreliable travel time estimates. To address this challenge, this study proposes a novel Python-based framework for dynamic fire station allocation that prioritizes minimum travel time rather than mere shortest distance. The model allows users to input an incident location and select traffic conditions - peak-hour, non-peak-hour, on any day of the week, as well as specify whether it is a weekday or weekend, returning the best and second-best fire station options based on minimum travel time with optimized routes. Travel time data from 180 routes covering 15 fire stations and 12 high-risk zones (as incident-locations) were extracted via Google Maps API. Analysis revealed that, unlike conventional models, for a given incident location, one fire station may be optimal during a specific time window (e.g., morning), while different stations become first and second optimal at other times (e.g., evening) due to shifting traffic patterns. Predictive models incorporating average historical traffic patterns outperformed real-time estimates in Dhaka’s mixed traffic scenario. Statistical tests, including paired and Wilcoxon-signed rank t-tests, confirmed significant differences ($p < 0.05$) between predicted and observed travel times, highlighting the limitations of conventional real-time routing. Heat map analysis further identified underserved zones, enabling strategic relocation of mobile fire service units. This adaptive, predictive planning framework can save critical minutes during emergencies, improve response efficiency, and is transferable not only to other developing cities with complex mixed-traffic conditions but also to diverse emergency services such as ambulance operations and emergency food distribution.

4 - **Jose Cosio, “Working Title: Sensing Radiation: An Analysis of Commercial Nuclear Radiation Detectors.”**

The goal of this work is to present a structured review comparing a nuclear radiation detectors with a focus on nuclear scintillators a materials with qualities tailored for high-energy radiation; At its core there’s a scintillator for this analysis it will be a CsI(Tl)-based detector manufactured by RadiaCode and it will be compared to another detector that has energy resolution capabilities focusing on the technology that enables their operation, the internal materials and how they function, and comparing some of their physical fundamentals such as material composition and more importantly how these materials are able to more efficiently analyze the gamma radiation emitted by a sample of Cs-137 or another gamma source as the primary test isotope. Many challenges still face the field of nuclear engineering, one of which is choosing the right sensor for the right application, as well as addressing limitations in sensor efficiency such as the capabilities of the internal material.

Research in this field is important as nuclear sensing equipment is widely deployed as well as rapidly growing across different fields such as nuclear power generation, medical applications, and for homeland security. However, selecting an instrument that matches a specific mission profile remains challenging due to the limitations of detector physics, performance specifications, and product classes.

The methodology of this work is composed of three parts as a starting point. The first element is a technical analysis of the manufacturer’s specifications as well as external literature, including evaluation of detector type, active material, specified efficiency, and energy resolution. This will then be followed by a controlled experiment focusing on the characterization of the nuclear material using the selected sensor, such as analyzing a sample of Cs-137 as a source of gamma radiation. Measurements are conducted under fixed parameters and consistent sources, accounting for their decay over time; the primary form of radiation being measured is gamma radiation as Cs-137 source, has a characteristic energy resolution. Some measured metrics will be the count rate, the energy resolution, peak identification capability, and comparison of their efficiencies.

5 - **Dipak Dahal, "Extension of Particle Geometry Space: Inclusion of Particle Length"**

Particle geometry governs the macroscopic behavior of granular materials, influencing compaction, strength, stability, and flow of particles. Particle geometry consists of multiple interrelated attributes such as size, shape, surface area, volume, and specific surface that vary simultaneously, making it difficult to characterize particle behavior or understand their combined effects using a single parameter. The Particle Geometry Space (PGS) provides a consistent geometry-based way to define particle volume, surface area, and shape; however, it is still inadequate for measuring particle length. A total of 2901 particles were analyzed from twelve different sources, showing that new particle length (Ł) is closely approximated by the particle circumdiameter (L). A strong correlation is observed between Ł and L (R^2 = 0.99), indicating that Ł eliminates the need for measuring the distance between the two farthest points in the particle using a bounding box or sphere. This new length connects Wadell's surface-based true sphericity S and volume-based sphericity Ψ (= D/L), which have remained unlinked for nearly a century. The analysis further demonstrates that S is influenced by both particle form and roundness. The relationship can be represented as $S = \Psi^{0.5} \times (M \times S^3)^{0.5}$. Since Ψ is a form indicator, we can conclude that $M \times S^3$ represents roundness. This study further demonstrates that $M \times S$ represents particle form, while $M \times S^3$ represents the contribution of particle roundness.

6 - **Badhan Chandra Das, "Jailbreaking Large Vision Language Models in Intelligent Transportation Systems."**

In recent days, Large Vision Language Models (LVLMs) have demonstrated extraordinary capabilities in multimodal reasoning and many real-world applications, such as visual question answering and image captioning. These highly advanced Artificial Intelligence (AI) tools are integrated in various domains, including healthcare, finance, and Intelligent Transportation Systems (ITS). However, LVLMs are not flawless: they are highly susceptible to adversarial vulnerabilities, including jailbreaking attacks. In this study, we systematically analyze the critical security vulnerabilities of LVLMs integrated in ITS under carefully crafted jailbreaking attacks. In the current literature, there is a lack of transportation-related datasets to evaluate the security vulnerabilities under jailbreaking attacks of LVLMs. To address these challenges, first, we carefully construct a dataset with harmful queries relevant to the transportation domain, following OpenAI's prohibited categories to which the LVLMs should not respond. Second, we introduce a novel jailbreaking attack that exploits the vulnerabilities of LVLMs through image typography manipulation and multi-turn prompting. Third, we propose a multi-layered response filtering defense technique to prevent the model from generating inappropriate responses. We perform extensive experiments with the proposed attack and defense on the state-of-the-art LVLMs (both open-source and closed-source). To evaluate the attack method and defense technique, we use GPT-4 as a judge to determine the toxicity of the responses generated. In addition to using the GPT-4 as a toxicity evaluator, we perform manual evaluation on the toxicity measurement to understand the credibility of the AI tool to determine the toxicity of text. Upon conducting extensive experiments on several popular open-source and closed-source LVLMs, we highlight severe security risks involved with jailbreaking attacks with image typography manipulation and multi-turn prompting in the LVLMs integrated in ITS. Further, we compare our proposed jailbreaking method with existing jailbreaking techniques in the literature, and our proposed method outperforms the existing methods with the same evaluation techniques. We conjecture that this study will raise awareness among AI researchers in the transportation domain about the safe, secure, and reliable deployments and development of LVLMs for ITS.

7 - **Precious Eze, "Evaluating LLMs for Career Guidance: Comparative Analysis of Computing Competency Recommendations Across Ten African Countries"**

Employers increasingly expect graduates to utilize large language models (LLMs) in the workplace, yet the competencies needed for computing roles across Africa remain unclear given varying national contexts. This study examined how six LLMs, namely ChatGPT 4, DeepSeek, Gemini, Claude 3.5, Llama 3, and Mistral AI, describe entry-level computing career expectations across ten African countries. Using the Computing Curricula 2020 framework and drawing on Digital Colonialism Theory and Ubuntu Philosophy, content analysis of 60 LLM responses to standardized prompts reveals consistent coverage of technical competencies such as cloud computing and programming, but notable differences in non-technical competencies, particularly ethics and responsible AI use. Models vary considerably in recognizing country-specific factors, including local technology ecosystems, language requirements, and national policies averaging only 35.4% contextual awareness overall. Open-source models demonstrated stronger contextual awareness and better balance between technical and professional skills, with Llama (4.47/5) and DeepSeek (4.25/5) outperforming proprietary alternatives ChatGPT-4 (3.90/5) and Claude (3.46/5). However, Mistral's poor contextual performance (0.00/4) despite being open-source indicates that development philosophy alone does not guarantee contextual responsiveness. This first comprehensive comparison of LLM career guidance for African computing students uncovers entrenched infrastructure assumptions and Western-centric biases that create gaps between technical recommendations and local realities. The findings challenge assumptions about AI tool quality in resource-constrained settings and underscore the need for decolonial approaches to AI in education, emphasizing contextual relevance and hybrid human-AI guidance models.

8 - **Alexander Guillen, "Detecting Hydraulic Reversal and Anomalous Seepage in a Managed Lake–Aquifer System: A Data-Driven and Computational Analysis of Lake Okeechobee"**

Lake Okeechobee's water level is subject to active anthropogenic control. Variations in lake stage directly influence hydraulic head distributions in adjacent groundwater systems. Under typical conditions, groundwater levels respond to lake fluctuations in a predictable manner governed by hydraulic gradients and aquifer properties. However, extreme climatic events or management actions may induce non-linear responses, including hydraulic reversals and anomalous seepage fluxes that deviate from historical behavior. Identifying and characterizing such events is critical for safeguarding groundwater resources, improving operational decision-making, and mitigating unintended ecological or structural impacts along the lake perimeter. To investigate these dynamics, groundwater data were obtained from monitoring well OKS-100, which records daily water levels in the SAS. Corresponding lake stage data were acquired from the Henry Creek Lock control structure, a regulated stage measurement location along the lake rim. A structured time-series analysis framework was implemented to characterize the coupled lake–aquifer response. This framework included joint trend evaluation of lake stage and groundwater head (e.g., GAGHT versus time), residual analysis to identify departures from expected behavior, correlation structure assessment, and lag-response quantification to distinguish normal system behavior from potential reversal events. Hydraulic gradients were computed from observed head differences and combined with representative estimates of hydraulic conductivity and effective porosity to estimate average linear seepage velocities. To further assess the physical plausibility and spatial manifestation of identified anomalous periods, a 3D physics-based groundwater flow model was constructed. The model was driven by observed lake-stage scenarios to simulate aquifer hydraulic head distributions under both typical conditions and candidate hydraulic reversal events identified through the time-series diagnostics. A linear regression between Lake Okeechobee stage and groundwater levels at well OKS-100 gives the relationship $G=0.6847L+2.9365$, meaning that groundwater rises about 0.68 ft for every 1-ft increase in lake stage. Because the slope is less than 1, the groundwater responds strongly to the lake but not at the same magnitude, showing some damping due to aquifer storage. At higher lake stages, the groundwater levels follow the lake more closely, suggesting a stronger hydraulic connection. At lower stages, the relationship becomes more scattered, indicating delayed or more complex groundwater response.

9 - **Ahmed Ibrahim, "Resilience of Grid-Forming Controls to Cyber-Physical Threats: A Hardware-in-the-Loop Validation"**

(1) Problem Statement: The rapid proliferation of inverter-based resources (IBRs) in modern power systems has introduced critical challenges regarding low system inertia and cyber-physical vulnerability. While Grid-Forming (GFM) inverters offer a solution for stability, traditional control strategies often struggle with dynamic transients, and their increasing reliance on communication networks exposes microgrids to malicious threats, particularly False Data Injection (FDI) attacks. (2) Research Objectives: This study aims to rigorously evaluate and compare the dynamic performance and cyber-resilience of three prominent GFM strategies such as Droop Control, Virtual Synchronous Generator (VSG) Control, and Dispatchable Virtual Oscillator Control (dVOC), and to validate a novel decentralized layer designed to mitigate FDI attacks. (3) Research Methodology: A high-fidelity Controller Hardware-in-the-Loop (CHIL) testbed was established to bridge the gap between simulation and deployment. The framework integrates OPAL-RT for real-time power stage emulation, EXata CPS for realistic network traffic and attack generation, and Texas Instruments C2000 DSPs for industrial-grade control execution. (4) Results/Conclusions: Experimental results demonstrate that the VSG strategy consistently outperforms Droop and dVOC in terms of dynamic agility and waveform quality. Specifically, VSG achieved the fastest settling time (0.63 s) and lowest power overshoot (0.548 W) compared to Droop (2.14 s, 1.27 W) and dVOC (1.84 s, 1.30 W), while maintaining the lowest voltage Total Harmonic Distortion (0.61%). Furthermore, the proposed physics-based resilience layer successfully detected and clamped FDI attacks, preserving system stability during active data manipulation. (5) Contribution/Significance: This work contributes a comprehensive experimental validation of GFM strategies within a realistic cyber-physical environment. A key differentiating contribution is the implementation of the resilience layer directly on embedded DSP hardware, proving its feasibility under strict computational constraints. (6) Broader Impacts: By combining robust inertial control with intrinsic cyber-defense mechanisms, this research provides a scalable pathway for integrating renewable energy sources safely, ensuring the reliability of future microgrids against both physical operational disturbances and sophisticated cyber-threats.

10 - **Md Rownak Islam, “Geospatial Controls on Microplastic Distribution and Their Co-Occurrence with Legacy Pollutants in Urban Stormwater Systems”**

Microplastics (MPs) are increasingly identified alongside legacy contaminants in urban stormwater, including sediments, nutrients, and metals, creating multifaceted challenges for water quality management in urban and coastal systems. This study evaluates the spatial and hydroclimatic drivers governing MP occurrence and their association with key water quality indicators, such as total suspended solids (TSS), total dissolved solids (TDS), pH, electrical conductivity (EC), total nitrogen (TN), total phosphorus (TP), and selected metals (Cr, Cu, Ca, and Pb). To characterize stormwater quality across heterogeneous urban environments, monthly samples were collected from 18 storm sewer catch basins representing six land-use types—high- and medium-density residential, commercial, industrial, institutional, and green spaces—throughout Miami-Dade County, Florida. Concurrently, stormwater conditions were assessed at 15 locations along three regional flood control canals: the Miami River, Little River, and Biscayne Canal. Samples were analyzed for bulk particle size distributions and MP size fractions to investigate transport processes and particle aggregation dynamics. These measurements were integrated with land-use attributes and hydroclimatic variables using GIS-based spatial analysis and principal component analysis (PCA). The findings offer insight into the coupled behavior of microplastics and legacy pollutants and provide guidance for optimizing flood control canal operations to reduce pollutant loading while preserving hydrologic performance under changing land-use and climate conditions.

11 - **Md Mezbahul Islam, “STEP-PD: Stage-Aware and Explainable Parkinson's Disease Severity Classification from Longitudinal Multimodal Clinical Assessments”**

Problem Statement Parkinson’s disease (PD) is progressive, with symptom burden and functional impairment changing over time; therefore, severity staging is crucial for clinical monitoring and treatment planning. Yet many computational studies focus on binary PD vs. healthy detection and underutilize longitudinal clinical assessments for stage-aware prediction.

Research Objectives This work aims to develop an accurate and clinically interpretable machine-learning framework for PD severity classification that (i) uses clinically meaningful severity boundaries, (ii) leverages longitudinal visits, and (iii) provides both global and patient-level explanations of severity-related features.

Research Methodology This study proposes STEP-PD, a severity-aware framework using all available visits from the Parkinson’s Progression Markers Initiative (PPMI). Subjective questionnaires and objective clinician-assessed measures are integrated. Severity is defined via Hoehn & Yahr staging and grouped into three categories: Healthy, Mild PD (stages 1–2), and Moderate-to-Severe PD (stages 3–5). We evaluate three binary tasks (Healthy vs. Mild, Healthy vs. Moderate-to-Severe, Mild vs. Moderate-to-Severe) and a three-class task using stratified cross-validation with imbalance-aware training. For interpretability, SHAP is used to generate global explanations (including a cross-task heatmap summarizing stage-dependent symptom relevance) and local patient-level waterfall explanations.

Results/Conclusions Across all tasks, XGBoost delivered the strongest and most stable performance: 95.48% (Healthy vs. Mild), 99.44% (Healthy vs. Moderate-to-Severe), 96.78% (Mild vs. Moderate-to-Severe), and 94.14% accuracy with 0.8775 Macro-F1 for three-class severity classification. Explainability analyses indicate a shift from early motor features (e.g., bradykinesia, tremor) toward progression-related axial and balance impairments (e.g., postural instability, gait dysfunction). Overall, longitudinal multimodal assessments enable accurate, interpretable, progression-aware severity classification.

Contribution/Significance STEP-PD advances PD modeling beyond binary detection by providing severity-aware prediction using longitudinal, routinely collected clinical assessments, paired with transparent global and individualized explanations to support clinically meaningful interpretation.

Broader Impacts This approach can support progression-aware clinical decision-making, improve monitoring and stratification in research/clinical trials, and offer a practical pathway toward explainable ML tools that clinicians can trust for PD staging and disease management.

12 - **Md Tasnim Jawad, “Exploring Hard Token Signals for Membership Inference Attacks against Large Language Models”**

Large Language Models are increasingly expanding into sensitive domains like healthcare, finance, and legal services, where protecting training data privacy is critical. These models remain vulnerable to Membership Inference Attacks (MIAs), which can reveal whether specific data samples were used during training or fine-tuning, creating serious privacy risks for individuals. However, most existing MIAs against LLMs rely on sequence-level, aggregated statistics, which often blur the distinction between generalization and memorization and thus limit attack effectiveness. We conduct a systematic analysis of how training data induces these shifts in token-level probability distributions. Based on our findings, we propose HT-MIA, a novel MIA method that captures overlooked fine-grained signals. HT-MIA compares token probability changes on hard tokens between a fine-tuned target model and a pre-trained reference model, isolating robust membership signals that are obscured by existing sequence-level approaches. Our approach achieves significantly higher accuracy in detecting training data membership. We evaluate our method across four diverse datasets, including medical records and general text. Through extensive experiments on both medical and general datasets, HT-MIA consistently outperforms seven state-of-the-art MIA baselines, achieving 86–94% AUC on general benchmarks and up to 88% on medical data. We further evaluate differentially private training via DP-SGD as a defense and quantify its effectiveness in mitigating these attacks. We analyze the privacy–utility trade-off under DP-SGD and measure the performance degradation required to reduce token-level leakage. Our results highlight significant privacy concerns in real-world LLM deployments and demonstrate that effective MIA methods pose serious risks to organizations that handle sensitive data. Through ablation studies, we also show that current defense mechanisms are inadequate to prevent such attacks, highlighting the urgent need for stronger safeguard mechanisms. Overall, HT-MIA establishes hard-token analysis as a strong foundation for advancing membership inference research on both attacks and defenses for LLMs.

