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2026

BOOK OF ABSTRACTS

April 24, 2026
UC Davis Conference Center

A message from the 2025-2026 PSA Board

On behalf of the 2025–2026 Postdoctoral Scholars Association (PSA) Board, we are pleased to welcome you to the 11th Annual UC Davis Postdoctoral Research Symposium. The symposium continues to serve as a cornerstone event for the UC Davis postdoctoral community, providing a platform to showcase cutting-edge research, foster interdisciplinary exchange, and strengthen connections across diverse academic fields. As in previous years, the success of this event reflects the exceptional dedication, talent, and collaborative spirit of our postdoctoral scholars.

Over the past year, the PSA has remained committed to advancing the professional development and well-being of postdoctoral scholars. Building upon a university-wide survey initiated in the previous cycle, we expanded our efforts to systematically assess the challenges faced by postdocs and their perspectives on institutional leadership. These data-driven initiatives aim to inform policies and programs that enhance the postdoctoral experience and support long-term career progression. In response to ongoing financial constraints across campus, the PSA undertook a strategic revision of its annual budget. Notably, this resulted in a 67% increase in travel grant awards, expanding support from 24 to 40 recipients annually. This effort underscores our commitment to enabling broader participation in scholarly dissemination and professional advancement. The PSA continued to prioritize community-building and inclusivity. A range of programs, including international cultural events, social gatherings, writing retreats, and career development activities, were organized to foster a supportive and connected postdoctoral environment.

The 2026 Symposium features 60 presentations from postdoctoral researchers spanning more than 20 disciplines, reflecting the breadth and depth of research at UC Davis. Contributions are presented across oral, flash talk, and poster formats, with awards recognizing excellence in each category. This year, Graduate Studies will present the 2026 Postdoctoral Excellence Awards at the conclusion of the symposium. Join us as we celebrate the outstanding achievements within our community.

We are honored by the participation of distinguished speakers and university leaders, whose engagement highlights the institution’s continued investment in postdoctoral scholarship and innovation. Their presence reinforces the importance of fostering an environment where research excellence and community engagement coexist. The symposium builds upon the success of prior years, which brought together a vibrant audience of postdoctoral scholars, faculty, staff, students, and families. This sustained level of participation reflects the strong sense of community that defines UC Davis.

We gratefully acknowledge the generous support of our sponsors, including the Office of Research, Graduate Studies, Global Affairs, the UC Davis Library, the Career Center, and numerous colleges and schools across campus. Their contributions are essential in ensuring that this symposium remains inclusive. We also extend our sincere appreciation to the Graduate Studies and Graduate Pathways teams, as well as all staff members, volunteers, speakers, and participants whose efforts make this event possible.

In closing, we recognize the dedication of the PSA Board and the broader postdoctoral community in sustaining high-quality programming during a year of significant challenges. This symposium stands as a testament to the resilience, collaboration, and scholarly excellence of UC Davis postdoctoral scholars.

We hope this event provides an enriching and inspiring experience for all participants.

Sincerely,

The 2025-2026 Postdoctoral Scholars Association Board

University of California, Davis

11th Annual Postdoctoral Scholars Association Research Symposium

April 24, 2026 | UC Davis Conference Center

Theme: Guided by Knowledge: Research, Discovery, and the Future We Build

Registration

8:00 – 9:00 AM | Registration, Breakfast & Poster Setup

Welcome Session (9:00 – 10:00 AM)

Room ABC

9:00 – 9:10 AM | Welcome Remarks — Luis Eduardo Contreras Llano & Esther Asamudo (PSA Chair & Vice Chair)

9:10 – 9:20 AM | Opening Remarks — Jean-Pierre Delplanque, Vice Provost & Dean of Graduate Studies

9:20 – 10:00 AM | Keynote Address — Simon Atkinson, Vice Chancellor for Research

Coffee Break (10:00 – 10:15 AM)

Oral Talks I (10:15 – 11:00 AM)

Room A (Moderator: Julie Bannon)

• Reshma Babu — Characterizing Sonomyographic Control and Motor Learning for Targeted Muscle Reinnervation Interfaces

• Yao Cai — High-fat diet disrupts daily physiology through protein S-palmitoylation

• Sohaib Mahri — A Phase 1 Study of Pyro-PBC Nanoparticle–Mediated Photodynamic Therapy in Feline Oral Squamous Cell Carcinoma: Safety and Preliminary Efficacy

Room B (Moderator: Abhishek Kumar)

• Xue Bai — Integrated Soil Health Practices for Water and Nutrient Management

• Yao Cai — Optoretinographic response of human photoreceptors during dark adaptation