13 - **Anderson Keah, "Credit for Prior Learning in Engineering for Non-Degree Technicians: A Comparative Policy Analysis of Technician-to-Engineering Pathways"**

Skilled technicians with industry and Career Technical Education (CTE) certifications, apprenticeship credentials, military technical training, or extensive on the job experience often possess competencies comparable to those of students who have completed college level coursework. Yet, when these non degree technicians pursue engineering bachelor's degrees, their prior technical learning is frequently overlooked or, when recognized, applied only as elective credit rather than toward required major courses. This pattern contributes to repeated coursework, higher costs, and longer time to degree. This paper examines whether engineering programs accredited by the Accreditation Board for Engineering and Technology (ABET) recognize technicians' prior technical learning from work experience, portfolio assessments, apprenticeships, Career and Technical Education (CTE) pathways, military technical training, and industry certifications. We also examine whether such learning is positioned to satisfy required major coursework or is restricted to electives or petition based applications. Drawing on credentialism, we interpret credit recognition policies as gatekeeping mechanisms that privilege academic legitimacy over demonstrated competence. Using a comparative policy analysis of Credit for Prior Learning (CPL) and Prior Learning Assessment (PLA) documents from 10 institutions across five U.S. regions, we find that recognition is narrow, uneven, and rarely accompanied by transparent or guaranteed major applicability. Because technicians disproportionately include veterans, first generation students, low income learners, rural learners, and racially minoritized learners, these patterns reproduce equity gaps when non-academic technical (hands on) learning is routed into electives or petition only processes. We propose equity centered, program level reforms that support the transparent recognition of non-academic technical learning (such as industry certifications, apprenticeships, and CTE credentials) through published equivalencies rather than through petition processes alone. These reforms would expand the likelihood that technical learning counts toward required major coursework and strengthen technician to engineer pathways. Keywords: Credit for Prior Learning (CPL); Prior Learning Assessment (PLA); industry certifications; apprenticeships; military training; ABET; engineering pathways; educational equity.

14 - **Mahfizur Rahman Khan, "Learning to Optimize Joint Beamforming Transmission over Riemannian Manifolds for RIS-Aided ISAC Systems"**

In the emerging era of 6G wireless networks, communication systems must both transmit data and sense their surrounding environment. For example, a self-driving car uses the same wireless signal to communicate with nearby vehicles while detecting obstacles in real time. This dual capability called integrated sensing and communication (ISAC), makes networks more compact and cost-effective. However, performing both tasks simultaneously creates a major challenge. The communication signals can interfere with sensing, degrading both data transmission and environmental detection. To address this challenge, this research develops an intelligent signal control framework that optimizes beamforming to balance both communication and sensing performance. The goal is to carefully shape and direct transmitted signals to maximize data rates while maintaining accurate environmental detection. To further enhance beamforming performance, we incorporate reconfigurable intelligent surfaces (RIS), which are programmable panels that control how wireless signals reflect and propagate through the environment. By jointly optimizing the base station beamforming and the RIS reflection patterns, we reduce interference and improve overall system efficiency. To perform this joint optimization effectively, we move beyond conventional Euclidean methods that treat signals in flat mathematical space. We model the beamforming and RIS design problem on curved spaces known as Riemannian manifolds. This geometry aware formulation better captures the structure of the signals and enables more efficient and accurate optimization. Additionally, we develop a model driven meta learning framework using recurrent neural networks to iteratively update the beamforming matrices and RIS phase shifts for optimization. The learning model discovers effective initialization strategies and adaptive update rules, which significantly accelerate convergence. Simulation results show that the proposed approach converges faster and achieves 25 to 40 percent higher total data rates compared to traditional Euclidean methods. The significance of this research lies in its pioneering integration of intelligent surfaces, manifold-based optimization, and machine learning for ISAC systems. By combining these approaches, we achieve substantial performance improvements in higher data rates compared to conventional methods. Its broader impact lies in enabling cost effective, reliable, and high performance 6G systems that can simultaneously communicate and sense, supporting safer autonomous systems and smarter infrastructure in wireless communication.

16 - **Md Jueal Mia, “Secure Edge AI Systems: From Federated Learning to Large Language Models”**

Data security has become a growing concern as modern AI systems increasingly rely on sensitive user data for training and inference. Although Federated Learning (FL) keeps raw data on local devices, shared model updates remain vulnerable to inference attacks such as gradient inversion and membership inference, which can reconstruct private training data or reveal sensitive user participation. These risks pose serious regulatory and ethical concerns, particularly in domains such as healthcare, finance, and government. In addition, the communication and computational overhead of transmitting large model updates limits the scalability of secure FL deployments. These challenges highlight the need for a secure and efficient FL framework that protects model updates against inference attacks while maintaining practical system performance. Our objective is to develop an inference-attack-resilient FL framework that ensures strong privacy guarantees without compromising communication efficiency or model performance, and to extend this protection to Large Language Models (LLMs), whose scale and representational sensitivity further amplify privacy risks. To achieve this goal, we design a secure FL architecture based on layer-wise fully homomorphic encryption (FHE), enabling encrypted aggregation of model updates without exposing raw gradients. For conventional neural networks, we introduce QuanCrypt-FL1, which integrates low-bit quantization, pruning, and dynamic clipping to reduce communication overhead while preserving accuracy and strengthening resistance to inference attacks. QuanCrypt-FL achieves up to 3× storage reduction, delivers 2× faster inference than Vanilla-FL, and outperforms existing secure FL methods by 1.5× while lowering encryption and training costs. Building on this foundation, we propose FedShield-LLM2, a secure and scalable federated fine-tuning framework for LLMs that combines FHE with pruning and LoRA-based parameter-efficient adapters. By securely aggregating only pruned adapter parameters, FedShield-LLM improves efficiency while maintaining strong privacy guarantees. Experimental results demonstrate lower training loss and higher-quality text generation than Vanilla FL and DP-LoRA, confirming its effectiveness in cross-silo federated environments. Overall, this work advances privacy-preserving AI by enabling secure and scalable federated learning for both conventional models and LLMs.

17 - **Ervin Moore, “Blockchain-empowered cyber-secure federated learning for trustworthy edge computing”**

Federated Learning (FL) is a privacy-preserving distributed machine learning scheme, where each participant’s data remains on the participant’s devices and only the local model generated utilizing the local computational power is transmitted throughout the database. However, the distributed computational nature of FL creates the necessity to develop a mechanism that can remotely trigger any network agents, track their activities, and prevent threats to the overall process posed by malicious participants. Particularly, the FL paradigm may become vulnerable due to an active attack from the network participants, called a poisonous attack. In such an attack, the malicious participant acts as a benign agent capable of affecting the global model quality by uploading an obfuscated poisoned local model update to the server. This paper presents a cross-device FL model that ensures trustworthiness, fairness, and authenticity in the underlying FL training process. We leverage trustworthiness by constructing a reputation-based trust model based on agents’ contributions toward model convergence. We ensure fairness by identifying and removing malicious agents from the training process through an outlier detection technique. Additionally, we establish authenticity by generating a token for each participating device through a distributed sensing mechanism and storing that unique token in a blockchain smart contract. Further, we insert the trust scores of all agents into a blockchain and validate their reputations using various consensus mechanisms that consider the computational task.

Data poisoning might not be entirely preventable. But there are commonsense measures that can help guard against it, such as placing limits on data processing volume and vetting data inputs against a strict checklist to keep control of the training process. Mechanisms that can help to detect poisonous attacks before they become too powerful are also critical for reducing their effects. AI systems that rely on data from the real world will always be vulnerable to manipulation. Using defense tools such as FL and blockchain can help researchers and developers build more resilient, accountable AI systems that can detect when they’re being deceived and alert system administrators to intervene.

18 - **Garikayi Mukamuri, "Blockchain-Based Proof of Concept for Enhancing Transparency, Traceability, and Certification in Artisanal and Small-Scale Gold Supply Chains"**

Problem Statement: Artisanal and small-scale gold mining (ASGM) in Zimbabwe accounts for over 60% of national gold output and supports more than one million workers. However, the sector suffers from systemic supply chain opacity, protracted payment cycles averaging 7–30 days, annual revenue leakage estimated at US$1.2–1.9 billion through smuggling, and the absence of verifiable ethical certifications. These challenges depress miner incomes to 60–80% of expected value and exclude Zimbabwean gold from premium international markets requiring responsible sourcing compliance. Research Objectives: This study aims to design, pilot, and evaluate a blockchain-based digital infrastructure integrating Internet of Things (IoT) sensors to enhance provenance verification, automate real-time payments, and enable ethical traceability across the ASGM value chain. Research Methodology: The research adopts a design science methodology, combining iterative prototyping with a planned six-month pilot deployment at Medic Syndicate Mine in Mt. Darwin, Zimbabwe. The proposed system architecture integrates a Hyperledger Fabric-based permissioned blockchain with low-cost IoT hardware—ESP32 microcontrollers, HX711 analog-to-digital converters, and strain gauge load cells—for automated gold weight measurement at approximately US$42 per station. Smart contracts will automate payment calculations incorporating purity-adjusted pricing and volume-based tier bonuses. A mixed-methods evaluation will triangulate quantitative system performance metrics with semi-structured interviews of key stakeholders including miners, buyers, regulators, and community representatives. Expected Results: Preliminary laboratory testing of the prototype demonstrates transaction processing latency under 5 seconds, weight measurement accuracy within ±0.22%, and system uptime exceeding 95%. The pilot phase targets processing transactions across 150 registered miners, with the system expected to significantly reduce payment settlement times, improve price transparency, and generate auditable records for ethical compliance verification. Contribution/Significance: This research will contribute the first field-tested empirical evidence of blockchain efficacy in Zimbabwe's ASGM sector, demonstrate a novel design science approach combining hardware, software, and human-centered research, and offer a scalable, low-cost blueprint replicable across Sub-Saharan artisanal mining contexts. Broader Impacts: The proposed system addresses formalization of extractive sectors historically resistant to digital integration, enabling data-driven regulatory oversight, curbing illicit gold flows, and promoting equitable value distribution for vulnerable mining communities across developing economies.

19 - **Hamed Najafi, “Data Augmentation for climate data”**

Deep learning downscaling of extreme precipitation suffers from severe data imbalance—rare events comprise less than 1% of training days, causing systematic underprediction of high-impact rainfall. Standard computer vision augmentation techniques such as rotations, flips, and random crops assume spatial invariance, but in climate data, spatial placement is physically meaningful. Rotating a sea-breeze convergence band or flipping a tropical rainband creates physically impossible configurations, rendering conventional augmentation invalid for geography-dependent extremes. This work investigates whether geography-aware generative augmentation can overcome the dual failure modes of extreme event prediction: intensity underprediction and incorrect spatial placement. We train a conditional Variational Autoencoder (cVAE) to learn the joint distribution of large-scale atmospheric forcing and high-resolution precipitation structure. The cVAE generates synthetic training samples for heavy-precipitation days by posterior sampling conditioned on real atmospheric inputs, preserving geographically consistent extreme placement. These samples augment training of a Super-Resolution Deep Residual Network (SRDRN) downscaling 100km GCM output to 4km PRISM observations over Florida (1981–2019). Evaluating eight augmentation strategies across P65–P99 thresholds, all universal methods—SMOTE, geometric transforms, CutMix, Mixup, amplitude scaling, Gaussian noise, and oversampling—achieved CSI ≤ 0.005 at P95, indistinguishable from no augmentation. The cVAE achieved CSI = 0.168 versus baseline 0.006, a 28-fold improvement with non-overlapping 95% bootstrap confidence intervals (p < 0.05); POD improved 33-fold (0.200 vs. 0.006) and P99 tail error decreased 28.5%. Critically, SMOTE produced the highest predicted maximum (177.7 mm/day) yet catastrophic detection skill (CSI = 0.0008), exposing a fundamental magnitude-placement decoupling: for Florida's geography-dependent extremes, correct spatial placement—not intensity generation—is the performance bottleneck. These results establish that universal methods fail not for statistical reasons but because they violate physical geography constraints, while the cVAE's conditioning on real atmospheric patterns preserves the land-sea geometry that governs where extremes occur. The framework generalizes to any geophysically constrained domain where spatial symmetry assumptions break down, including tropical cyclone tracks, wildfire spread, and coastal flooding. Ongoing work extends this approach to ERA5-to-4km downscaling, where phase-aligned forcing provides a rigorous test against a high-quality operational baseline.

20 - **Carlos Otero, "A Biophysical CA3–CA1 Microcircuit Model of Sharp-Wave Ripples in Primates"**

Sharp wave-ripples (SWRs) are synchronous local field potential (LFP) events in the hippocampus that are strongly implicated in memory processing. Although SWRs and their generating circuitry are well studied in rodents, comparatively few computational models address primate hippocampal anatomy, where neuronal morphologies and laminar organization differ substantially. Even fewer are biophysically realistic models with multi-compartment neuronal models that are essential in capturing certain properties of these SWRs. This gap limits mechanistic interpretation of primate SWRs and hinders direct comparison between simulations and primate neural recordings. Here, we present a biophysically realistic, primate-focused CA1 microcircuit model built in the Allen Institute's Brain Modeling Toolkit (BMTK). The model is organized as a layer-resolved CA1 column aligned to the hippocampal mantle and includes pyramidal cells (PCs, n = 800 cells) and parvalbumin-positive basket cells (PVBCs, n = 160 cells) as a minimal inhibitory motif for ripple-frequency synchronization. Pyramidal somata are positioned in stratum pyramidal, while interneurons are placed in appropriate CA1 laminar compartments to capture pathway-specific targeting of perisomatic and dendritic domains. Synaptic connectivity is implemented with biologically motivated rules that capture recurrent excitation, PVBC-mediated inhibition, and feedforward excitation consistent with CA3 to CA1 drive. To link circuit activity to measured signals, we simulate extracellular potentials from the network using a point-source approximation at virtual electrode sites. The resulting simulated LFP reproduces key SWR signatures, including the emergence of ripple-band activity during network synchrony and spectral structure consistent with SWR-filtered recordings. By providing a mechanistic, biophysically grounded model of primate CA1 circuitry that produces SWR-like extracellular dynamics, this framework enables controlled tests of how primate-specific morphology, laminar targeting, and inhibitory microcircuit interactions shape SWR expression, which aids in advancing circuit-level understanding of hippocampal memory processes in primates.

21 - **Michelle Pancier, "The AI Landscape in STEM: A Large-Scale Analysis of Generative AI Policies of STEM Courses Across Florida's State University System"**

The increasing ubiquity and transformative potential of generative artificial intelligence (AI) technologies has shifted the landscape of post-secondary STEM education. Instructors face the unprecedented challenge of deciding to what extent, if at all, students may use AI in their courses. To examine the rapid propagation of AI in higher education, we carried out a study within Florida's State University System (SUS) examining the explicit policies and sentiments regarding generative AI use, as articulated in the syllabi of STEM-designated undergraduate courses across six SUS institutions. We used web-scraping to collect institutional syllabi across publicly hosted syllabi platforms (n=3350), created a subset of syllabi that included AI-related search terms, and manually pruned the syllabi based on false-positives and redundancy, resulting in N=796 documents satisfying our search criteria. Syllabi were manually coded to assess factors such as the permissibility of AI, policy source and placement, and AI-adjacent applications in coursework. We found wide variability across institutions in the prevalence of AI-related policies in syllabi, ranging from 15% to 100% of syllabi within an institution including explicit policies. AI policies were usually included as a stand-alone section (82%), which were more likely to have more detailed breakdowns regarding the use of AI, as opposed to integrated within the broad academic integrity section (18%). Most syllabi contained restrictive policies that prohibit the use of AI (60%), with the rest of the cases permitting its use only under specific conditions. Not only did we find few faculty implementing AI policies throughout their courses across most institutions, but the analysis also found significant variation across the language deployed by the institutions, despite institutionally recommended policies for generative AI. Moreover, we found that referencing AI hallucination and the presence of an AI policy served as the classifications with the largest influence in the differences across faculty within institutions. This study serves as a foundation for providing guidance across institutions and centralized institutional systems in formulating policies that are consistent while allowing instructor flexibility.

22 - **Debabrata Paul, “Identifying Statistically Significant Motorcycle Crash Hotspots: A Geospatial Analysis of Urban and Rural Florida”**

Motorcycle crashes are a major traffic safety issue because they occur frequently and often result in severe outcomes. Despite their popularity as a mode of transportation and recreation, motorcycles exhibit crash rates 68% higher per vehicle-mile traveled than other vehicles, and the fatality rate for motorcyclists is over 24 times higher than that of passenger car occupants in the USA. To support proactive safety planning and data-informed resource prioritization- the strategic allocation of safety-related funds and interventions to the most crash prone locations, this study presents a spatial methodology for identifying and characterizing statistically significant motorcycle crash hotspots. These hotspots are defined as locations where high crash concentrations are unlikely to occur by random chance, i.e., hotspots with more than 90% confidence, across rural and urban regions in Florida. Four years of motorcycle crash data (2020–2023) from Signal4 Analytics were used to conduct geospatial analysis and identify high-risk locations. The Getis-Ord Gi* statistic was applied in ArcGIS Pro, using a context-specific buffer of 0.5 miles for rural and 0.25 miles for urban service areas to evaluate hotspot patterns in each geographic context. The analysis revealed notable differences in hotspot distribution and density, with urban areas showing higher crash clustering in densely populated counties and rural hotspots aligning with key corridors and arterial roadway segments. This research presents a replicable GIS-based framework to assist transportation agencies in targeting safety interventions and achieving the ultimate goal of zero fatalities on Florida’s roadways.

23 - **Pratik Poudel, “Neuro-Symbolic Architecture-Specific KV-Cache Eviction”**

Large-language-model (LLM) inference is heavily constrained by the Key–Value (KV) cache, whose memory usage grows linearly with sequence length and quickly becomes a deployment bottleneck. Existing cache-eviction strategies rely on fixed heuristics that assume stable attention patterns, yet empirical analysis across modern open-weight LLMs reveals substantial variability in how models allocate attention. These mismatches can degrade inference quality and reduce system efficiency. This work investigates the dynamics of attention-driven working sets that govern KV-cache utilization and develops an interpretable, model-aware eviction framework. We collect exhaustive attention traces from open-weight LLMs spanning 0.5B–72B parameters to quantify how attention mass concentrates over tokens and to measure architectural differences in sink and anchor behaviors. The analysis shows that attention working sets exhibit consistent linear scaling while displaying strong model-dependent variability. Using these traces as supervision, we train shallow decision-tree classifiers that map token-level cache features — including recency, cumulative attention, and positional relevance — to eviction decisions. The resulting trees form an explicit neurosymbolic policy: human-readable rules that encode architecture-specific cache-management strategies while retaining adaptability across models. Across multiple architectures, domains, and cache budgets, the learned policies reduce KV-cache size by more than 90% while preserving 92–96% of the perplexity achieved by a full, unrestricted cache. The interpretable rules reveal distinct architectural patterns, such as prefix protection, recent-attention dominance, and cumulative-history sensitivity. Compared with generic streaming baselines, the proposed policies consistently achieve lower perplexity, demonstrating that model-aware eviction improves inference fidelity. By bridging neural attention dynamics with transparent symbolic decision rules, this work offers a practical path toward memory-efficient LLM deployment. The approach enables substantial reductions in inference memory requirements without sacrificing predictive performance, supporting more accessible and resource-efficient use of large models.

24 - **Rahmina Rubaiat, "Concussion Detection Through Speech: A Deep Learning Approach"**

Statement of the Problem:
Sport-related concussions often produce subtle symptoms that may go undetected with traditional assessments. Speech alterations are a potential biomarker, but reliable, objective tools for speech-based concussion detection are limited.
Background:
Previous research with high school and college athletes has shown that specific speech tasks can reveal concussion-related deficits. Advances in machine learning and signal processing enable automated analysis of speech features, which may provide a scalable approach to concussion screening.
Methods:
Audio recordings were collected from concussed and control participants performing a standardized set of spoken words (e.g., education, participation). Features including mel spectrograms, zero crossing rate, Mel-frequency cepstral coefficients (MFCCs), chroma, and spectral contrast were extracted. Convolutional neural networks (CNNs) were trained separately on each feature set using stratified cross-validation. Model performance was evaluated using accuracy, precision, recall, and F1-score.
Results:
Across all features, classification accuracy exceeded 70%. Models based on MFCCs and mel spectrograms yielded the strongest performance, with balanced precision, recall, and F1-scores. Zero crossing rate and spectral features also achieved competitive results, indicating that multiple acoustic measures contain clinically relevant information for concussion detection.
Conclusions:
This study demonstrates that speech-based CNN models can distinguish concussed from control participants with promising accuracy. These findings support the feasibility of using automated speech analysis as a non-invasive, accessible tool for concussion screening. Further validation with larger cohorts may enable translation to clinical and sideline applications.

25 - **Hojat Allah Salehi, "CorBin-FL: A Differentially Private Federated Learning Mechanism Using Common Randomness"**

This research addresses critical privacy concerns in collaborative machine learning for sensitive domains including healthcare diagnostics, financial fraud detection, and smart transportation systems. By providing formal privacy guarantees, CorBin-FL enables institutions to collaborate and benefit from larger, more diverse datasets while ensuring that individual records are protected from exposure or reconstruction. The communication efficiency of our approach makes privacy-preserving federated learning practical for resource-constrained environments such as mobile devices and IoT networks. As federated learning adoption grows across industries, privacy mechanisms like CorBin-FL become essential for ensuring that collaborative AI development does not come at the cost of personal privacy, particularly for vulnerable populations whose data is used in training sensitive applications.

Federated learning (FL) has emerged as a promising framework for distributed machine learning. It enables collaborative learning among multiple clients, utilizing distributed data and computing resources. However, FL faces challenges in balancing privacy guarantees, communication efficiency, and overall model accuracy. In this work, we introduce CorBin-FL, a privacy mechanism that uses correlated binary stochastic quantization to achieve differential privacy while maintaining overall model accuracy. The approach uses secure multi-party computation techniques to enable clients to perform correlated quantization of their local model updates without compromising individual privacy. We provide theoretical analysis showing that CorBin-FL achieves parameter-level local differential privacy (PLDP), and that it asymptotically optimizes the privacy-utility trade-off between the mean square error utility measure and the PLDP privacy measure. We further propose AugCorBin-FL, an extension that, in addition to PLDP, achieves user-level and sample-level central differential privacy guarantees. For both mechanisms, we derive bounds on privacy parameters and mean squared error performance measures. Extensive experiments on MNIST and CIFAR10 datasets demonstrate that our mechanisms outperform existing differentially private FL mechanisms, including Gaussian and Laplacian mechanisms, in terms of model accuracy under equal PLDP privacy budgets.

26 - **Swodesh Sharma, "Securing the Synchrophasor: An ECDH Approach"**

The increasing reliance on Phasor Measurement Units (PMUs) for wide-area monitoring and control of power systems necessitates robust cybersecurity measures that do not impede real-time performance. This work presents the design and implementation of a Hardware-in-the-Loop (HIL) testbed for validating secure synchrophasor data communication. We integrate an Elliptic Curve Diffie-Hellman (ECDH) key exchange protocol to establish secure channels for transmitting synchrophasor data compliant with the IEEE C37.118 standard.

Unlike purely software-based simulations, our HIL testbed allows for realistic testing of the communication infrastructure under various simulated grid conditions and active cyber-attack scenarios. The study evaluates the trade-offs between cryptographic strength and communication latency. This work demonstrates the feasibility of using ECDH for lightweight, yet strong, encryption for time-critical power system applications, offering a blueprint for secure WAMS implementation.

Experimental results demonstrate the efficiency of the proposed architecture: the average handshake time for symmetric key generation was 65 ms. In terms of real-time performance, the total average latency per data frame was 16.827 ms, with the specific latency overhead attributed to encryption and integrity verification (AES encryption/decryption and HMAC generation/verification) amounting to only 0.065 ms per frame. While the security wrapper introduced a data overhead of 48.1% (increasing frame size from 108 bytes to 160 bytes), the minimal temporal impact confirms the approach's viability. This work demonstrates the feasibility of using ECDH for lightweight, yet strong, encryption for time-critical power system applications, offering a blueprint for secure WAMS implementation.

27 - **Somnath Somadder, “Real-Time Pressure Drop and Yield Stress Prediction in Non-Newtonian Kaolin Slurry Using an Experimentally Validated CFD-Machine Learning Framework: Application to Nuclear Waste Fluid Processing”**

Real-time and accurate estimation of pressure drop and yield stress in nuclear waste simulant slurries remains challenging due to their non-Newtonian behavior, which hinders precise flow prediction and operational control. Conventional viscometry techniques are limited to offline measurements and cannot support dynamic operational adjustments in nuclear waste slurry handling systems. This study introduces a novel, experimentally validated computational fluid dynamics–Machine Learning (CFD-ML) framework that enables fast, accurate, and inline prediction of slurry hydrodynamics in a closed-loop pipeline. The framework was evaluated using kaolin-based nuclear waste simulant slurries with specific gravities between 1.25 and 1.32 (≈32.3–39.1 wt%) and inlet velocities ranging from 1.77 to 4.81 $m \cdot s^{-1}$, representing a wide span of rheological behavior and practical flow conditions. Within this range, the CFD-predicted pressure drop agreed well with experimental measurements, with a maximum deviation below 3.1%, demonstrating the reliability of the model for non-Newtonian slurry transport. A Latin Hypercube–based CFD dataset trained ML models, with Polynomial Regression delivering superior performance (R^2 = 0.9993, MARE = 0.0068, training time = 0.07 s), enabling near-instantaneous predictions. The trained polynomial surrogate was subsequently used to derive an explicit constitutive expression relating pressure drop to flow velocity and slurry rheological properties. Beyond forward modeling, Bayesian Optimization showed the most consistent performance, with yield stress and plastic viscosity estimates exhibiting standard deviations of ≤0.2 Pa and $\leq 5\times10^{-4}$ Pa·s, respectively, across all test pressures. In comparison, the Jaya and Particle Swarm Optimization methods displayed noticeably higher variability, with standard deviations ranging from 0.7 to 1.8 Pa for yield stress and (0.8–2.1) $\times10^{-3}$ Pa·s for plastic viscosity. The proposed CFD–ML framework enhances the speed and accuracy of rheological property and pressure drop estimation, supporting real-time analysis of non-Newtonian slurry flow in pipeline systems.

28 - **Rony Thomas Murickan, “High Strain Rate Driven Phase Evolution and Deformation in Pristine Two-Dimensional Boron Nitride During Cold Spray Deposition”**

Two-dimensional (2D) materials such as boron nitride nanoplatelets (BNNPs) possess exceptional thermal stability, radiation shielding capability, corrosion resistance, and layered morphology, yet their use has been largely limited to reinforcement roles due to the lack of scalable deposition methods for producing thick, pristine coatings. High-temperature deposition methods such as chemical vapor deposition (CVD), physical vapor deposition (PVD), and thermal spray can degrade the intrinsic structure and functional properties of BNNPs and often rely on precursors or matrix reinforcements, limiting coating thickness and scalability. This work demonstrates cold spray as a solid-state, high-strain-rate processing pathway for consolidating micron-scale BNNPs (~7 µm) into ~237 µm thick coatings on aluminum using nitrogen gas at 500°C and 120 psi. Microstructural analysis revealed impact-induced platelet flattening, in-plane fragmentation, and needle-like features near the coating–substrate interface, indicative of severe deformation during particle impact. This deformation induced structural defects and turbostratic distortion while preserving the underlying hexagonal BN phase, enabling progressive coating buildup through solid-state bonding. By establishing the strain-rate-driven mechanisms governing deformation, defect formation, and consolidation of BNNPs, this work provides a scalable pathway for fabricating thick, binder-free 2D material coatings. These findings enable broader utilization of pristine BNNP coatings for thermal management, electrical insulation, radiation shielding, corrosion protection, and multifunctional surface engineering in advanced engineering systems.

29 - **A S M Shanawaz Uddin, “Will Coastal Marshes Experience Increasing Salinity Extremes? A Nonlinear LSTM-Based Modeling and Projection Framework under Multi-Scenario Sea-Level Rise”**

Salinity extremes are a major destabilizing factor in coastal marsh ecosystems, yet most predictive studies assume instantaneous salinity responses to water-level (WL) fluctuations and neglect short-term hydrodynamic memory and dispersive flushing processes. This simplification limits reliable projection of salinity hazards under accelerating sea-level rise (SLR). A clear research gap therefore exists in developing a dynamic, data-driven framework capable of capturing nonlinear salinity evolution while remaining robust for future scenario analysis. This study develops a Long Short-Term Memory (LSTM) deep learning model to simulate and project salinity dynamics using daily salinity and marsh water-level height data from multiple monitoring sites in Louisiana and Florida. The dataset consists of extended multi-day records obtained from the United States Geological Survey (USGS). Although calibrated using these regions, the framework is designed to be transferable to other vulnerable coastal cities. The LSTM architecture explicitly incorporates hydrological memory through (i) antecedent WL over the previous 48 hours, (ii) contemporaneous WL at prediction time, and (iii) a dispersive process-time variable representing post-inundation salt flushing. This structure captures both rapid salinity intrusion during elevated WL and delayed salinity decay driven by drainage and dispersion. Model validity was assessed using k-fold cross-validation, ensuring separation of training and independent test datasets. Performance metrics from unseen test data demonstrate strong predictive skill in reproducing daily salinity variability and extreme salt-stress events, confirming model generalizability and resistance to overfitting. Future projections were generated by applying multiple SLR scenarios consistent with the National Oceanic and Atmospheric Administration to progressively adjust WL conditions. Simulations across several 21st-century time horizons indicate nonlinear amplification in the frequency, duration, and clustering of high-salinity extremes under rising WL regimes. Overall, this statistically validated and physically interpretable LSTM-based framework provides a transferable tool for projecting salinity extremes in marsh systems and coastal cities worldwide where WL-driven salinity intrusion threatens long-term ecological resilience.

30 - **Medeba Uzzi, "Facile design of a robust cathode for Aqueous Zinc-ion Batteries"**

Aqueous Zinc-ion batteries (AZIBs) have emerged as viable supplements to Lithium ion batteries (LIBs) in the quest to satisfy growing energy demands. The state-of-the-art in cathode design for AZIBs involves complex syntheses. This research aimed at developing a simple and budget-friendly design for cathodes which are able to withstand multiple charge/discharge cycles with minimal degradation. The synthesis involved coating graphite substrates with a mixture of manganese dioxide and two types of conductive additives (copper and carbon black) in various proportions (10, 15 and 20%). Small quantities of carbon nanotubes (CNTs), polyvinylidene fluoride (PVDF) and 1-mehtyl-2-pyrrolidone (NMP) were added for improved conductivity, cohesion and homogeneity respectively. The synthesized cathodes were assessed for adhesion of the coating using the scratch test. Chemical durability and performance were assessed through Electrochemical Impedance Spectroscopy (EIS) performed on a two-electrode cell comprising a zinc anode and the prepared cathode in 0.5M aqueous zinc sulphate electrolyte. Analysis of the cell was conducted at current densities of 0.8 mA and 1.6 mA. Measurements of charge transfer resistance, capacitive resistance and diffusion rates were used to assess the state of health of the cells. The surfaces of the anode and cathode were characterized before and after electrochemical cycling utilizing optical profilometry, SEM/EDS and XRD.

Preliminary studies illustrate that cathodes containing 20% Cu additive presented the greatest cycling stability, structural integrity and most consistent charge transfer kinetics as observed by the minimal changes in the EIS spectra over 5 cycles, particularly in the mid and low frequency regions. These cathodes produced cells with the lowest charge transfer resistance and highest capacitance. Further, SEM analysis of the corresponding anodes revealed more uniformed microstructure for the cells operated at lower discharge/charge current densities implying more uniformed plating and lower susceptibility to dendrite growth. The insights gained from these electrochemical measurements and surface characterization studies will guide the rational design of AZIB cathodes with improved electrochemical performance and extended operational lifetime. This advancement represents a critical step towards developing durable, sustainable energy storage systems capable of meeting growing global energy demands.

31 - **Yonacary Wingard, “System-Level Structural Behavior and Constructability Effects in a Full-Scale Timber Structural Prototype”**

This research investigates system level structural behavior in a full scale light frame timber structural prototype subjected to wind driven loading demands representative of ASCE 7 design criteria. While conventional design procedures evaluate individual members and connections, global structural response is strongly influenced by diaphragm interaction, shear wall behavior, load path continuity, and constructability driven detailing decisions.

A two story timber structural system was analytically designed using Allowable Stress Design in accordance with ASCE 7, NDS, and SDPWS provisions. Wind pressures were evaluated in orthogonal directions, and governing shear, uplift, and overturning demands were quantified. Shear wall capacities, hold down forces, diaphragm shear transfer, and connection performance were assessed to establish demand to capacity ratios and system redundancy.

The prototype integrates roof trusses, floor diaphragms, wood structural panel shear walls, boundary members, and anchorage systems to ensure a continuous load path from roof to foundation. Analytical predictions of load distribution and stiffness behavior are evaluated alongside constructability constraints including connection stiffness, assembly sequencing, and fabrication tolerances.

The findings highlight the influence of detailing and construction decisions on load redistribution, torsional response, and serviceability performance. This research contributes insight into the limitations of simplified analytical assumptions and supports improved performance based design strategies for timber structural systems.

Health & Life Sciences

32 - **Rafiu Adebayo Adeyemo, "Field Validation of a Phormia regina (Diptera: Calliphoridae) Age Estimation Technique"**

The age of an insect associated with a corpse is often interpreted as a minimum time since death. This age estimate typically uses insect development rate data from artificial laboratory conditions and some mathematical or graphical prediction method. However, there has been little empirical validation of the accuracy of this extrapolation from lab conditions to the complex environment of a corpse in the field. We measured the performance of estimating the age of a larva of the forensically important blow fly P. regina in outdoor rat carcasses using a stage-based accumulated degree-hour (ADH) approach derived from laboratory development data on blended chicken liver at a constant temperature. P. regina eggs of known age were inoculated on eight thawed rat carcasses placed outdoors in Miami. Carcass temperature was recorded with data logger. These were control rats from which wild flies were excluded. Rats exposed to wild egg input are still being processed. All larvae were removed from each rat 72 hours after oviposition, and larval age was recorded as accumulated degree-hours, an index combining time and temperature for cold- blooded organism. 2,864 larvae were examined under the microscope to determine the stages of development through the number of spiracular slits. Predictions of specimen age based on life stage, as a 95% confidence set, included the true age for 95.9% of the larvae. These findings provide preliminary support for the practice of using laboratory growth studies in forensic entomology casework.