• David Garcia — Regional Distribution and Clinicopathologic Correlates of Mineralized Blood Vessels in Autopsy-Confirmed Alzheimer Disease

Room C (Moderator: Xiaotong Yang)

• Jessica Bolin — Projected decline of habitat refugia for red abalone (Haliotis rufescens) across California

• Joanna Rothwell — Detection, Persistence and Antimicrobial Resistance Profiles of Foodborne Pathogens in Nut Orchards with Integrated Grazing Animals

• Mario Vendrell Catalayud — Rapid Detection of MOAH Contamination in Food Matrices Using A-TEEM and Machine Learning Models

Mental Health Break (11:00 – 11:15 AM)

Flash Talks (11:15 – 11:30 AM)

Room A (Moderator: Julie Bannon)

• Noha Amaly — A Sustainable Cellulose/Clay Aerogel Platform for On-Farm Nitrate Removal and Monitoring in Agricultural Wastewater

• Reginald Chinweze — Practice Patterns of Joint-Preserving Alternatives to Reverse Shoulder Arthroplasty for Irreparable Rotator Cuff Tears

• Nisanth Kumar Panneer Selvam — Hemodynamic analysis of patient-specific radioembolization using computational fluid dynamics

Room B (Moderator: Abhishek Kumar)

• Esther Asamudo — Sex Differences in Cardiac Recovery mediated by CaMKIIδ S-Nitrosylation During Ischemia/Reperfusion

• Camille Loret — Compact dCasMini Epigenetic Platform: Enabling Single-AAV Delivery for X-linked Gene Regulation

• Yiming Qian — Girls' pubertal development is associated with functional connectivity in peer evaluation task

Room C (Moderator: Rajalekshmy Padmakumari)

• Xiaotong Yang — Characterization of the Penetration Response of Rotary CPT in Sands and its Engineering Application

• Sophia Minnillo — PAIRR: Designing a GenAI AWF System to Prioritize Linguistic Diversity

• Sangeetha Ramesh — A recombinant platform for scalable production of sulfated peptides

Mental Health Break (11:30 – 11:45 AM)

Career Development Session (11:45 AM – 12:15 PM)

Room ABC

• Daniel J. Moglen - Personal values in career exploration

Lunch (12:15 PM – 1:00 PM)

Oral Talks II (1:00 – 2:00 PM)

Room A (Moderator: Luis Eduardo Contreras Llano)

• David Dallas-Orr — Conversations in Health-Literacy using AI-Technology in Osteoarthritis (CHAT-OA): Analysis of a Randomized Control Trial

• Jessica Huang — Effect of NHIP on reactive oxygen species levels in MeCP2+/- neural progenitor cells

• Abhishek Kumar — From laboratory to farm: Evaluating biochar-assisted composting for climate change mitigation and nutrient retention

• Shahid Khan — Engineering Tunable Cyborg Bacterial Vaccines Using Intracellular Hydrogelation

Room B (Moderator: Esther Asamudo)

• Cassandra Hatzipantelis — A genetically encoded biosensor platform for assessing GPCR dimer formation and modulation

• Amber Jolly — A novel, rapid method confirms leaf airspace unsaturation in hypostomatous leaves

• George Kuodza — Newborn blood DNA methylation correlates likelihood of autism spectrum disorder with grandparental cigarette smoking

• Saskia Desiree Mesquida Pesci — From Lab to Field: A Molecular Test for detecting Phytophthora spp. in Nursery Water Systems

Room C (Moderator: Xiaotong Yang)

• Brenton Hirao — Non-Eruptive Volcano-Tectonic Seismicity at Mount St. Helens, USA (2008–2024)

• Reginald Chinweze — Active Epilepsy Is Associated with Higher Early Emergency Department Utilization and Long-Term Ipsilateral Recurrent Instability After Primary Shoulder Stabilization

• Xiaoyu Liang — Effects of High Elevation Wildfires on Peak Snow Water Equivalent in California's Sierra Nevada Headwater Regions

• Rajalekshmy Padmakumari — Synergistic Roles of Host Immunity and Antibiotic Treatment in Reducing Bacterial Infection in Mice

Mental Health Break (2:00 – 2:15 PM)

Early Career Faculty Panel (2:15 – 3:00 PM)

Mental Health Break (3:00 – 3:15 PM)

Oral Talks III (3:15 – 4:00 PM)

Room A (Moderator: Sophia Minillo)

• Parvanendhu Pradeep — Arenavirus Matrix Protein Z Reprograms Mitochondrial Architecture Across Diverse Arenaviruses