33 - **Nirbachita Islam Adrita, “Nitrated Hsp90 molecular control of tumor cell metabolism”**

(1) Problem Statement: Heat shock protein 90 (Hsp90) is a ubiquitous, highly conserved molecular chaperone that stabilizes and regulates a broad range of signaling proteins. We recently discover that nitration induces significant structural changes in Hsp90, conferring a new proliferative activity in schwannomas and glioblastoma (GBM), the deadliest brain tumor. Mechanistically, Hsp90 nitrated at tyrosine 56 (Hsp90NY56) activates the P2X7 receptor (P2X7R) signaling complex to boost glycolysis, while Hsp90 nitrated at tyrosine 33 (Hsp90NY33) associates with the outer mitochondrial membrane and decreases the electron transport chain activity. How these site-specific modifications reprogram Hsp90 function remains unknown. (2) Research Objectives: We hypothesize that site-specific nitration remodels Hsp90 interactome to promote tumor cell proliferation, altering P2X7R signaling complex composition when Hsp90 is nitrated at Y56, and assembling a regulatory mitochondrial complex when nitrated at Y33. (3) Research Methodology: Here, we leveraged GBM specimens and relevant cell culture models and applied a combination of complementary approaches to determine the composition of Hsp90NY33 and Hsp90NY56 regulatory complexes. We confirmed co-localization of Hsp90NY56 with P2X7R and of Hsp90NY33 with the mitochondria in GBM cell lines by confocal microscopy, and combining immunoprecipitation and blue-native PAGE in membrane-enriched tumor lysates together with surface plasmon resonance, we found that within the signaling complex, Hsp90NY56 indirectly interacts with P2X7R isoform B, the most abundant isoform in GBM. (4) Results/Conclusions: We are currently identifying the additional partners isolated from the complex. Moreover, immunoprecipitation followed by mass spectrometry analysis and infrared western blot identified proteins associated with Hsp90NY33 in the mitochondria, including the voltage-dependent anion channel 1 (VDAC1), which regulates ATP/ADP exchange, and hexokinase 2, a glycolytic enzyme that associates with and controls VDAC activity, which could explain Hsp90NY33 mitochondrial regulation. (5) Contribution/Significance: Additional proteomic and metabolic analyses are underway to validate these interactions in nervous system tumors, providing mechanistic insights critical for developing new therapeutic strategies against these relentless tumors. (6) Broader Impacts: Our findings highlight the significance of NY-Hsp90 in tumors and opens the possibility of targeting NY-Hsp90 and its interactome as a therapeutic strategy for nervous system tumors.

34 - **Mahnoor Ali, “A Pilot Multimodal Investigation of Manganese Exposure Associating Neuroimaging and Blood Biomarkers”**

Despite growing evidence on the association of chronic Mn exposure with neurotoxicity in occupational health, there remains a scarcity of studies integrating neuroimaging biomarkers with blood-based measures to characterize Mn-related brain changes. Existing research has largely relied on single-modality approaches, limiting insight into how systemic biomarkers correspond to region-specific alterations in brain structure and metabolism. The objective of this pilot study is to evaluate the feasibility and biological coherence of integrating blood-based biomarkers with MRI and PET derived imaging biomarkers in individuals with measured Mn exposure. This research project includes a nested pilot study of Mn-exposed ferroalloy workers (n=6) and age and sex-matched control workers (n=5), randomly selected from the PHIME (Public Health Impact of Metal Exposure) occupational cohort (n=400) of ferroalloy workers initiated in 1990 in the Province of Brescia, Northern Italy. In the longitudinal analysis, the study investigates the impact of occupational Mn exposure to brain beta-amyloid deposition, cognitive function, and blood-based biomarkers in the ferroalloy workers with a focus on genetic predisposition for Alzheimer’s disease (AD). In previous studies, plasma manganese levels analyzed using student’s t-test were significantly higher in the exposed group compared to controls (p= 0.027), confirming occupational exposure. Blood-based biomarkers (Aβ42, Aβ40, Aβ42/Aβ40 ratio, Total Tau, NfL, GFAP) were assessed using a linear regression model adjusted for age showed statistically not significant differences (p > 0.05), however the reduced Aβ42/Aβ40 ratio observed in the exposed group aligns with established markers of amyloid plaque burden in Alzheimer’s disease (AD). Protein microarray revealed significant differences (p < 0.05) in antibodies targeting neuronal and autoimmune proteins, including Aβ (25-35), GFAP, serotonin, NOVA1, and Siglec-1/CD169. LC-MS/MS-based pathway analyses revealed disruptions in olfactory signaling, mitochondrial fatty acid β-oxidation, biogenic amine synthesis, transmembrane transport, and choline metabolism in Mn exposed workers. PET imaging results analyzed using t-tests showed significantly more diffused beta-amyloid deposition in manganese-exposed workers compared to controls (p < 0.05). This study aims to utilize structural T1-weighted MRI to assess signal characteristics and morphometry in Mn-sensitive brain regions. Incorporation of functional MRI could also help examine resting-state network properties and regional functional patterns in relation to existing blood biomarkers.

35 - **Noble Amadi, “Neural Efficiency in Bilingual Preterm-Born Children During Executive Function Tasks: A Pilot fNIRS Study Using the Dimensional Change Card Sort Test”**

Problem Statement: Preterm-born children are at elevated risk for executive function (EF) impairments, particularly in cognitive flexibility. Although bilingualism is linked to EF advantages in term-born children, its neurocognitive impact in the preterm-born population remains underexplored.

Objectives: This pilot study investigated whether bilingualism enhances cognitive flexibility development in preterm-born children. Specifically, we examined behavioral performance and prefrontal cortical activation during the Dimensional Change Card Sort (DCCS) task, an established measure of cognitive flexibility, using functional near-infrared spectroscopy (fNIRS). We hypothesized that bilingual children would exhibit more efficient EF-related activity compared to monolingual children.

Methodology: Sixteen right-handed preterm-born children aged 6–7 years participated (7 monolingual, 9 bilingual). EF was assessed using the DCCS with three structured phases: Color sorting, Shape sorting, and the Border sorting conditions. Behaviorally we assessed the children on accuracy and speed (reaction time). Prefrontal hemodynamic activity was recorded using a NIRX Scout 16–24 fNIRS system. Raw fNIRS data were preprocessed by removing motion artifacts, followed by band limited filtering (0.02–0.8 Hz) to reduce physiological noise. The filtered optical signals were then converted to Δ[HbO] and Δ[HbR] via the Modified Beer–Lambert Law. For group-level comparisons, the frequency-domain features were extracted from the hemodynamic signals and used for between-group analysis across task phases. Channel-wise activation magnitude was quantified using the area under the curve (AUC) metrics, and significant group differences were summarized via ΔAUC (AUC_bilingual − AUC_monolingual) to determine which group exhibited higher cortical engagement by condition.

Results/Conclusions: Bilingual children showed significantly faster reaction times while maintaining accuracy levels comparable to monolinguals in completing DCCS tasks. fNIRS analysis revealed spatially localized between group differences across task conditions, with the Border condition demonstrating the greatest divergence. Across significant channels, bilingual children exhibited higher AUC values, particularly in Brodmann Areas 9, 10, and 44, regions associated with cognitive flexibility and prefrontal control.

Significance: Findings provide preliminary evidence that bilingualism may influence EF-related neural recruitment in preterm-born children. The results also support investigating bilingual exposure as a potentially modifiable factor to strengthen EF development and guide early interventions aimed at improving long term cognitive outcomes in preterm-born children.

36 - **Mehnaz Ashraf, “Spatiotemporal analysis of wetland degradation and land use changes in regions of California: A GIS based assessment”**

Wetlands are among the most diverse and productive ecosystems in the biosphere. They play a significant role in supporting biodiversity, regulating global hydrological cycle, acting as climate buBer and safeguarding human well-being (Bureau 2001. In fact, wetland ecosystem services have the highest value per ha of any ecosystem, accounting for 47% of the total value of any global ecosystem. Globally, wetland area ranges from 917 to 1275 million ha, representing about 6% of the Earth surface. Despite being the most productive ecosystems, wetlands remain one of the most threatened ecosystems. Since 1700, approximately 87% of global wetlands have been lost, with majority of deterioration occurring in the 20th and early 21st centuries. This study intended to analyze NLCD land cover data to assess land-cover changes aBecting wetlands across California region between 1990 and 2023. Comparative analysis was performed to identify trends and pattern of land cover change. Changes in area was calculated, and maps were generated to visualize changes. The findings indicate significant land cover transitions, particularly an increase in urban land cover by 21.4% and a decline in wetland area by 1.6%. Wetland encroachment was assessed using land-cover transition analysis which showed 858.42 ha area transitioned from wetland to urban, 3616.11ha from wetlands to agriculture. Spatial analysis revealed regional drivers of degradation with urbanization being the main driver in San Diego and Los Angles while agriculture in central valley region such as Fresno and Merced. The findings from this study indicate leading drivers of wetland loss hence emphasize the need for sustainable development strategies to mitigate future loss. Additionally, the study demonstrates the eBectiveness of GIS-based land-cover change analysis in supporting environmental monitoring.

37 - **Lucas Bertolami, “Generating GAA repeat instability surrounding the frataxin gene through the CRISPR guided gene-targeted demethylation of H3K27”**

Friedreich’s Ataxia (FRDA) is a genetic disease that has an incidence of 3-4:100,000 with muscle weakness, lack of muscle coordination, impaired speech, neurodegenerative symptoms, and cardiomyopathy. Currently there are no methods of curing the disease but only some methods to alleviate the disease symptoms. FRDA is caused by the silencing of the frataxin gene through heterochromatinization on the expanded GAA repeats, featuring high level of trimethylation of histone H3 lysine 27 (H3K27me3). Previous results from our group showed that the inhibition of H3K27 methyltransferases can promote GAA repeat instability, suggesting that it is possible for expanded GAA repeats to contract by modulating histone H3K27 methylation for FRDA treatment. We hypothesize that demethylation of H3K27 on the expanded GAA repeats at the frataxin gene can lead to instability via base excision repair (BER), serving as a target of GAA repeat contractions in FRDA. We developed a CRISPR/dCas9-mediated frataxin-targeted demethylation of H3K27me3 on the expanded GAA repeats in FRDA using lysine demethylases KDM6A and KDM6B. We expect that demethylation of H3K27me3 on the expanded GAA repeats can lead to the chromatin opening on the frataxin gene, allowing the recruitment of DNA BER enzymes to shorten the repeats. Our preliminary results showed that demethylation of H3K27me3 by KDM6B by targeting a specific flanking region of the expanded repeats stimulated GAA repeat expansion in FRDA neural cells, suggesting that H3K27me3 is necessary for preventing GAA repeat expansion by cooperating with DNA repair enzymes that can shorten the repeats at the frataxin gene. This research would open avenues into possible treatments for trinucleotide repeat expansion diseases, as currently given the genetic nature, none have any cure and instead only have ways of alleviating the symptoms. Although our research would not lead to the generation of a treatment directly it is important as it focuses on the understanding underlying the stability of the GAA repeats, if our research is successful it can be utilized to develop future treatments.

38 - **Alexandra Briceno, "Association Between Serum Triglycerides and Cognitive Performance in Midlife Latino Adults at Risk for Alzheimer's Disease"**

Problem Statement: Dyslipidemia, including elevated triglyceride levels, is associated with cognitive impairment and increased risk for Alzheimer's disease (AD). Vascular dysfunction has been proposed as one pathway through which dyslipidemia may contribute to cognitive decline. Despite this evidence, it remains unclear whether triglyceride levels relate to cognitive performance during midlife, a period when vascular and metabolic risk factors may influence later cognitive trajectories.

Objectives: This study examined the association between serum triglyceride values and cognitive performance across domains measured using the National Alzheimer's Coordinating Center (NACC) neuropsychological battery.

Methodology: This cross-sectional analysis was conducted within the ongoing Tri-Sleep Study at Florida International University. Analyses were limited to participants with available triglyceride values and completed cognitive testing (N=51 for most outcomes and N=49 for executive function accuracy). Triglyceride values were abstracted from medical records within one year prior to the study visit; abstraction is ongoing. Cognitive domains assessed included verbal memory, executive function, visuospatial memory and construction, and semantic fluency. Multiple linear regression models examined associations between triglycerides (mg/dL) and each cognitive domain, adjusting for age, sex, race, education, and income.

Results: The analytic sample had a median age of 53.1 years (IQR: 48.4, 55.7), was predominantly female (78%) and White (80%). Triglyceride concentration had a median of 97.0 mg/dL (IQR: 72.5, 131.5). Higher triglyceride levels were significantly associated with lower verbal memory performance, including immediate recall ($\beta = -0.023$; SE = 0.011; $p = 0.047$) and delayed recall ($\beta = -0.026$; SE = 0.011; $p = 0.029$). Triglycerides were also associated with poorer executive function, reflected by longer completion time ($\beta = 0.388$; SE = 0.056; p < 0.001) and fewer correct responses ($\beta = -0.0097$; SE = 0.002; p < 0.001).

Significance: These findings suggest that higher triglyceride levels in midlife may be associated with differences in memory and executive function among adults at risk for AD, highlighting the relevance of metabolic factors for cognitive health.

Broader Impacts: Because triglycerides are routinely collected in primary care, understanding their cognitive associations may inform earlier identification of adults who could benefit from prevention-focused monitoring. These results support continued investigation of modifiable lifestyle factors relevant to cardiometabolic and cognitive health.

39 - **Aliyou Moustapha Chandini, "Intersection between alcohol consumption, depressive symptoms and health-seeking behaviors among recent Latino immigrants in South Florida"**

Background: Latino immigrants, a growing part of the US population, experience a complex interaction between post-immigration stress, alcohol use, depressive symptoms, and healthcare utilization. Latino immigrants consistently report underutilisation of healthcare services, harmful alcohol use, and elevated depressive symptoms. This study examines the sociodemographic factors that influence the health-seeking behaviours and how alcohol use affects the relationship between depressive symptoms and health-seeking behaviours of recent Latino immigrants. Methods: A secondary data analysis was conducted using a dataset of recent Latino immigrants in South Florida collected between 2018 and 2022. The study included 540 participants using respondent-driven sampling. Trained research staff conducted surveys with participants using validated instruments that measured alcohol use (AUDIT), depressive symptoms (CES-D), and post-immigration stress (HIS-2). Multivariable logistic regression and moderation analyses were performed on the sample. Results: The mean age of participants was 27.46 years; 50% were female, 61% were employed, and 82% were documented. Most participants sought care from formal sources (69.9%). Depressive symptoms (odds ratio [OR] = 1.84, 95% confidence interval [CI]: 1.00–3.25) and perceived stress (OR = 1.01, 95% CI: 1.00–1.10) were associated with higher odds of seeking informal care. In contrast, participants with less than a high school education had lower odds of seeking informal care (OR = 0.52, 95% CI: 0.29–0.91). No interaction effect of alcohol use was observed in the relationship between depressive symptoms and health-seeking behaviour. Conclusions: In recent Latino immigrants, depressive symptoms and higher levels of perceived stress are significantly associated with higher odds of seeking informal care. Alcohol use did not moderate the relationship between depression and health-seeking behaviour. These findings highlight the central role psychosocial and socio-demographic factors play in shaping the health-seeking behaviours in this vulnerable population. Interventions aimed at improving health-seeking behaviours among recent Latino immigrants should prioritize early identification of depressive symptoms and post-migration stress while simultaneously strengthening enabling resources such as insurance coverage.

40 - **Rodica Charles, "Implementation of Patient-Preferred Music Intervention in the Adult Surgical ICU Patients Experiencing Pain"**

This research study evaluates a nurse-delivered, patient-preferred music intervention as a complementary strategy for pain management in adult surgical ICU patients who can self-report pain.

Problem Statement: Pain in the surgical ICU is often managed primarily with pharmacologic therapies, contributing to high opioid and sedative exposure and suboptimal patient experience. There is growing support for multimodal, nonpharmacologic interventions; however, evidence on the implementation and impact of structured, nurse-delivered patient-preferred music embedded in real-world ICU workflows remains limited.

Research Objectives: The primary objective is to integrate 20–30-minute, nurse-delivered patient-preferred music sessions (2–3 times daily) into the ICU pain management protocol and evaluate feasibility and staff adherence. Secondary objectives are to examine changes in pre- and post-session NRS pain scores, opioid and sedative use, patient and staff satisfaction, and barriers and facilitators to sustainable implementation.

Research Methodology: This is a prospective, single-arm research project using the PDSA framework in a 20-bed adult surgical ICU. Eligible participants are adults (≥18 years) able to self-report pain and expected to remain in the ICU for 48–72 hours. Nurses obtain informed consent, elicit music preferences, and deliver sessions using in-room internet-connected computers. Data include demographics, pre/post NRS pain scores, opioid/sedative doses from the EHR, session adherence via nurse checklists, and patient/staff surveys. Quantitative data are analyzed descriptively and with within-patient comparisons; qualitative feedback is thematically coded.

Results: It is anticipated that the intervention will be feasible to deliver with acceptable adherence, will produce modest reductions in pain scores and opioid/sedative exposure, and will be viewed as acceptable and beneficial by patients and staff. The study is expected to identify practical workflow and system barriers that must be addressed for routine use.

Significance: This project moves beyond efficacy trials to generate implementation-focused evidence on how to operationalize patient-preferred music as part of multimodal ICU pain management, guided by nursing leadership and interprofessional collaboration.

Broader Impacts: Findings can inform local policy and protocol changes, support scaling of music interventions across ICUs, and contribute to broader efforts to reduce opioid reliance, enhance patient-centered care, and embed low-cost, nonpharmacologic therapies into critical care practice.

41 - **Sreshtha Chowdhury, "Prediction of Toxicant Emission from E-Cigarette Puffing Behavior Using Machine Learning"**

Problem Statement: Electronic cigarettes (e-cigarettes) are the most prevalent nicotine product among young people in the United States and pose significant public health concerns. Beyond nicotine, e-cigarettes emit respiratory toxicants such as aldehydes. Measurement of these toxicants requires complex, resource-intensive laboratory methods. Therefore, there is growing interest in developing data-based approaches that can directly infer toxicant emissions from puffing or device-recorded data. Objective: To predict toxicant emission from e-cigarette puffing behavior. Methods: Data were collected from 193 e-cigarette users aged 21-35 years. Puffing behavior was recorded during ad libitum vaping sessions and played back using a puffing robot to quantify emissions of 13 aldehydes and total particulate matter (TPM). Supervised regression models, including ordinary least squares (OLS), lasso regression, random forest (RF), gradient boosting (XGBoost), support vector regression (SVR), and artificial neural networks (ANN), were trained to predict toxicant emissions from puffing parameters. Models were evaluated using an 80/20 train-test split with 200 bootstrap iterations, and performance was assessed using R^2, RMSE, and MAE. Results: The XGBoost model achieved good predictive accuracy (with minimal error) across all toxicants, consistently yielding R^2 values ≥ 0.4, with particularly strong performance for butyraldehyde ($R^2 = 0.76$), acetaldehyde ($R^2 = 0.72$), and TPM ($R^2 = 0.83$). In the models, inhaled volume, total puffs, nicotine concentration, flavor, and device type consistently showed superior performance in predicting emissions for most toxicants. Conclusions: Machine learning models can accurately predict e-cigarette toxicant emissions using puffing topography with important implications for regulatory science, tobacco product evaluation, and public health research on emerging tobacco products. Significance: Our study provides a proof-of-concept for integrating machine learning into regulatory science, offering an innovative tool for accurately estimating toxicant emissions from e-cigarette puffing data, thereby reducing reliance on resource-intensive laboratory playback analyses. Broader Impacts: Specifically, our models can facilitate population-level exposure assessments and guide product safety evaluations.

42 - **Inge Claassen, “Nitrated Hsp90 supports glioblastoma cell proliferation”**

Glioblastoma (GBM) is the most aggressive form of brain cancer. With no effective therapies, patients rely on a standard of care that has remained unchanged for over two decades. To address this therapeutic gap, it is crucial to identify novel mechanisms that drive GBM cell growth and can be selectively targeted. GBM arises in an oxidative environment where the potent oxidant peroxynitrite is produced and promotes protein tyrosine nitration (NY), an oxidative post-translational modification prevalent in diseased tissues but mostly absent in healthy cells. This disease-specific nitroproteome represents a unique opportunity to identify tumor-selective targets, yet its role in GBM has remained unclear. Using highly relevant primary GBM culture models and a platform we developed to interrogate the nitroproteome, we show that nitrated proteins promote GBM cell proliferation and identified the first nitrated protein with tumorigenic activity: nitrated Heat Shock Protein 90 (NY-Hsp90). Decreasing levels of nitration in GBM primary cultures and cell lines for 48 h using complementary methods significantly reduced cell viability. This decrease was not due to induction of apoptosis but to cell cycle arrest, implicating specific nitrated proteins as proliferative drivers. We recently demonstrated that selective nitration of Hsp90 at Y33 (Hsp90NY33) and Y56 (Hsp90NY56) induces structural changes that trigger a novel proliferative function. Advancing these findings to GBM, we detected endogenous Hsp90 nitration at both residues in tumors and culture models. Moreover, introducing Hsp90NY33 or Hsp90NY56 produced by genetic code expansion (GCE) either into astrocytes lacking detectable nitration or into GBM cells after reducing endogenous nitration was sufficient to trigger proliferation via a P2X7 receptor and intracellular calcium-mediated mechanism. Together, these results establish a direct proliferative role for NY-Hsp90 in GBM. Elucidating its mechanism could open the door to urgently needed therapeutic strategies for this devastating disease.

43 - **Michaela Clarke, “Quantification of Major Alkaloids in Kratom: A Comparative Study of Online, Smoke Shop, and Kratom Bar Products”**

Kratom (Mitragyna speciosa), a plant indigenous to Southeast Asia, has gained increasing popularity in the United States as an alternative to addictive substances. The plant contains more than 25 alkaloids, with mitragynine accounting for approximately 66% of the total alkaloid content and 7-hydroxymitragynine accounting for approximately 2%. [1] Ingesting doses below 5 g generally produces stimulant-like effects, while consumption of doses greater than 15 g has been associated with psychosis, seizures, and nausea. [2]

This study aims to quantify concentrations of mitragynine and 7-hydroxymitragynine across kratom products sold online, bars, and smoke shops. Samples included powders, teas, shots, gummies, and tinctures.

A method was developed using an Agilent 1290 UHPLC system coupled to a 6460 LC/QqQ/MS-MS with a Zorbax Eclipse Plus C18 column (3.0 x 50 mm, 1.8 mm) and a guard column, operated in positive electrospray ionization mode. The aqueous mobile phase consisted of 5 mM ammonium formate in 0.1% formic acid (A) and 0.1% formic acid in acetonitrile. The gradient was performed at 95% A for one minute and 5% B for six minutes. Mitragynine, 7-hydroxymitragynine, and corresponding deuterated samples of mitragynine and 7-hydroxymitragynine were purchased from Cayman Chemical. Powdered samples (10mg) were extracted in acidified acetonitrile to achieve a 1ppm concentration, while liquid formulations underwent a 666,000x dilution.

A calibration curve was created with concentrations ranging from 0.5 ppb to 100 ppb, spiked with 10 ppb of internal standard. The method achieved limits of detection (LOD) and quantification (LOQ) of 0.086 ng/mL and 0.26 ng/mL for mitragynine, and 0.036 ng/mL and 0.11 ng/mL for 7-hydroxymitragynine, respectively. In all analyzed samples across all retail avenues, 7-hydroxymitragynine concentrations remained below the LOD and the LOQ. Mitragynine concentrations varied by source: Rogue Rhino showed the highest levels among online products, Super K (23 ng/mL) led the smoke shop category, and Tec9 (Miami) had the highest concentration among samples from kratom bars.

Future work will include quantifying other alkaloids in kratom that exhibit similar psychoactive effects to 7-hydroxymitragynine and mitragynine from the samples used within this project.

44 - **Sagar Dahal, “Convention on International Trade in Endangered Species of Wild Fauna and Flora Implementation Status of Four Flagship Faunal Species of Nepal”**

Conservation Action Plans are developed and endorsed by government bodies and serve as the primary policy documents for systematic conservation practices to be conducted at the species level for a given time period. We developed a rule categorization framework to analyze the successes of conservation actions associated with the implementation of CITES for four flagship species: Bengal tiger (Panthera tigris), one-horned rhinoceros (Rhinoceros unicornis), Asian elephant (Elephas maximus), and snow leopard (Uncia uncia), in which Nepal has extensively invested for conservation. The specific objectives are to 1) assess the achievements of actions set for CITES implementation of the four species; and 2) investigate the proposed objectives and actions related to CITES implementation in the conservation action plans for these species. The newest conservation action plan for these four flagship species has reviewed the successes of conservation actions under “Achieved”, “Partially Achieved”, and “Not Initiated”. They also proposed conservation actions for the effective time periods. Only actions supporting CITES implementation were derived from these documents, and descriptive and inferential statistics were used to investigate the status of CITES implementation status for the four species. We found that CITES implementation is not uniform across species, and major hurdles include the need for commitments to international cooperation. Among the four species, the Asian elephant is doing satisfactorily under CITES, whereas the execution of the most actions is warranted for tiger suggesting the concerned authority to prioritize actions towards achieving CITES goals for the specific flagship species.

45 - **Sourav Das Gupta, “The Role of Caregiver Health on School Absenteeism: Findings from the 2023 National Survey of Children's Health”**

Background: School absenteeism is a vital indicator of child well-being and educational outcomes. Caregiver health may be an influential family-level factor influencing school attendance. This study aims to understand how caregiver physical and mental health may be associated with school absenteeism of children. Methods: Weighted data from the 2023 National Survey of Children’s Health was analyzed for children aged 6–17 years (n = 32,638) and their primary caregiver. Absenteeism was categorized as ≤10 versus >10 missed school days in a calendar year. Predictor variables included maternal and paternal physical health and maternal and paternal mental health, which were dichotomized as good versus poor. Covariates included child sex, race and children with special health care needs (CSHCN) status. Logistic regressions were conducted using complex sampling procedures to examine associations between caregiver health status and school absenteeism of children. Results: Overall, 5.8% of children missed ≥11 school days in the past year. After adjusting for covariates, children of caregivers reporting poor maternal physical health (AOR = 2.43, p = .003) and poor maternal mental health (AOR = 1.92, p = .009) were significantly associated with higher school absenteeism. Paternal physical and mental health were not statistically significant. Additionally, Children with special health care needs were nearly four times more likely to miss school >10 days (AOR = 3.70, p < .001) compared to non-CSHCN peers, while child sex and race were not associated with school absenteeism. Conclusions: School absenteeism is strongly associated with caregiver health, particularly maternal well-being. Findings highlight the need for policies and interventions that strengthen maternal health and provide targeted support for families with CSHCN to help mitigate absenteeism and improve child outcomes.

46 - **Matthew Dias, “Discovering Novel DNA Gyrase Poisons using A Unique Fluorescent-based High Throughput Screening Assay”**

Antimicrobial resistance (AMR) is a leading threat to global development and public health. WHO reported in 2023 that 1.3 million deaths were directly attributed to AMR infections. To address this crisis, the discovery of new classes of antibiotics is urgently needed. A ubiquitous target found in bacteria is DNA gyrase, an essential enzyme responsible for regulating and altering DNA topology through transient double-strand breaks. Fluoroquinolones (FQs), potent gyrase poisons, operate through a unique mechanism stabilizing the gyrase-DNA cleavage complex, effectively converting gyrase into an intracellular DNA-damaging enzyme. However, FQ resistance has become increasingly common, reducing the effectiveness of these antibiotics. Furthermore, all FQs carry FDA black box warnings due to potential severe side effects. Progress in identifying novel gyrase poisons from small-molecule libraries have been limited by the lack of efficient high-throughput screening (HTS) assays. In this study, a novel fluorescence-based HTS assay was developed to identify bacterial DNA gyrase poisons. Under high concentrations of gyrase and in the presence of poisons, multiple cleavage complexes form on circular plasmid DNA, leading to the generation of short linear DNA fragments. T5 exonuclease selectively digests these linear fragments while leaving supercoiled circular DNA intact. Upon addition of SYBR Green, samples containing gyrase poisons exhibit a significant reduction in fluorescence intensity. The HTS assay was miniaturized to a 1536-well plate format and validated using the LOPAC1280 library. Subsequently, a compound library comprising of 6,000 molecules was systematically screened, resulting in the identification of a novel lead compound, L-pyr-AMC. This methodology provides an innovative framework for the rapid discovery of gyrase poisons and may accelerate the development of new antibiotic classes to combat AMR.

47 - **Jessica Dominguez, "Carbazole Alkaloids as Secondary Metabolites from Citrus Endophyte Bacillus amyloliquefaciens"**

Carbazole alkaloids and their derivatives are well recognized for their diverse bioactivities and for their versatile molecular framework, which facilitates a wide range of applications. The Rutaceae family has long been regarded as the primary source of natural carbazole biosynthesis; however, it remains unclear to what extent associated endophytic microbes contribute to these compounds. Here, we report the isolation of an endophytic bacterium from a sweet orange (Citrus × sinensis) tree belonging to the family, Rutaceae, that was found to produce carbazoles under shake flask fermentation conditions. Two carbazole compounds, 1 methylcarbazole and 3 methylcarbazole, were identified by LC–MS, and based on 16S rRNA gene sequencing, the endophyte was identified as being most closely related to Bacillus amyloliquefaciens. To the best of our knowledge, this is the first report of a bacillus species biosynthesizing carbazole alkaloids. These findings are significant because they challenge the long held assumption that carbazole alkaloids in Rutaceae are solely plant derived and suggest that endophytic bacteria may be at least partly responsible for their production, raising fundamental questions about the true origins of carbazole biosynthesis. We consider possible scenarios for this phenomenon and discuss the broader implications for our understanding of the origins and evolution of plant associated secondary metabolites. This work further highlights endophytes as important and underrecognized sources of pharmaceutically relevant carbazole scaffolds.

48 - **Marie Dubois, "Foliar Phytohormones Restructure the Basil Rhizosphere Microbiome and its Functionality"**

The rhizosphere microbiome responds to plant physiological signals, but it remains unclear how foliar application of phytohormones indirectly reshape belowground bacterial and fungal communities and their functional potential. To determine whether foliar application of different types of phytohormones alters (i) rhizosphere bacterial (16S) and fungal (ITS) community diversity and composition and (ii) microbial metabolic activity, relative to corresponding controls. Basil (Ocimum basilicum) plants were treated with seven phytohormones: salicylic acid (SA), jasmonic acid (JA), abscisic acid (ABA), melatonin (MT), kinetin (KT), indole acetic acid (IAA), and gibberellic acid (GA). Rhizosphere bacterial (16S) and fungal (ITS) communities and microbial metabolic activity were assessed at harvest. Controls included water (WC), ethanol and water (EWC), KOH and water, and an untreated baseline soil control (CT). Hormone treatments produced treatment-specific restructuring of rhizosphere communities. Bacterial communities showed shifts in α-diversity and composition, including increased Nitrospira under JA and MT and reduced relative abundance of Bacillus under AA and GA. Fungal communities showed the strongest responses: ABA and MT increased fungal richness relative to controls, while KOH and CT showed reduced diversity. Key taxa shifted markedly Talaromyces declined under JA and MT, whereas Amesia–Chaetomium (absent/rare in controls) became dominant under multiple hormone treatments. Functional profiling aligned with these community patterns: MT and JA exhibited the highest microbial metabolic activity over time. Foliar phytohormone applications can indirectly but substantially modulate rhizosphere microbial structure and function, with marked effects on fungal communities and dominant taxa. These results support hormone mediated plant-microbe signaling as a potential strategy to steer rhizosphere microbiomes in agroecological systems, contributing to improved soil health and crop resilience.

49 - **Fatuma Felician, "Functional Evolution of Aromatase as a Framework for Understanding Cytochrome P450s Dynamics."**

Cytochromes P450 (CYPs) are membrane-bound, heme-containing monooxygenases that metabolize nearly 70% of clinical drugs in addition to essential endogenous substrates. Their broad substrate specificity underlies many clinically significant drug-drug interactions, yet the structural and dynamic principles that govern CYP selectivity remain poorly understood. To address this gap, we investigated the functional evolution of CYP19 (aromatase), a highly conserved CYP family member that catalyzes the conversion of androgens to estrogens and is a key therapeutic target in estrogen-dependent cancers. Owing to its narrow substrate specificity and deep evolutionary roots, aromatase provides a powerful system for dissecting CYP structure-function relationships. Using ancestral sequence reconstruction, nanodisc (ND) reconstitution, and synchrotron X-ray footprinting mass spectrometry (XFMS), we examined the biophysical and functional properties of an ancestrally reconstructed CYP19 enzyme. The ancient enzyme exhibits striking functional parallels to human CYP19A1 despite sharing only ~ 50% sequence identity. Ancestral enzyme substrate binding affinity is like the human enzyme but with significantly higher cooperativity. Both enzymes were catalytically active when reconstituted with cytochrome P450 reductase. Using XFMS, which reports on conformational changes vis-à-vis changes in solvent accessibility, indicated that substrate binding induces similar conformational changes in both the ancestral and human enzymes. In summary, these results support that function, and dynamics are evolutionarily conserved in aromatases. Furthermore, nanodisc-embedded ancestral CYP19 provides a tractable platform for dissecting CYP biophysics and dynamics, with implications for drug metabolism and the design of improved aromatase modulators.

50 - **Md Ariful Hoque, “New Two-Parameter Ridge Estimators for Improving the Linear Regression Model under Multicollinearity: Theory, Simulation, and Application”**

Multicollinearity among explanatory variables is a common issue in linear regression analysis and can severely compromise the stability, precision, and interpretability of regression coefficient estimates obtained using ordinary least squares (OLS). This problem is especially prevalent in biomedical and public health research, where predictors are often highly correlated. To address this limitation, biased estimation techniques such as ridge regression have been widely studied, and more recently, two-parameter ridge-type estimators have been proposed to further improve estimation performance.

This presentation introduces a newly developed two-parameter ridge estimator designed to enhance the accuracy and stability of regression coefficient estimates in the presence of multicollinearity. The proposed estimator is examined alongside existing two-parameter methods through a rigorous theoretical evaluation based on the mean squared error (MSE) criterion. Conditions under which the proposed estimator outperforms competing approaches are discussed.

To assess empirical performance, an extensive Monte Carlo simulation study is conducted under varying sample sizes, correlation structures, and error variances. The simulation results demonstrate that the proposed estimator consistently provides lower MSE, and more stable estimates compared to traditional OLS and several existing ridge-type estimators. Finally, the practical applicability of the method is illustrated using a real-world dataset, highlighting its usefulness in applied research settings.

Overall, this work contributes to the ongoing development of robust and efficient regression estimation techniques and provides practical tools for researchers dealing with multicollinearity in health and life sciences data.

Keywords: Ordinary least squares (OLS); Multicollinearity; New Two-parameter estimator; Mean squared error (MSE); Monte Carlo simulation; Shrinkage estimation; Real data application.