• Stefan Sanow — High-throughput machine-learning quantification of plant cellular barriers across species and microbial treatments

• Shubham Tiwari — What Makes Recharge Effective for Streamflow Support? Lessons from Basin Scale Hydrologic Modeling

Room B (Moderator: Abhishek Kumar)

• Abagael Pruitt — Arctic Rusting Streams and Rivers Show Spatial and Temporal Variability in Dissolved Metal Concentrations from Acid Rock Drainage

• Alejandro Sánchez-Gómez — Structural uncertainty in reservoir operations models: a benchmark study across CONUS

• Luis Eduardo Contreras Llano — Programmable Non-replicating Mammalian Cells for Robust Biomanufacturing

Room C (Moderator: Esther Asamudo)

• Abdul Shiraj — Investigating the use of Xeno Nucleic Acids (XNAs) in guide-strand design for RNA-editing by ADAR

• Nawal Taaime — Water management impacts on the accumulation of potentially toxic elements in rice grain: a meta-analysis

• Xueyao Zhang — Valorization of Dairy Byproducts into Polyhydroxyalkanoates (PHA) Bioplastics via Halophilic Fermentation

Poster Session & Networking (4:00 – 5:00 PM)

P1 • Ana Ripolles-Garcia — Longitudinal flavoprotein fluorescence (FPF) in the optic nerve as a biomarker of oxidative stress in a nonhuman primate model of autosomal dominant optic atrophy (ADOA)

P2 • Deepa Dehari — Immunological and Safety Profile of CCL3 Therapy in Diabetic Wound: A Pre-Clinical Study

P3 • Reginald Chinweze — A Question of Reduction: Percutaneous Reduction Improves Modified Radiographic Union Scores for Intercalary Femoral Fractures at 12 weeks

P4 • Sanah Suri — Trusting Machine Learning with Physics: A Fidelity Verification Framework for Complex Systems

P5 • Bidisha Chakraborty — Early-life immune landscape shapes cognition across the lifespan in rhesus macaques

P6 • Kushal Prasad Choudhary — Mathematical modeling of modern stromatolites

P7 • Samarth Singh — Re-designing reservoir operations for a decarbonizing grid under climate change

P8 • Anirudh Gaur — GASP-1–Mediated GLP-1 Receptor Trafficking Contributes to the Development of Tolerance to Incretin Drug

P9 • Elizabeth Sahagun — A Longitudinal Immune-Metabolic Analysis of Early-to-Mid Pregnancy: Adaptations and Distinct Patterns Associated with Maternal Health Factors

P10 • Erfan Taatizadeh — Deep Learning-Based Mesh-Free Simulation of Hepatic Blood Flow for Y-90 Radioembolization Planning

P11 • Ananya Markandeya — Almond-Ash Activated Concrete: Scaling Biomass Ash & Paver Production

P12 • Cyril Journeau — Toward Comprehensive Catalogs of Volcanic Seismicity: Insights from Template-Matching, Machine Learning and Network Coherence at Mount Saint Helens Volcano

P13 • Dong Woo Shin — Mitochondrial respiratory complexes of *Ustilago maydis*

P14 • Eamonn Needham — Beyond Equilibrium: Amorphous Precursor-Mediated Ti Uptake and Its Implications for TitaniQ Thermobarometry

P15 • Flavia Almeida — AI and Kinetic Modeling of Thermal Death in Yellow Mealworm (*Tenebrio molitor*) Larvae

P16 • Hannah Justen — Interspecific competition in poison frog tadpoles

P17 • Junbeom Jang — Low-cost spark-induced breakdown spectroscopy for real-time characterization and source identification of toxic metals

P18 • Mohammad Yunus Naseri — Understanding Drivers of Water Availability at the Local Level in California

P19 • Robin Malik — Dietary tribromoethanol supplementation reduces enteric methane emissions in beef cattle

P20 • Rodrigo Profeta — Genomic diversity and host-specificity in *Corynebacterium pseudotuberculosis* using comparative population genomics

P21 • Timothy Fenton — Utilizing biophysically accurate computational models of NaV1.2 to simulate mutations and therapeutics in neonatal and adult neurons and neuronal networks

P22 • Tingting Chen — Optimizing sample preparation for solving multiple respiratory structures from *V. radiata*

Dinner (5:00 – 6:30 PM)

• Dinner service & informal networking

Awards & Closing Ceremony (5:30 – 6:00 PM)

Room ABC (Moderators: Luis Eduardo Contreras Llano & Esther Asamudo)

• Closing Remarks: Ellen Hartigan-O’Connor — Associate Dean for Graduate Studies and Postdoctoral Scholars

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Oral Presentations I

Rapid Detection of MOAH Contamination in Food Matrices Using A-TEEM and Machine Learning Models

Mario Vendrell-Calatayud[1], Yuzheng Yang[2], Hong Peng[2], Adam Gilmore[3], Selina C. Wang[1]

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***Keywords*:** Machine learning, Food contamination, Analytical chemistry

***Abstract*:**

Mineral Oil Aromatic Hydrocarbons (MOAH) are hazardous contaminants that can enter food through packaging, environmental pollution, or industrial lubricants. The coupled HPLC-GC-FID method is the gold standard for MOAH analysis, but it is time-consuming and resource-intensive, limiting its suitability for routine screening. This study evaluates fluorescence spectroscopy with absorbance and transmittance as a rapid alternative for detecting MOAH contamination from high-risk sources along the supply chain.

Absorbance-Transmittance-Excitation Emission Matrix (A-TEEM) spectroscopy combined with machine learning algorithms was applied to sunflower oil, whole milk powder, and cocoa butter. Spectral datasets comprised 936 points for sunflower oil, 1,560 for milk powder, and 1,248 for cocoa butter, balanced between uncontaminated controls and samples spiked with 1.0 ppm MOAH standards using one-step methanol dilution. Seven algorithms (Random Forest, SVM, KNN, Gradient Boosting, Logistic Regression, LDA, CART) were trained and externally validated with diesel oil–contaminated samples (0.1–5.0 ppm) and non-contaminated samples.

Logistic Regression achieved 100% accuracy for sunflower oil, KNN for milk powder, and Random Forest for cocoa butter. High sensitivity and specificity across matrices demonstrate robustness. This approach shows strong potential for rapid, cost-effective routine screening of MOAH in food materials, with opportunities for further optimization and scalability.

Funding acknowledgements: *This project is funded by the MARS Global Food Safety Center*

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Characterizing Sonomyographic Control and Motor Learning for Targeted Muscle Reinnervation Interfaces

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***Keywords**:* Ultrasound, Prosthetic, Motor Learning, Visual Feedback, Adaptation, Retention, Targeted muscle reinnervation

***Abstract*:**

Targeted muscle reinnervation (TMR) leverages surgically reinnervated muscles as biological amplifiers for intuitive prosthetic control. Ultrasound-based sonomyography (US) offers a novel means of capturing muscle contractions, supporting proportional, multi-degree-of-freedom control. This study pursued two primary aims: (1) identify optimal sonomyographic control parameters and characterize how control performance evolves over time following TMR surgery, and (2) establish a platform for evaluating motor learning using US-based proportional position control. To address Aim 1, two TMR participants were assessed at multiple post-surgical timepoints. US recordings captured muscle activation during functional grasp patterns (e.g., power) to track the evolution of control. For Aim 2, able-bodied participants performed a subset of grasps to match graded levels of virtual hand closure across multiple sessions and feedback conditions. Preliminary results demonstrate that four to six grasps can be classified with 82% to nearly 100% accuracy, showing improvements six to nine months post-TMR. Able-bodied participants exhibited reliable proportional control, accurately modulating virtual position according to the graded target, even with gain manipulations between movement and visual feedback. Overall, these findings support US-based sonomyography as a feasible platform for tracking motor learning and stabilizing control outcomes, with implications for optimizing the timing of prosthesis prescription following upper limb loss.

***Funding Acknowledgements**: This work was supported by the Congressionally Directed Medically Research Program (CDMRP).*

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High-fat diet disrupts daily physiology through protein S-palmitoylation

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***Keywords*:** Diet, Circadian Clocks, Sleep, Seizure

***Abstract*:**

Poor food quality and irregular mealtime compromise health. We and others previously reported that nutrient-sensitive posttranslational modifications (PTMs) on proteins mediate the impact of mealtime on circadian biology. Here, we report daily rhythms of S-palmitoylation, a lipid-derived PTM that modulates membrane anchoring of proteins due to changes in hydrophobicity, in *Drosophila* tissues. We observe that daily S-palmitoylation rhythms are responsive to changes in nutrient intake by subjecting flies to high-fat diet (HFD). Lipidomics and enzymatic activity assays revealed HFD compromises lipogenesis pathways that supply substrates for S-palmitoylation. We then adopted quantitative proteomics to obtain daily profiles of site-specific S-palmitoylation in head tissues and identify proteins that are regulated by rhythmic S-palmitoylation. 305 out of 4690 modified peptides displayed rhythmic S-palmitoylation in flies fed with regular diet, while HFD disrupted these rhythms. These rhythmic peptides are enriched for proteins involved in synaptic signaling and other nervous system processes. Indeed, we observed altered sleep time and increased seizure in flies with mutation in genes that regulate S-palmitoylation. Furthermore, these flies display reduced blood-brain-barrier permeability, a sign of disrupted nervous system homeostasis. This study provides new insights into the metabolic regulation of daily physiology and sheds light on the deleterious effects of HFD.