51 - **Ukesh Karki, “Self-Inhibited but Primed: Rethinking miRNA–AGO2 Loading via Computational Modeling”**

MicroRNAs (miRNAs) are critical post-transcriptional regulators of gene expression, primarily functioning through association with Argonaute proteins in the RNA-induced silencing complex (RISC). Canonical models depict miRNAs in an extended conformation spanning the PAZ to MID domains of AGO2, yet high-resolution AGO2–miRNA structures remain limited, restricting our structural understanding. Here, we aim to systematically investigate the conformational variability of AGO2-bound miRNAs across a broad set of human sequences, including both previously resolved and unresolved miRNA-AGO complexes. To achieve this, we leveraged AlphaFold3, an AI-based structural prediction tool, in combination with physics-based molecular dynamics simulations to map the landscape of miRNA–AGO2 interactions. Our analyses reveal a previously uncharacterized 'self-inhibited' hairpin conformation in which the 3′ end loops back toward the 5′ end, rather than occupying the PAZ domain. We further characterized the influence of nucleotide position and composition on miRNA folding, identifying sequence motifs that promote unconventional orientations. Such intramolecular folding may disrupt canonical RISC assembly, impairing gene-silencing function and potentially rendering both miRNA and AGO2 dysfunctional. If present in biological systems, this conformation could explain instances of erratic gene expression despite the presence of miRNAs, while highlighting alternative regulatory mechanisms that fine-tune post-transcriptional control. Overall, these findings expand our understanding of non-canonical miRNA behavior and suggest potential avenues for the rational design of miRNAs to modulate AGO2 function and develop more precise miRNA-based therapeutics.

52 - **Niloufar Khakpour, “Capillary Pericytes Regulate Local Cerebral Blood Flow: Insights from a Mathematical Model”**

Local cerebral blood flow is tightly regulated by an organized microcirculatory network that delivers oxygen and nutrients to neuronal tissue while dynamically adapting to changes in metabolic demand, blood pressure, and neuronal activity. This regulation is mediated by mural cells, including smooth muscle cells (SMCs) in parenchymal arterioles and pericytes (PCs) in capillaries. While arteriolar SMCs are well established as key drivers of myogenic autoregulation, the contribution of capillary PCs to cerebral blood flow regulation has not been thoroughly investigated. To address this gap, we developed an integrated multiscale mathematical model linking mural cell electrophysiology, intracellular Ca^{2+} dynamics, vessel wall biomechanics, and microvascular network hemodynamics. The model describes membrane potential and Ca^{2+} signaling in SMCs, PCs, and endothelial cells, incorporating major ion channels, pumps, and exchangers. A biomechanical formulation couples intracellular Ca^{2+} to active and passive wall stresses, enabling simulation of pressure-induced diameter changes. These cellular-scale models are embedded within reconstructed cortical microvascular networks to evaluate how local mural cell behavior influences tissue-level perfusion. At the single-cell level, simulations reproduced key experimental features of myogenic behavior, including pressure-induced depolarization, Ca^{2+} influx, and active constriction in both SMCs and PCs following an initial passive dilation. At the network scale, simulations predicted physiologically realistic distributions of pressure, flow, and hematocrit. Contractile PCs in proximal capillaries were essential for stabilizing perfusion across changes in inlet pressure and maintaining blood supply to deeper cortical layers, whereas loss of PCs tone led to flow redistribution and perfusion deficits consistent with cerebral small vessel disease.

53 - **Rovindra Lakenarine, “An observer-based assessment of Ray Bycatch in a tropical shrimp trawl fishery”**

Bycatch in shrimp trawl fisheries poses a significant threat to marine megafauna such as elasmobranchs, yet quantitative assessments remain limited in many regions, particularly in the Global South. Here, we quantified ray bycatch patterns and mortality dynamics in the Atlantic seabob (Xiphopenaeus kroyeri) trawl fishery in Guyana, South America. Using fisheries observer data collected from April 2024 to March 2025, we evaluated species bycatch composition, size-related mortality risk, and seasonal variation in total bycatch.

We used a generalized linear mixed model (GLMM) to assess the relationship between body length and a binary mortality indicator for each species separately, with Vessel ID as a random intercept. Mortality probability declined significantly with increasing disk width, indicating that smaller individuals were more vulnerable to bycatch mortality. A one-standard-deviation increase in disk width was associated with a 39% probability of post capture survival. Seasonal variation in bycatch was evaluated using a negative binomial generalized linear model (GLM) with fishing effort standardized by a log offset (rays per vessel/day). Although predicted ray bycatch was higher during the dry season, seasonal variation was not statistically significant.

These findings suggest that body size is a stronger driver of mortality risk in ray bycatch in this fishery. The predominance of smaller individuals among mortalities highlights potential population-level implications for ray assemblages in Guyanaâ€™s trawl fisheries and underscores the need for size-selective mitigation strategies to reduce bycatch impacts.

54 - **Aidan Lenzen, “Graph-Based Spectral Analysis of Tissue Architecture for Microsatellite Instability Prediction in Colorectal Adenocarcinoma”**

Microsatellite instability (MSI) determines immunotherapy eligibility in colorectal cancer, yet the molecular testing involved can be extremely costly in terms of time and finances. Approaches employing deep learning techniques predict the level of MSI from H&E (Hematoxylin and Eosin) histopathology, but rely on black-box CNNs (Convolutional Neural Networks) that ignore tissue spatial organization and cell-cell interactions that are fundamental to a complete understanding of tumor biology. We examine whether mathematical frameworks based on Laplacian operators provide interpretable biomarkers for MSI prediction in a superior manner compared to either traditional statistical analysis or the more opaque methods of machine learning. We hypothesize that spectral graph analysis captures tissue organization patterns correlating with MSI histopathology. We analyzed N=594 cases of colorectal adenocarcinoma from TCGA-COAD-READ with known MSI status. Whole-slide H&E images underwent automated cell segmentation via HoVer-Net and yielded spatial coordinates for inflammatory, stromal, and epithelial populations. Tissue-scale spatial graphs were constructed with the cells themselves being represented as nodes and edges based on spatial proximity. Use of the discrete Laplacian-Beltrami operator enabled shape analysis of glandular architecture. The graph Laplacian allowed us to model spatial interactions between cells. Analysis of graph eigenvalues revealed spatial cell clustering patterns that quantify tumor heterogeneity. We investigated spectral features against CNN-based methods like ResNet50 using standard classification metrics with rigorous data splitting. This work is ongoing and preliminary eigenvalue distributions have demonstrated distinct spectral signatures between MSI-high and MSI-low cases. Comparative metrics will be available when the results are finalized. This work lays the foundation for a mathematically rigorous and geometrically interpretable framework that aims to avoid the opaqueness of neural networks and statistical limitations, while providing clinically actionable MSI biomarkers rooted in tissue architecture. Spectral methods allow for transparency in pathologists' decision-making processes, can reduce the costs of molecular testing, and can be extended to other cancers, where spatial organization can predict therapeutic responses.

55 - **Ngan Ellie Linh, “Molecular evolution of ciprofloxacin-induced mutagenesis in E. coli”**

Antibiotic resistance is a global health concern, with mutation-driven resistance reducing the effectiveness of many antibiotics. Ciprofloxacin, a widely used antibiotics, inhibits and poisons bacterial DNA gyrase and topoisomerase IV, thereby disrupting DNA replication and transcription. It is a highly effective antibiotic used to treat a variety of bacterial infections, including those of the urinary tract, skin, bones, joints, and respiratory system. However, since its introduction, mutations have been reported in bacteria from patients treated with ciprofloxacin. These mutations typically occur in the quinolone resistance–determining regions (QRDRs) of the gyrA and parC genes, which encode DNA gyrase subunit A and topoisomerase IV subunit C, respectively. Ciprofloxacin also induces mutations in efflux pump regulatory genes. Interestingly, at high concentrations, ciprofloxacin can also induce mutations in RNA polymerase, such as in rpoB, the gene encoding the β-subunit of RNA polymerase in E. coli. The molecular mechanism underlying this phenomenon remains elusive. In this study, we induced resistance in E. coli by exposing cells to increasing concentrations of ciprofloxacin, with MIC up to 4 mM. DNA sequencing revealed systematic mutations: at low concentrations, mutations appeared in gyrA and parC; at intermediate concentrations, in efflux pump regulatory genes; and at high concentrations, in RNA polymerase genes. E. coli cells harboring RNA polymerase mutations grew very slowly. We hypothesize that these mutations significantly reduce the transcriptional speed of RNA polymerase, thereby decreasing transcription-coupled DNA supercoiling (TCDS). As a result, DNA gyrase, the primary target of ciprofloxacin, may no longer be required to remove positive supercoils generated ahead of RNA polymerase. This mechanism may explain why high concentrations of ciprofloxacin selectively induce mutations in RNA polymerase. Future biochemical and genetic experiments will test this hypothesis.

56 - **Ibis Tarini Lopez-Jimenez, "Context-dependent regulation of coral-macroalgae interactions: environmental thresholds and herbivory across heterogeneous reef environments"**

Coral reefs worldwide face unprecedented degradation from multiple interacting anthropogenic stressors, with competitive dynamics between corals and macroalgae representing critical determinants of ecosystem trajectory and resilience, yet how environmental gradients and herbivory jointly regulate these interactions remains poorly quantified. We conducted an 11-month observational field study across four fringing-reef sites on Culebra Island, Puerto Rico, spanning natural gradients in sedimentation, nutrients, seawater temperature, salinity, and Diadema antillarum density. Integrated benthic surveys, coral-macroalgae interaction assessments, and multivariate analyses showed patterns consistent with threshold-like responses: at sites with higher sedimentation (> 0.006 $g \cdot cm^{-2} \cdot day^{-1}$) we observed predominantly macroalgal-dominated communities regardless of herbivore density. Macroalgal functional identity significantly influenced outcomes, with fleshy macroalgae winning 74.2% of competitive interactions. Environmental parameters collectively explained 55.68% community variation, with sedimentation (17.7%), sea urchin density (16.9%), and salinity (16.4%) as primary structuring axes. Within-site patterns suggested effective herbivore regulation at favorable environmentally conditions, but at degraded sites environmental stressors can overwhelmed top-down herbivore control regardless of herbivory density. Although our four-site design limits definitive causal attribution between specific environmental variables and community outcomes, our findings provide quantitative benchmarks indicating that ecosystem resilience requires simultaneous environmental remediation and herbivore restoration. These results emphasize the importance of context-dependent management strategies that explicitly account for local environmental baselines when designing and prioritizing restoration interventions. Key words: coral-macroalgae interaction, phase shift, herbivory, Diadema antillarum, sedimentation, Caribbean reefs, ecosystem thresholds, marine conservation.

57 - **Ayesha M Imu, "Interaction of PFAS compounds with NCS proteins: Molecular targets for neurotoxicity"**

The calcium binding proteins play irreplaceable roles in maintaining cellular calcium homeostasis. Among these, the neuronal calcium sensor (NCS) family comprises EF-hand proteins predominantly expressed in neurons and retinal cells. Two proteins from different subclasses DREAM and NCS1 contribute to fine-tuning synaptic plasticity, neurotransmitter release, dopaminergic signaling, memory. These proteins are associated with a range of neurological diseases, including Alzheimer's disease, Parkinson's disease, Huntington's disorder, autism, bipolar disorder. Per- and polyfluoroalkyl substances (PFAS) like perfluorooctanoic acid (PFOA), are a broad class of synthetic chemicals renowned for their persistence and global distribution. Chronic PFAS exposure is connected to adverse neurological effects, such as developmental deficits (e.g., ADHD in children) and an increased risk of neurodegenerative diseases like Parkinson's and Alzheimer's in adults. The short-chain PFAS compounds like heptafluorobutyric acid (PFBA) was found to have similar impact although considered safer initially for its shorter biological half-life. However, the specific molecular targets of PFAS in the brain are not yet fully identified. DREAM and NCS1 undergo conformational rearrangements that expose hydrophobic patches necessary for engaging its protein partners and some small hydrophobic molecules. Our preliminary docking results indicate that both DREAM and NCS1 have at least two binding sites for PFOA and PFBA. The fluorescence emission of intrinsic tryptophan showed significant quenching, with Kd values of nanomolar range for Apo and Ca2+ bound DREAM and NCS1 in presence and absence of PFOA and PFBA. Nile red displacement studies for competitive binding of PFOA and PFBA also provided comparable dissociation constants in calcium-bound and apo states for both proteins. Analysis of frequency domain lifetime measurements also confirm more one binding site owing to different hydrophobicity of these environmental toxicants. We plan to use isothermal titration calorimetry and MD simulation to determine thermodynamic parameters and to explore the conformational dynamics of these protein complexes with these PFAS compounds. Overall, these approaches show NCS proteins can be the potential molecular targets for the PFAS compounds.

59 - **Amanda Martinez, “Estrogen-Linked Mitochondrial Dysregulation in Alzheimer's Disease: Investigating NRF1 as a sex-specific regulator”**

Alzheimer’s disease (AD) is the leading cause of dementia worldwide and disproportionately affects women, who comprise nearly two-thirds of diagnosed cases. Although increased longevity contributes to this disparity, female sex remains an independent risk factor for AD, implicating biological mechanisms beyond age alone. Converging clinical, neuroimaging, and molecular evidence suggests that the perimenopausal to menopausal transition represents a critical window during which AD-related pathophysiology accelerates in women, coinciding with a sharp decline in estrogen. Mitochondrial dysfunction is an early and central feature of AD pathogenesis, preceding hallmark amyloid-β and tau pathology. Impaired bioenergetics, increased oxidative stress, and disrupted mitochondrial quality control contribute directly to synaptic failure and neuronal loss. Estradiol exerts neuroprotective effects by supporting mitochondrial function, antioxidant defenses, and cerebral energy metabolism, yet the molecular mediators linking estrogen decline to mitochondrial dysfunction in AD remain incompletely defined. Nuclear Respiratory Factor 1 (NRF1) is a master transcriptional regulator of mitochondrial biogenesis and oxidative phosphorylation and is directly regulated by estrogen signaling, positioning it as a compelling candidate mediator linking estrogen loss to mitochondrial impairment in AD. In this study, we analyze single-nucleus RNA-sequencing data from the GEO dataset GSE222494, which includes sporadic AD, and cognitively normal controls. We apply Bayesian network modeling to infer probabilistic gene regulatory relationships, identify NRF1-centered mitochondrial subnetworks, and assess sex-specific differences in network structure across disease states. By integrating transcriptomic data with systems-level causal inference, this work aims to clarify the role of NRF1 in Alzheimer’s related mitochondrial dysregulation and to evaluate its potential as a therapeutic target.

60 - **German Mejia, “Stringent Response Induced by Serum Starvation and Acid Stress in H. pylori.”**

Helicobacter pylori, a microaerophilic, Gram-negative bacterium colonizes the surface of the human gastric epithelium and infects nearly 50% of the global population. Infection with H. pylori is associated with an increased risk of gastritis, peptic ulcers, and gastric cancer. To establish infection, H. pylori must withstand various environmental stressors within the stomach, including nutrient limitation and acidic conditions. These stressors have been shown to activate the stringent response, a global regulatory mechanism in H. pylori that is believed to be mediated solely by the spoT gene. SpoT catalyzes the synthesis of the alarmone molecules ppGpp and pppGpp, which modulate transcription by binding to RNA polymerase and altering gene expression. SpoT is also involved in the production of polyphosphate, a presumed messenger molecule regulating stress-related gene transcription and expression.

To investigate starvation- and acid-induced stringent response and the role of spoT in the stringent response, H. pylori wildtype and spoT mutant strains were grown under serum starvation (absence of fetal bovine serum, FBS) and under combined serum starvation and acid stress. Two genomewide experiments, RNA-seq experiments and azide-trimethylpsoralen sequencing (ATMP-seq), DNA supercoiling assays are used to investigate how serum starvation and combined serum starvation with acid stress affect H. pyroli genome wide transcription and modulate genomewide DNA supercoiling. Our results show that serum starvation, as well as the combination of serum starvation and acid stress, significantly alter the gene expression landscape and DNA supercoiling dynamics across the H. pylori genome. Transcriptome analysis also reveals the overexpression of several virulence factors, including flaA, flaB, katA (catalase), sodB (superoxide dismutase), and napA, during serum starvation. Under acid stress, additional upregulation of acid-response genes, such as those encoding urease components, is observed. Additionally, serum starvation and combined serum starvation with acid stress led to increased negative supercoiling of plasmid pHel3 compared to cells grown with FBS.

61 - **Santiago Moreno, "Dysregulated SP1 Transcriptional Activity Contributes to Loss of Protective Shear Response in PAH"**

Pulmonary arterial hypertension (PAH) is a progressive and life-threatening disease characterized by pulmonary vascular remodeling, endothelial dysfunction, and elevated pulmonary arterial pressure leading to right heart failure. A defining feature of PAH is the inability of pulmonary endothelial cells to appropriately sense and respond to hemodynamic shear stress. Under physiological laminar flow, endothelial cells activate a protective transcriptional program that promotes anti-inflammatory signaling, nitric oxide production, quiescence, and alignment in the direction of flow. Disruption of this mechano-transductive response contributes to vascular remodeling; however, the upstream transcriptional regulators governing shear-responsive gene networks in PAH remain poorly understood. We hypothesized that altered regulation of key transcription factors impairs shear-dependent endothelial adaptation in PAH.

Using weighted gene co-expression network analysis (WGCNA) of publicly available PAH transcriptomic datasets, we identified a significant reduction in SP1-associated gene expression modules in PAH samples compared to controls. Unsupervised clustering of canonical shear-responsive gene sets further distinguished PAH patients from healthy individuals, suggesting disrupted flow-mediated transcriptional signaling in disease.

To model endothelial shear responses in vitro, human pulmonary artery endothelial cells were cultured under physiological laminar flow using an Ibidi microfluidic system, with or without SP1 knockdown via siRNA. Under shear stress, control cells aligned in the direction of flow, whereas SP1-deficient cells exhibited complete loss of morphological alignment. SP1 silencing significantly reduced expression of KLF2 and KLF4 at both mRNA and protein levels, transcription factors essential for shear-induced endothelial adaptation. Importantly, KLF2 overexpression rescued the alignment defect following SP1 knockdown, demonstrating that SP1-dependent regulation of KLF2 is required for proper shear-induced morphological alignment to flow. RNA sequencing of SP1-deficient endothelial cells confirmed downregulation of key shear-responsive genes, including KLF4 and MEF2A, alongside impaired flow alignment.