Funding Acknowledgements*: This work was supported by NIH R01 DK124068.*

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Optoretinographic response of human photoreceptors during dark adaptation

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***Keywords*:** Retina, Dark Adaptation, Optical Coherence Tomography, Optoretinography

***Abstract*:**

Dark adaptation is the essential process that restores visual sensitivity following exposure to bright light, yet the underlying mechanisms remain incompletely understood, and existing methods lack the resolution to probe individual photoreceptors. Here, we establish a high–spatiotemporal–resolution framework for quantifying cone dark adaptation *in vivo* using optoretinography (ORG) with adaptive optics optical coherence tomography (AO-OCT). This approach enables direct measurement of stimulus-evoked optical path length changes in single photoreceptor outer segments at milliseconds over a multi-minute recovery period following a strong photopigment bleach. We quantified cone ORG responses using four parameters. Interestingly, ORG response amplitude recovered more slowly than temporal features, revealing distinct recovery behaviors that may reflect separate contributions from photopigment regeneration and downstream phototransduction processes. These findings highlight ORG as a sensitive and fully objective method for quantifying dark adaptation process. This approach may support future studies aimed at understanding mechanisms underlying dark adaptation and probing functional deficits in diseases affecting outer-retinal health.

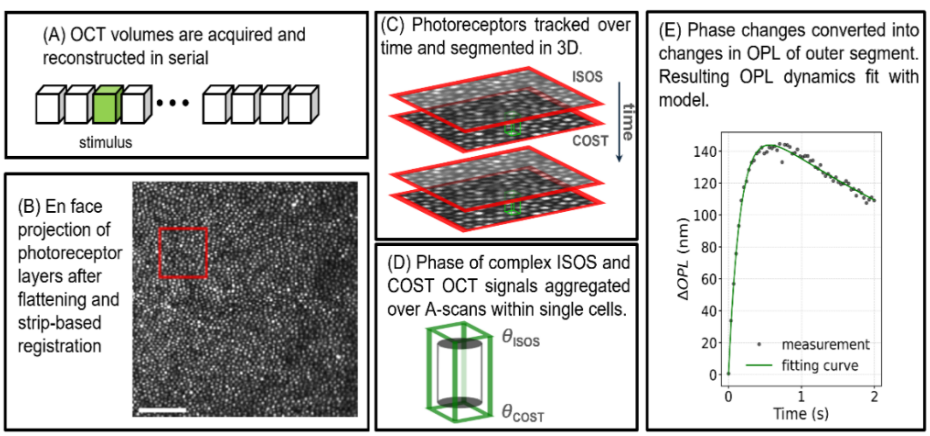

Figure 1:Key components of the ORG acquisition and processing pipeline.

Funding Acknowledgements: *NIH grants R01-EY-034340, R01-EY-033532, R01-EY-031098, R01-EY-26556, P30-EY-012576, and Research Council of Finland (356826).*

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Oral Presentations II

From laboratory to farm: Evaluating biochar-assisted composting for climate change mitigation and nutrient retention

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Keywords**:** Biochar, Composting, Dairy Manure, Methane, Nitrous Oxide

Abstract**:**

Composting is widely used for organic waste management; however, methane and nitrous oxide emissions, along with nutrient losses, limit its climate and agronomic benefits. This study evaluated biochars derived from agroforestry residues (walnut shell and wood chip) and their iron-modified forms, applied at 10% (w/w), across laboratory, backyard, and farm-scale composting systems. The focus was on CO_2-equivalent emissions (CH_4 and N_2O), nutrient dynamics, and plant bioassays. At the laboratory scale, biochar reduced CO_2-equivalent emissions and altered nutrient partitioning. Unmodified biochars increased carbon retention, while iron-modified biochars shifted nutrient stoichiometry toward higher N:P ratios. At the backyard scale, biochar-amended composts showed lower emissions than the control, with iron-modified biochars providing the strongest mitigation, alongside greater carbon retention and reduced availability of nitrogen, phosphorus, and dissolved organic carbon. At the farm scale, iron-modified biochar treatments reduced CO_2-equivalent emissions by ~8–10%, mainly through suppression of CH_4, while N_2O responses varied. Composting lowered C:N ratios, with further reductions in biochar-amended treatments. Plant bioassays showed increased shoot growth with compost, while biochar-amended composts maintained comparable performance; iron-modified biochars reduced biomass at higher rates, consistent with moderated nutrient availability. Overall, biochar-assisted composting improved emission mitigation and nutrient retention across scales.

Funding Acknowledgements*: This work was supported by Shell International Exploration and Production Inc.*

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A novel, rapid method confirms leaf airspace unsaturation in hypostomatous leaves

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***Keywords*:** Plant Ecophysiology, Plant Water-Relations, Plant Biophysics, Leaf Gas Exchange

***Abstract*:**

The movement of water vapor and CO_2 within leaves influences plant function, stress responses, and terrestrial productivity and evapotranspiration. Recent investigations have challenged a foundational assumption of plant physiology, namely that leaf intercellular airspaces are saturated with water vapor. However, confirmation across taxa, particularly those with hypostomatous leaves, remains limited. We developed a rapid method wherein the nitrogen in air is replaced with helium, which allows transpiration rate to be manipulated independently of vapor concentration, enabling inference of intercellular humidity. We found airspaces of hypostomatous leaves to be consistently unsaturated, implying a dynamic resistance for water transport across mesophyll cell membranes that augments stomatal restriction of water loss, but not of CO_2 uptake. These results significantly reshape our understanding of plant-atmosphere interactions. Further investigations of the drivers and prevalence of leaf airspace unsaturation across diverse species and conditions will provide valuable insights into this novel mechanism for plant drought resilience.

Funding Acknowledgements*: This work was supported by the National Science Foundation Postdoctoral Research Fellowship in Biology (NSF PRFB) award #2410582.*

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Magmatic Volatile Flux Drives Non-Eruptive Volcano-Tectonic Seismicity at Mount St. Helens, USA From 2008–2024

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***Keywords*:** Earthquakes, Seismology, Volcanology, Geophysics

***Abstract*:**

Seismicity during non-eruptive periods is useful for observing stress changes related to magmatic transport and volatile exsolution within active volcanoes. Mount St. Helens in Washington, USA, is the most active volcano in the continental United States and has been in quiescence since 2008. To explore the processes driving seismicity at Mount St. Helens, we create a high-resolution seismicity catalog of non-eruptive seismicity from 2008 through 2023, consisting of 31,133 events. We find persistent shallow seismicity (−2.2 to 2 km below sea level (BSL), 0–4.2 km below the surface) throughout the entire study period that concentrates beneath the dacite dome complex from the 1980–1986 and 2004–2008 eruptions. Additionally, there is frequent deeper seismicity (2–8 km BSL, 4.2–12.2 km below the surface) beginning in 2016. We examine a selection of deep earthquake swarms and find complex along-depth seismicity patterns. Within swarms, increases in shallow seismicity rates can precede or are concurrent with increases of deep seismicity rates. Lastly, we discover a series of semi-periodic, shallow, burst-like swarms, consisting of low-amplitude, repetitive similar earthquakes, indicating periodic valve-like release of fluid pressure from the conduit. Increased seismic activity beginning in 2016 indicates ongoing repressurization within the magmatic system driven by recharge or crystallization-induced second boiling within the upper-crustal reservoir after 2008. The data indicate that non-eruptive seismicity at Mount St. Helens is controlled by fluid pressure changes from gas flux sourced from the magma reservoir that migrates through crack networks.

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A genetically encoded biosensor platform for assessing GPCR dimer formation and modulation

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***Keywords*:** GPCRs, Receptor Engineering, Psychedelics

***Abstract*:**

The advent of cpGFP-based conformational biosensors has enabled the reporting of receptor activation through direct conformational change, independent of downstream transducer coupling. This approach ensures rapid, pathway-agnostic detection of ligand–receptor interactions that has been harnessed for in vivo target engagement studies and high throughput screening. We sought to leverage this conformational biosensor technology to develop a modular biosensor platform capable of detecting GPCR dimerisation and dimer-induced changes in constitutive and ligand-dependent receptor activation. We engineered three cpGFP-based biosensors, psychLight (5-HT2A), GRAB5-HT (5-HT2C) and nLight (α-1A), and eight putative GPCR dimer partners (A1, 5-HT2A, 5-HT2C, KOR, CB1, mGlu2, D2 and α-1A) to create dimerLight, a system enabling concurrent optical detection of dimer formation and biosensor activation. This platform successfully yielded 24 homo- and heterodimer combinations, revealing both known and previously undescribed dimer pairs. Notably, the 5-HT2A–mGlu2 dimer (dimerLight$_{\text{5-HT2A–mGlu2}}$) selectively enhanced the maximal response to hallucinogenic 5-HT2A agonists, but not non-hallucinogenic agonists, an effect abolished when mGlu2 was replaced with a non-dimerising ΔTM4 variant. dimerLight therefore provides a genetically encoded strategy for identifying GPCR dimers and quantifying ligand-dependent, dimer-specific modulation of receptor activation. This offers a framework for dissection allosteric interactions and uncovering previously inaccessible dimensions of GPCR pharmacology.