Collectively, these findings identify SP1 as a critical upstream regulator of endothelial mechano-transduction and suggest that disruption of SP1-mediated shear signaling contributes to endothelial dysfunction and vascular remodeling in PAH. Ongoing studies will define the molecular mechanisms linking shear stress to SP1 activation and evaluate whether restoring SP1-dependent signaling can reestablish vascular homeostasis in PAH.

62 - **Milagros Munoz Salas, "Musa haekkinenii: Ecophysiological Implications of Light Intensity and Water Quality on a Newly Adapted High-Value Ornamental"**

Musa haekkinenii is an emerging ornamental species with potential for container production and urban landscaping; however, optimal cultivation guidelines under nursery conditions remain limited. This study evaluated the effects of light intensity and irrigation water quality on morphological and physiological performance, including stomatal anatomy, and substrate nutrient dynamics under greenhouse conditions. A 210-day factorial experiment was conducted using a split-plot design with two light regimes (full sun, 450 µmol m^{-2} s^{-1}; shade, 100 µmol m^{-2} s^{-1}) and two irrigation water qualities (reverse osmosis, EC 27 µS/cm; well water, EC 330 µS/cm). Uniform six-month-old plants were cultivated in 14-L containers filled with a peat–coir–bark substrate amended with controlled-release fertilizer. Morphological traits were recorded at 15, 30, 60, 90, 120, 150, 180, and 210 days after treatment (DAT) to assess structural and reproductive development. Physiological performance was evaluated using chlorophyll indices (SPAD and atLEAF), normalized difference vegetation index (NDVI), stomatal conductance, and electron transport rate. Stomatal density and size were quantified through epidermal microscopy, and theoretical maximum stomatal conductance was estimated from anatomical measurements. Leachate chemistry was monitored to assess nutrient leaching and substrate salinity. Data were analyzed using linear mixed-effects models, two-way ANOVA with Tukey post hoc comparisons, and principal component analysis. Plants grown under shade and irrigated with reverse osmosis water exhibited greater vegetative growth, enhanced chlorophyll status, and lower substrate salinity compared to plants grown in full sun with well water, which showed reduced growth and greater salt accumulation. Treatment-related variation in stomatal traits corresponded with differences in gas-exchange performance, indicating physiological acclimation to light and water quality conditions. These findings identify environmental management strategies that improve crop uniformity, physiological stability, and production sustainability of Musa haekkinenii under nursery conditions.

63 - **Rabeya Illyas Noon, “Synthesis Meta-Analysis Method: Origin, Methodological Development, and Application”**

Background: Synthesis analysis is an extension of meta-analysis designed to integrate information from studies with incomplete multivariable data. Unlike conventional meta-analytic approaches, synthesis analysis constructs multivariable regression models by combining univariate regression coefficients and pairwise correlations reported across independent studies. This approach enables the evaluation of consistency and robustness of statistical findings across diverse populations and settings, even when complete datasets are unavailable.

Objective: The objective of this study is to identify and evaluate the conceptual origins, methodological advancements, and applications of synthesis analysis through a scoping review within the statistical and public health literature.

Method: Eligible studies, such as peer-reviewed articles published in English between 2000 and 2025 that presented methodological innovations and applied examples relevant to a range of statistical outcomes were included. Searches were systematically conducted across major databases. Articles were excluded if they did not provide sufficient methodological detail for implementation or if their primary focus was not on the analysis of statistical models.

Results: A total number of 248 studies were identified. Among these, 7 studies met the inclusion criteria. The findings indicate that synthesis analysis offers a robust alternative to traditional meta-analysis when multivariable data are partially reported.

Conclusion: Synthesis analysis extension improves risk estimation and statistical power and reduces biases. Extending synthesis analysis to survival data is a novel meta-analytic approach that allows for a more comprehensive synthesis of public health studies.

64 - **Grace Obiyo, "Trophic interactions and dynamics of trace metal accumulation in North American river otters (Lontra canadensis) in Florida using stable isotopes as ecological tracers"**

North American river otters (Lontra canadensis) are semiaquatic predators occurring in both freshwater and estuarine habitats in North America, including in urbanized ecosystems. Due to their high metabolic rates, this species has the potential to represent an ideal model organism to further understand the dynamics of trace element accumulation in aquatic food webs, such as in fast-changing Florida waterways. Here, we examined the trophic interactions using stable carbon ($\delta 13C$) and nitrogen ($\delta 15N$) isotopes and trace metal accumulation of river otters around the Indian River Lagoon (IRL), Florida. Stable isotopes revealed the existence of two isotopic clusters, possibly indicative of freshwater vs estuarine foraging habitat preferences. In the population, $\delta 13C$ only predicted Se levels, while $\delta 15N$ showed a significant negative relationship with Hg, contrasting with expectations of biomagnification for upper trophic level consumers. Unexpectedly, females also accumulated significantly higher Pb and Cd than males. Age only predicted Cd accumulation, with concentrations increasing with age, while Se and Hg were not affected by age nor sex. Toxicity assessment using the Se:Hg molar ratio analysis indicated substantial variability in Hg exposure, with over 65% of sampled otters potentially experiencing Hg toxicity. These findings demonstrate the complex interactions between habitat use, trophic interactions, and biological traits in shaping trace metal bioaccumulation in aquatic predators such as river otters, underscoring their value as sentinel species for monitoring aquatic ecosystem health.

65 - **Mustapha Olatunji, “RNA Integrity in Modulating Genome Stability”**

RNAs are essential biomacromolecules responsible for protein translation and gene expression. They also play a crucial role in chromatin regulation and mediating DNA repair, including RNA-guided repair of DNA base damage to maintain normal cellular functions. However, RNAs are susceptible to genotoxicant-induced damage leading to cancer, Alzheimer’s, and Parkinson’s disease, among others. Yet, it remains unknown whether and how RNA integrity can alter DNA repair, modulating genome stability. To address this, we revealed the effects of oxidative RNA damage 8-oxoG and AP site on RNA-guided DNA synthesis on an RNA-DNA hybrid by human DNA polymerases and the underlying structural basis. We showed that 8-oxoG on an RNA template significantly reduced their fidelity by promoting incorrect nucleotide and ribonucleotide incorporation in DNA by pol β and pol η. An AP site on the RNA template eliminated pol □ DNA synthesis and promoted pol □ incorporation of dA opposite the AP site. We further demonstrated that the RNA 8-oxoG and AP site induced bending of the RNA-DNA hybrid substrate, disrupting the of fidelity of pol β and pol η by altering their substrate. Our results provide the first evidence that disruption of RNA integrity by RNA damage can alter genome integrity through RNA-guided DNA repair on R-loops. Our study will open a new avenue in revealing RNA integrity in modulating genome stability and regulating disease progression. This will provide solid basis for developing the next generation of novel strategies for effective RNA-based and gene-targeted disease therapy, diagnosis and prevention.

66 - **Florence Onifade, "Age-dependent transcriptional responses to Flock House Virus infection in Drosophila melanogaster"**

Problem Statement Aging is associated with altered immune function, yet the mechanisms by which age influences host responses to viral infection are not well understood. Drosophila melanogaster infected with Flock House Virus (FHV) provides a tractable system to examine age dependent host-virus interactions at the molecular level. Research Objectives This study aimed to characterize age- and time-dependent transcriptional responses to FHV infection in young and aged flies at early (24 hr) and late (120 hr) post-infection timepoints. Research Methodology: Young and aged flies were injected with FHV, with Tris-injected flies serving as injection controls. We generated virus-specialized ClickSeq and Poly A ClickSeq (PACseq) RNA libraries and analyzed both the viral RNA genome and the host transcriptomic response using established bioinformatics pipelines. Differential expression analyses were performed using an adjusted p-value threshold of 0.05 and $|\log2 \text{ fold change}| \geq 1$ to assess transcriptional differences across age and time conditions. Viral RNA abundance was also quantified. Primary statistical comparisons were performed within the matched experimental dataset (FHV vs Tris-injected controls). Non-injected controls from a separate cohort were incorporated for qualitative baseline context but were not included in formal differential expression testing. Results/Conclusions Preliminary analysis identified significant age and time-dependent transcriptional changes following FHV infection. Distinct gene expression profiles were observed between young and aged flies, particularly at 120 hours post-infection. Functional annotation of differentially expressed genes revealed biologically relevant pathway-level patterns, including genes associated with antiviral and RNA interference responses with additional trends emerging across age and time. Viral reads mapping to FHV genome increased over time and varied between age groups, suggesting differences in infection dynamics. Contribution/Significance This work provides insight into how aging shapes host transcriptional responses to viral infection and demonstrates the value of transcriptomic approaches for dissecting age- and time-dependent host-virus interactions in a collaborative research context. Broader Impacts Understanding age-associated differences in antiviral responses has broader implications for studies of immune decline and pathogen susceptibility. Additionally, this analysis informs the design of future molecular investigations within the broader project and contributes to training in transcriptomic analysis and critical evaluation of experimental design.

67 - **Kingshuk Panda, "A Conditional Tat-Responsive Dual-Guide CRISPR Platform for Infection-Selective Multi-Locus Editing of HIV Provirus"**

CRISPR-mediated excision of integrated HIV-1 proviral DNA is a promising therapeutic strategy. However, its clinical translation is hindered by off-target toxicity from constitutive Cas9 expression and rapid viral escape under single-site selective pressure. To overcome these barriers, we developed an HIV-inducible, dual-guide CRISPR-Cas9 antiviral platform designed for selective genome editing in infected cells and robust suppression of viral replication. The system is driven by a Tat-responsive HIV LTR–Hsp70 fusion promoter that activates transcription only during HIV infection, thereby minimizing off-target activity in uninfected cells. Using a Pol II–based expression cassette, we engineered a polycistronic construct encoding Cas9 and two guide RNAs targeting highly conserved regions of the HIV genome spanning envelope glycoprotein and reverse transcriptase/pol loci across both R5- and X4-tropic strains. The guides are separated by a cis-acting minizyme ribozyme that mediates precise transcript cleavage, generating functional individual gRNAs and enhancing guide stability and activity. Promoter mapping studies demonstrated strict Tat-dependent Cas9 expression and confirmed the requirement of NF-κB elements for inducible transcription without significant leakiness. In vitro validation in HIV-infected HeLa-CD4 and CEM T-cell models showed that single-plasmid delivery of the dual-gRNA CRISPR system resulted in strong and sustained suppression of viral replication, as measured by p24 antigen output. Comparable suppression was validated in X4-infected primary $CD4^+$ T cells and R5-infected THP-1–derived macrophages. No significant cytotoxicity was detected. This inducible dual-CRISPR architecture increases targeting efficiency, reduces the likelihood of viral escape, and enables infection-restricted genome editing, representing a next-generation, precision gene-therapy strategy for durable HIV suppression.

68 - **Sepideh Rezaei, "Synthesizing supercoiled circular DNA molecules in vitro"**

Supercoiled (Sc) circular DNA molecules, such as plasmids, are fundamental tools in molecular biology and biotechnology, and have been explored for therapeutic use since the 1990s. However, conventional plasmids are produced in Escherichia coli, where they acquire bacterial-specific DNA methylations, including 6-methyladenine (6mA) at Dam sites and 5-methylcytosine (5mC) at Dcm sites. In addition, they carry unnecessary bacterial sequences such as replication origins and antibiotic resistance genes, and are often contaminated with genomic DNA, RNA, endotoxins, and antibiotics. Since humans lack enzymes to remove these bacterial modifications, E. coli-derived plasmids may trigger immune responses, reduce transfection efficiency, and pose safety concerns in clinical applications. Therefore, there is an urgent need for unmodified, bacteria-free Sc circular DNA molecules that are high-purity, sequence-defined, and clinically safe. In this study, we have developed two novel in vitro biochemical methods to synthesize unmodified Sc circular DNA entirely without the use of bacteria. First, linear DNA containing two loxP sites in the same orientation is generated by PCR or rolling circle amplification (RCA) using Φ29 DNA polymerase. Cre recombinase then converts the linear DNA into relaxed (Rx) circular DNA. T5 exonuclease is employed to selectively digest any remaining linear DNA molecules. Finally, DNA topoisomerases efficiently convert the Rx circular DNA into the desired Sc form. Using these methods, we produced several unmodified Sc circular DNA molecules ranging from 196 bp to several kilobases, including EGFP-FL, a 2,002 bp minicircle encoding only the essential elements for EGFP expression. Remarkably, Sc EGFP-FL demonstrated significantly higher transfection efficiency in both human HeLa and mouse C2C12 myoblast cells compared to standard E. coli-derived plasmids. These in vitro–synthesized Sc DNA molecules are completely free of bacterial methylations, unwanted sequences, and contaminants, and can be produced in scalable quantities (micrograms to grams). Together, our work establishes a versatile, high-purity, and clinically compatible platform for DNA vaccines, gene therapy, and advanced biochemical and biophysical research.

69 - **Simanta Roy, "Predicting Nicotine Exposure from E-cigarette: A Machine Learning Approach Incorporating Device, Aerosol, and Clinical Data"**

Importance: As e-cigarette use continues to rise globally, the need for reliable and scalable methods to quantify nicotine exposure in young e-cigarette users has become more crucial. Objective: This study aims to develop supervised machine learning (ML) models that predict nicotine emission and plasma nicotine levels based on puff topography, personal and device characteristics, and e-liquid consumption. Main Outcomes and Measures: This study analyzed 259 measurements from e-cigarette users aged 21-35 years by combining human puff topography data with laboratory toxicant emission tests generated through validated playback procedures. Puffing behavior was recorded during ad libitum vaping sessions and replicated with a puffing robot (playback) to measure nicotine emissions. Plasma nicotine levels were determined via liquid chromatography-mass spectrometry. Six supervised regression models, including ordinary least squares, lasso, random forest, XGBoost, support vector regression, and neural networks, were trained to predict nicotine emissions and plasma nicotine from puffing parameters. The models were evaluated using an 80/20 train, test split with bootstrap resampling over 200 iterations, with performance metrics assessed by R^2, RMSE, and MAE. Results: Among the ML methods evaluated, XGBoost consistently demonstrated the best performance (highest R^2, minimal RMSE, and MAE) for predicting both nicotine emissions and plasma nicotine levels. For nicotine emission prediction, XGBoost achieved the highest accuracy using either puff number ($R^2 = 0.778 \pm 0.153$) or liquid consumption ($R^2 = 0.747 \pm 0.149$) in combination with average puff duration and device characteristics (nicotine concentration and device). Using these emission estimates together with individual characteristics (age, sex, height, and weight), XGBoost-based plasma nicotine models showed the best explanatory performances for both puff-based ($R^2 = 0.613 \pm 0.174$) and liquid-consumption-based ($R^2 = 0.699 \pm 0.168$) predictors. Conclusions and Relevance: This study shows that ML methods can effectively estimate nicotine emissions and plasma nicotine exposure directly from puffing behavior and device features. These models can support product regulation, assess addiction risk, and facilitate population-level surveillance.

70 - **Sutirtha Sengupta, “Modulation of GAA repeat instability via CRISPR/dCas9-mediated frataxin-targeted histone demethylation in Friedreich's ataxia”**

Friedreich’s ataxia (FRDA) is genetic neurodegenerative disorder caused by GAA repeat expansion within intron 1 of the frataxin (FXN) gene manifested by FXN gene silencing. Deficiency of the FXN expression causes mitochondrial dysfunction, oxidative stress, and massive oxidative DNA damage in FRDA. Currently, no cure is available for FRDA due to the inherited expanded GAA repeats in patient’s genome. Studies from our group have shown that DNA base excision repair (BER) pathway can interplay with the inhibition of histone methylation to contract the expanded GAA repeats by removing DNA damage in FRDA cells and mice. We further hypothesize that FXN gene-targeted histone demethylation can interplay with BER to contract the expanded GAA repeats at the FXN gene in FRDA neural cells. To test this hypothesis, we developed frataxin gene-targeted CRISPR/dCas9-mediated H3K9 demethylation systems using dCas9- histone H3K9 demethylase KDM4D fusion protein with five different guide RNAs that target various regions surround the expanded GAA repeats. We showed that dCas9-KDM4D fusion protein located at 316 bp (guideRNA1) and 55 bp (guideRNA3) at the upstream of the expanded GAA repeats and 296 bp (guideRNA6) downstream of the repeats promoted GAA repeat contraction at the FXN gene in FRDA neural cells. Our results indicated that FXN-gene targeted histone H3K9 demethylation led to GAA repeat contraction in a histone demethylase location-dependent manner. Our study provides the first evidence that the FXN gene locus-specific epigenetic editing can modulate GAA repeat stability FRDA, opening a novel avenue for gene therapy of trinucleotide repeat expansion neurological diseases.

71 - **Azam Shirali, “BiMba: Predicting Protein Binding Sites using Vision Mamba”**

Accurately identifying protein binding sites is a central challenge in structural biology. Binding sites on protein surfaces, consisting of groups of residues, govern how proteins recognize and interact with their partners; therefore, identifying them is essential for understanding biological function and for guiding the design of effective drugs and biomolecules. Despite major progress in computational approaches, their performance remains limited because most models underrepresent the combined influence of surface properties and residue-level information, leaving room for improvement. Here, we introduce BiMba (Protein Binding site prediction using Vision Mamba), a state-space–driven deep learning framework that leverages the efficient long-range modeling capability of the Vision Mamba (ViM) architecture to learn from 3D protein surfaces represented as 2D physicochemical grids. BiMba integrates multiple complementary sources of information, capturing both geometric and physicochemical determinants of molecular recognition into surface patches, which are encoded into 2D images after adding additional residue-level descriptors such as polarity and secondary structure, yielding a unified representation that couples spatial topology with biochemical context. BiMba demonstrates superior performance across diverse and specialized benchmark datasets, surpassing existing state-of-the-art methods. In addition, BiMba incorporates perturbation-based and gradient-based interpretability analyses by extracting hidden attentions from Mamba layers, enabling visualization of feature relevance and biologically meaningful residue clusters. Overall, our findings establish state-space models as efficient, interpretable, and scalable architectures for molecular surface learning, advancing the application of deep learning in structural bioinformatics.