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Conversations in Health-Literacy using AI-Technology in OsteoArthritis (CHAT-OA): Analysis of a Randomized Controlled Trial

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***Keywords*: Artificial Intelligence, Digital Health, Health Literacy, Patient Education, Patient Experience, Randomized Controlled Trial**

***Abstract*:**

Many orthopaedic patients experience uncertainty and anxiety when choosing among treatment options for hip or knee osteoarthritis, and limited health literacy may worsen decisional stress. We conducted a randomized controlled trial in which adults presenting for orthopaedic consultation were randomized 1:1 to usual care or access to a large language model–based chatbot before the visit. This preliminary report focuses on post-visit baseline outcomes completed within 7 days. The primary outcome was the Beck Anxiety Inventory (BAI; 0–63), and the primary analysis was per-protocol (controls vs participants who completed the chatbot).

At the time of analysis, 86 participants had been randomized; 70 had complete BAI data. Mean post-visit BAI was 4.47 (SD 5.30) among participants who interacted with the chatbot and 8.25 (SD 7.65) among those who did not (mean difference −3.78; 95% CI −7.59 to 0.03; $p=0.052$). In adjusted linear regression controlling for LiMP score, age, sex, and baseline PROMIS physical and mental health, chatbot interaction remained associated with lower BAI but was not statistically significant ($\beta=-1.97$; 95% CI −5.36 to 1.41; $p=0.249$). Higher PROMIS physical health was independently associated with lower BAI ($\beta=-0.41$ per 1-point; 95% CI −0.69 to −0.13; $p=0.0047$). Ongoing enrollment and longer follow-up will clarify durability and effects on decisional conflict.

Funding Acknowledgements*: *This work was supported by the Orthopaedic Research and Education Foundation.

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Newborn blood DNA methylation correlates likelihood of autism spectrum disorder with grandparental cigarette smoking

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Keywords**:** Autism Spectrum Disorder, DNA Methylation, Epigenetics, Whole-Genome Bisulfite Sequencing, Biomarker

Abstract**:** Autism spectrum disorder (ASD) cases have been on the rise, and the underlying causes are not fully understood. Grandparental non-genetic factors, such as smoking and advanced age at conception, have been associated with likelihood of ASD in grandchildren, but potential molecular mechanisms warrant further investigation. We examine ASD versus typically developing (TD) newborn dried blood spots (NDBS) DNA methylation (DNAm) patterns to make biological connections between grandparental exposures and grandchildren's ASD diagnosis. We used two unique three-generation cohorts from California. We obtained NDBS from 456 grandchildren (245 ASD, 211 TD) and assayed DNAm using whole-genome bisulfite sequencing. To analyze the DNAm, we identified correlation methylation (co-methylation) networks using Comethyl, which were further correlated with grandchildren's neurodevelopment and grandparental exposures. We identified five co-methylation networks significantly associated with ASD. The light-yellow module was negatively correlated with both ASD (Bicor=-0.1, p=0.04) and paternal grandparents' smoking (Bicor=-0.23, p=0.04). Some of the genes in this network, such as *CD164*, have previously been associated with schizophrenia and smoking. The results from this study provide biological insight into grandparental factors associated with the likelihood of ASD and show that altered DNAm may be a mechanism by which grandparental factors, such as smoking transfers across generations.