72 - **Vaishnavi Sundar, “Exploratory Analysis of Nasal Microbiome Diversity and Manganese Exposure in Adolescents and Ferroalloy Workers”**

Environmental neurotoxicants can affect human health through the nasal-brain axis, highlighting this pathway as a priority in occupational and public health research. Manganese (Mn), a known neurotoxicant is released during ferro-alloy production and mining due to the increasing needs for EV batteries, has been associated with adverse neurological outcomes following chronic inhalation exposure. The nasal microbiome is a key interface along the nose-brain axis and may influence neurotoxicant entry through the olfactory pathway. However, the relationship between Mn exposure and nasal microbiome communities remains poorly understood. We hypothesize that Mn exposure may alter nasal microbial structure, potentially serving as a neurotoxicity precursor.

We examined nasal microbiome diversity among adolescents ($n = 42$) and ferro-alloy workers ($n = 5$) living and/or working in Mn-impacted areas in the province of Brescia, Northern Italy. Study areas were categorized by exposure intensity: Garda Lake (GL, low exposure), Bagnolo Mella (BM, active/moderate exposure), and Valcamonica (VC, historical/cumulative exposure) and workers as high exposure control. Following 16S rRNA sequencing and data normalization to 377 features, statistical analyses were performed using MicrobiomeAnalyst. Alpha diversity was assessed via Chao1 and Shannon indices to measure richness and evenness, respectively, with significance determined through ANOVA and pairwise T-tests ($p < 0.05$). Beta diversity profiling used Bray-Curtis dissimilarity visualized through PCoA with PERMANOVA to confirm community clustering by exposure profile ($p < 0.05$).

Alpha diversity analyses suggested differences in microbial richness by sex and Mn exposure. Richness differed between males and females (Chao1, $p = 0.03$), whereas microbial evenness was comparable across groups. Richness also differed between moderate (BM) and high (VC) Mn exposure zones (Chao1, $p = 0.04$), consistent with a possible threshold-dependent association. Beta diversity analyses demonstrated variation in overall community composition by sex and exposure category (PERMANOVA, $p < 0.05$). These exploratory findings suggest that Mn exposure, alongside host biological factors, may be associated with nasal microbiome diversity and composition. Further analyses are warranted to identify specific taxa, evaluate functional relevance, and clarify implications for neurological health.

73 - **Mayra Tabares, "Evaluation of brevetoxin on neural proteomic profile and the effects of mercaptan-based cysteamine derivatives on brevetoxin binding and induced muscle cytotoxicity."**

Brevetoxins (PbTx), neurotoxins produced by K. brevis that bloom during red tide events, can cause marine mammal poisoning, mortalities, and deaths of fish, sea birds, and turtles and exhibit adverse human health effects. Brevetoxins can bind to the voltage-gated sodium channel (VGSC) and inhibit thioredoxin reductase (TrxR), a major regulator of cellular redox homeostasis. Currently, no treatments are available for the neurotoxic or respiratory effects of brevetoxins on wildlife or humans. Synthesis and evaluation of mercaptans as potential "antitoxins", based on the hydrophilic FDA-approved acrolein scavenger, cysteamine, that may react with and thereby detoxify PbTx-2 were studied and IC50 of PbTx-2 was determined to further understand how PbTx-2 can alter human neural proteomic profiles. Sulfonamides and amide derivatives were prepared and characterized by HRMS, 1H, and 13C NMR. Calculated LogP of thiols were determined and reactivity with PbTx-2 was assessed using FT-ICR-MS. LogP exhibited an increase in lipophilicity of cysteamine derivatives compared with cysteamine and monosubstituted and disubstituted PbTx-2 adducts were detected in most of the reactions tested. To assess their ability to act as potential PbTx-2 "antitoxins", fluorescent receptor binding (RBA) and cytotoxicity assays were performed. Some cysteamine derivatives exhibited a reduction of PbTx-2 binding affinity on RBA, showing some level of "antitoxin" properties. PbTx-2 modified with aromatic sulfonamides containing inductive electron donating (-CH3) and resonance electron withdrawing (-NO2) groups showed to be more effective in comparison to branched aliphatic or resonance electron donating (-OCH3) groups. Despite lower PbTx-2 binding, cytotoxicity revealed a decrease in SJCRH30 cell survival upon brevetoxin-cysteamine derivatives exposure, contrary to the expected reduction in toxicity due to lower binding, suggesting an interplay with additional PbTx-2 biological targets that could influence cellular response. Furthermore, PbTx-2 IC50 on neural cells was determined to be 1.7 µM to guide dose selection for proteomic studies. Our research shows that PbTx-2 conjugation with mercaptans could interfere with VGSC binding, but that enhanced cytotoxicity may not be the sole mechanism, suggesting additional pathways are involved, which provides insights to develop therapeutic strategies and identify biomarkers to detect and reduce marine animal mortality and human health problems caused by red tide blooms.

74 - **Eman Taher, "Targeting Florida red tide: Curcumin inhibits Karenia brevis thioredoxin reductase"**

Recurring blooms of the Florida red tide dinoflagellate Karenia brevis, a type of harmful algal bloom (HAB), result in adverse economic, environmental, and public health outcomes. These effects have been largely attributed to the production of a suite of neurotoxins known as the brevetoxins. Recent studies have shown that curcumin, a naturally occurring polyphenol known for its redox-modulating and anticancer effects, can significantly decrease both K. brevis cell counts and brevetoxin concentrations. However, its molecular target remained unknown. In this study, we identified K. brevis thioredoxin reductase (KbTrxR), a key regulator of cellular redox homeostasis, as a direct target of curcumin. Enzyme inhibition assays using 5,5'-Dithiobis (2-nitrobenzoic acid) (DTNB) as a substrate revealed time-dependent inhibition of the KbTrxR by curcumin, with an IC50 of 3.0 µM, approximately 20-fold more potent than PbTx-2. The enzyme inhibition was also observed when using hydrogen peroxide as a substrate, confirming curcumin's broad inhibitory effects on KbTrxR redox activity. LC-MS/MS analysis revealed covalent adduction of curcumin to Cys53, a catalytic residue at the N-terminal redox center of KbTrxR, through a likely Michael addition reaction, converting KbTrxR into a prooxidant. This represents the first report of curcumin targeting the N-terminal Cys of TrxR. These findings provide new insights into the redox-disruptive mechanism of KbTrxR by curcumin, supporting its potential as a naturally derived inhibitor relevant to HAB mitigation strategies.

75 - **Carlos Tapia, "Economic Burden of Toxic Invasive Plant Management Across Florida's Counties"**

Invasive species pose escalating ecological and economic challenges by degrading ecosystem services, threatening public health, and imposing substantial management costs. Many toxic plants—often introduced through ornamental pathways—rapidly spread across Florida's native ecosystems. This study provides an ecological economic assessment of the statewide financial burden of managing six toxic invasive plant species: Rosary Pea, Golden Dewdrop, Flame Lily, Chinaberry, Oleander, and Castor Bean.

Using georeferenced, citizens-supported iNaturalist database, we conducted a risk analysis incorporating thirteen ecological and social parameters, including proximity to transportation corridors, parks, and water bodies. A Varimax rotated factor analysis produced composite invasion risk scores, which were combined with species density estimates to model county level chemical and mechanical control costs.

We estimate a statewide management cost of $1.79 billion, with the highest expenditures concentrated in rapidly urbanizing coastal counties in Central and South Florida. Oleander represented the largest share of projected costs. Rural counties in North Florida showed lower estimated expenditures.

By quantifying these economic burdens, the study advances natural capital accounting and ecological risk modeling, identifies priorities for rapid response, and supports more cost effective and preventive invasive species management within an ecological economics framework.

76 - **Ayodele Tyndall, "The Association between Serum Cholesterol Measures and Domains of Cognitive Function in Midlife Latino Adults at Risk for AD"**

Problem Statement: Lipids are essential for cognitive function and constitute a large part of the brain. However, dysregulation of lipid metabolism increases the risk of developing Alzheimer's disease (AD), linked to high levels of low-density lipoprotein cholesterol (LDL-C), high total cholesterol (TC), and low levels of high-density lipoprotein cholesterol (HDL-C) in midlife. Few studies have examined lipids and cognitive function in midlife Latino populations.

Objective: This study examines the association between cholesterol measures and cognitive function in midlife Latino adults at risk for AD.

Methods: This study cross-sectionally examines baseline data from 40–60-year-old adults at risk for AD based on first-degree relatives diagnosed with AD. Participants are enrolled in the Tri-Sleep Study in South Florida. Demographics questionnaires on age, race, sex, income, and education were completed. The National Alzheimer's Disease Coordinating Center (NACC) neurophysiological battery assessed cognitive domains: attention, speed of processing, visuospatial, executive function, verbal episodic memory, and language. With the participants' permission, LDL-C, HDL-C, and TC lab results were collected from medical records. A linear regression, adjusted for age, sex, race, education, and income, examined the relationship between cholesterol measures and cognitive performance.

Results: In the sample, the median (IQR) age of the participants was 53(48-55) years, and 80% were White. Data were available for 51 participants for TC, 49 for HDL-C, and 50 for LDL-C. In an adjusted linear regression model, verbal episodic memory was significantly associated with TC (β= 0.038, 95% CI: 0.004, 0.073, p = 0.030) and LDL-C (β= 0.042, 95% CI: 0.003,0.080, p= 0.034). Higher HDL-C levels were significantly associated with better processing speed (β= 0.019, 95% CI: 0.004,0.034, p= 0.014).

Significance: Higher TC and LDL-C were associated with better verbal memory performance, while higher HDL-C was linked to stronger processing speed. These results are inconsistent with the literature, as lower levels of TC and LDL-C benefit midlife cognitive performance. However, these findings underscore the complex role of cholesterol in cognitive function and the need to clarify which levels promote optimal cognitive health.

Broader Impact: Future studies may examine cholesterol threshold levels needed to maintain healthy cognitive performance and aging to prevent AD.

77 - **Holly Velligan, “Evolution of Host Adaptation in Phytophthora nicotianae using Serial Passage Assays”**

Phytophora nicotianae is a notorious oomycete pathogen infecting hundreds of plant species worldwide, making its broad host range a significant threat to agriculture and ecological stability. However, the evolutionary mechanisms underlying host-range expansion in this pathogen remain poorly understood. The objective of this research is to uncover the evolutionary processes that facilitate host-range shifts in P. nicotianae. Preliminary experiments revealed that P. nicotianae can infect Romaine lettuce, a crop not previously reported as a host. Inoculated seedlings developed clear necrotic symptoms, and Koch’s postulates confirmed successful infection, establishing Romaine lettuce as a newly identified host and forming the foundation of this study. A serial passage experiment was conducted on lettuce seedlings using the founder strain of P. nicotianae. Mycelial agar plugs were placed at the seedling hypocotyl and incubated at 28°C in the dark for seven days. The pathogen was re-isolated from necrotic tissue and transferred to new seedlings, with passages repeated for eight generations across two independent trials. AUDPC-based analyses showed that overall disease severity remained stable across generations; however, infection rate increased between generations five and six. This pattern indicates rapid pathogen adaptation to a previously unreported host, with enhanced infection efficiency emerging after multiple host-mediated selection cycles. This study advances plant pathology and evolutionary biology by experimentally demonstrating rapid host adaptation, identifying increased infection rate as an early indicator of adaptive change. The research reveals evolutionary dynamics that are often overlooked when disease severity alone is measured. The establishment of Romaine lettuce as a host further expands the ecological relevance of P. nicotianae and provides a new model system for investigating host-range evolution in oomycetes. These findings have major implications for agriculture and food security. Specifically, for disease emergence, resistance durability, and agricultural resilience under environmental change.

78 - **Conor Wolfe, “Antagonistic Potential of Tomato Endophytes against Verticillium dahliae”**

Verticillium dahliae is a soil-borne fungal pathogen that significantly impacts over 200 plant species, notably tomato and cotton. It employs antimicrobial and phytotoxic compounds like sulfacetamide and oxalic acid (OA) to induce cellular damage, alter plant-associated microbiomes, and downregulate plant immunity and metabolism, enhancing its pathogenicity. V. dahliae's resilience in soils has rendered conventional control approaches largely ineffective, often resulting in loss of farmland for economically important crops.

While biological controls such as Trichoderma, Bacillus, and Pseudomonas strains have shown promise, limited research has focused on endophytic microbiomes that live within the host plant. The objective of the research was to explore the biocontrol potential of endophytes that are tolerant to sulfacetamide or capable of degrading OA.

Tomato (variety Sungold) plant samples were collected from two separate, fungal and bacterial endophytes were isolated from plant tissue samples. Selection and screening were based on the ability of endophytes to grow in the presence of sulfacetamide and OA and inhibit V. dahliae in dual culture assay. Our initial screening yielded six fungal endophytes capable of growing in high concentrations of sulfacetamide and OA. Two demonstrated the ability to degrade oxalic compounds, confirmed by the zone of clearance. In our second screening involving both bacterial and fungal isolates from greenhouse grown tomatoes, 32 bacteria isolates showed tolerance to sulfacetamide while 38 isolates showed tolerance to oxalic acid. Five of the fungal isolates were found to be tolerant to sulfacetamide while another 5 isolates found to be tolerant to OA. Among the bacterial isolates tested, one demonstrated the strongest antagonistic effect by inhibiting V. dahliae growth, as well as a reduction of microsclerotia formation. Preliminary observations indicate that antagonistic activity is due to inhibitory effect of volatile metabolites released by the bacterial endophyte. The biocontrol effectiveness of these novel endophytes in planta needs to be assessed.

79 - **Ximeng Zhao, “E-cigarette's Acute Effect on Cardiopulmonary Fitness in Young Adults”**

Problem Statement: E-cigarettes have gained increasing popularity among young adults in the U.S., however, their acute effects on cardiopulmonary fitness remain understudied. Although several studies have examined this question, findings have been inconsistent and many are limited by methodological constraints. Research Objectives: This study aimed to evaluate the acute effects of vaping on cardiopulmonary fitness in healthy young adults. Research Methodology: A pilot randomized crossover trial was conducted in 10 healthy adults (aged 21–26 years). Participants completed two sessions in randomized order: (1) maximal cardiopulmonary exercise testing (CPET) alone, and (2) ad libitum vaping for up to 60 minutes followed by identical CPET. Verified abstinence from nicotine, caffeine, and alcohol was required prior to each session. Data were analyzed using paired Student’s t-tests for single-time-point outcomes and linear mixed-effects models for repeated measures to assess differences between vaping and non-vaping sessions. Results: Body weight adjusted VO_2max was significantly lower during the acute vaping session compared with the exercise-only session ($p = 0.013$). Peak VCO_2 was significantly lower during the acute vaping session ($p = 0.004$). No significant differences were observed between sessions in total workload, peak RER, O_2 pulse, VE/VCO_2 slope, peak minute VE, or post-exercise heart rate and blood pressure recovery trajectories. Conclusion: Acute vaping was associated with a significant reduction in VO_2max adjusted for body weight, suggesting an impairment in exercise capacity. Although other measures did not differ between sessions, the small sample size limits statistical power and may have reduced the ability to detect those effects. Contribution/Significance: Preliminary findings support the feasibility of the study protocol and provide initial evidence warranting a larger, adequately powered trial to confirm the observed reduction in VO_2max, clarify underlying physiological mechanisms, and determine whether repeated acute effects may contribute to longer-term impairments in cardiopulmonary fitnes.

82 – **Sofia Lopez Farina, “Acoustic Monitoring of the Florida Bonneted Bat to Support Conservation in the Florida Redlands”**

The Florida bonneted bat (Eumops floridanus) is one of the rarest and most endangered mammals in the United States, and its conservation has become increasingly urgent as rapid urbanization and habitat loss continue to reduce suitable roosting and foraging habitats. This study used passive acoustic monitoring to characterize Florida bonneted bat activity in the Florida Redlands, an agriculturally important region where bat-mediated insect suppression can benefit both biodiversity and farming communities. Acoustic recorders were strategically deployed near water systems, elevated areas, crop fields, and human structures to evaluate spatial patterns of activity, while environmental variables including temperature, wind, precipitation, and lunar illumination were recorded to assess how abiotic factors influence nightly behavior. All detections were archived through the North American Bat Monitoring Program (NABat) to support long-term accessibility and conservation planning. Across the study, 15,787 total acoustic detections were recorded, of which 10,062 (63.74%) were classified as noise and 5,725 were identifiable bat calls representing multiple species. Florida bonneted bats accounted for approximately 207 confirmed calls (≈1.31% of all detections), indicating consistent but relatively low activity compared with more common sympatric species. In contrast, Brazilian free-tailed bats generated more than 1,800 calls (>11% of total detections), and northern yellow bats exceeded 470 calls (>3%). Hourly activity analyses revealed a pronounced early evening peak for Florida bonneted bats around 7:00 PM, whereas Brazilian free-tailed and northern yellow bats exhibited bimodal activity with an additional peak near 4:00 AM. These findings establish a quantitative baseline of Florida bonneted bat presence and temporal niche partitioning in the Redlands, providing critical information to guide habitat management, land-use decisions, and future conservation strategies.