Funding Acknowledgements*: This work was supported by NIH R01 ES031701, R01 HD112991.*

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Effect of NHIP on reactive oxygen species levels in MeCP2+/- neural progenitor cells

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***Keywords*:** Hypoxia, Reactive Oxygen Species, MeCP2

***Abstract*:**

Oxygen is critical for proper brain function. During hypoxia, insufficient oxygen levels can increase the level of reactive oxygen species (ROS), damaging neurons and their DNA. Our lab discovered *NHIP* (neuronal hypoxia inducible, placenta), a gene that encodes a short peptide that may protect neurons from hypoxia-induced stress. When exogenous NHIP peptide was added to a neuronal cell line 24 hours prior to 1% hypoxia exposure, ROS levels decreased. In a screen for proteins that interact with NHIP, we identified methyl-CpG-binding protein 2 (MeCP2) as a potential binding partner. Loss of MeCP2 leads to Rett Syndrome (RTT), and many RTT patients display breathing abnormalities that lead to intermittent hypoxia. We hypothesize that the interaction between NHIP and MeCP2 promotes proper hypoxia response. Preliminary experiments show that NHIP decreases ROS levels in neural progenitor cells isolated from wild-type mice, but not in neural progenitor cells isolated from $MeCP2^{+/-}$ mice, which have dysfunctional MeCP2 protein. This suggests that proper MeCP2 function is necessary for the reduction of ROS levels by NHIP. Characterization of NHIP and the mechanism by which it reduces ROS levels will allow for evaluation of its potential use in protecting neurons from injury under hypoxic conditions.

Funding Acknowledgements*: This research is supported by NIH/NIEHS R01ES029213.*

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Engineering Tunable Cyborg Bacterial Vaccines Using Intracellular Hydrogelation

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Keywords: Cyborg bacteria, Intracellular Hydrogelation, Synthetic Biology, Vaccines

Abstract:

Whole-bacteria vaccines are primary human tools to tackle infections ranging from recalcitrant urinary tract infections to respiratory and blood infections. Classical whole-bacteria vaccines use two main states of living systems: killed bacteria; live but weakened bacteria. Here, we enable a third bacterial state for vaccine applications: "non-replicating but metabolically active" or Cyborg bacteria. Cyborg bacterial vaccines are created through a tunable intracellular hydrogelation approach to control the phenotypic and physical state of Cyborg bacterial vaccines, using Pseudomonas aeruginosa and Klebsiella pneumoniae as infection models. Through flow cytometry and CFU assays, we confirm that Cyborg bacterial vaccines are non-proliferative but metabolically active. In addition to metabolic activity, Cyborg bacteria exhibit significant resistance to oxidative stress, maintaining a low intracellular ROS level. Secretome data reveal the retention of key immunogenic and secreted proteins, while high-toxicity effectors are not detected under our conditions. We also demonstrate that Cyborg bacteria remain stable in the presence of immune cells, resulting in the durable and tunable activation of immune systems. Immunological studies demonstrate that Cyborg bacterial vaccines effectively activate antigen-presenting cells and enhance T-cell response. In vivo vaccination and infection challenge in C57BL/6 mice demonstrate ~70-80% survival rates compared to heat-killed bacteria. Our Cyborg bacterial vaccine platform leverages the novel non-replicating-but-active state of bacteria, resulting in tunable, superior, and safe immune activation. Our platform may enable the rapid discovery and creation of Cyborg bacterial vaccines against emerging antibiotic-resistant bacteria.

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Synergistic Roles of Host Immunity and Antibiotic Treatment in Reducing Bacterial Infection in Mice

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***Keywords*:** Innate Immunity, Immunocompetent, Immunocompromised, Antibiotics, Infection

***Abstract*:**
Background: Antibiotics and host immunity are often considered independent defenses, with antibiotics primarily reducing bacterial burden to levels manageable by immune clearance. Using a *Pseudomonas aeruginosa* wound infection model in immunocompetent (C57BL/6) and immunocompromised (NSG) mice, we hypothesized that tobramycin-mediated bacterial killing releases pathogen-associated molecular patterns (PAMPs) that activate innate immune signaling, enhance inflammatory responses, and promote leukocyte recruitment, thereby improving infection control. We further postulated that this synergistic interaction is impaired in immunocompromised hosts, leading to reduced antibiotic efficacy.

Methods: Tobramycin was administered intraperitoneally to C57BL/6 and NSG mice prior to wound challenge with PA103 (10^6 CFU/wound). Wounds were harvested 24 hours post-infection to assess bacterial burden, bioactive LPS levels, Toll-like receptor expression, pro-inflammatory cytokine production, leukocyte infiltration, and neutrophil activation. To test whether reduced PAMP availability contributed to impaired immune responses in NSG mice, a low dose of LPS was topically applied to wounds before infection. Neutrophil depletion studies using anti-Ly6G antibodies were performed to define the role of neutrophils.

Results and Conclusions: Tobramycin treatment amplified innate immune responses in immunocompetent mice, resulting in enhanced inflammatory signaling, robust neutrophil recruitment, and effective bacterial clearance. This immune amplification was absent in NSG mice but was restored by topical PAMP supplementation. Neutrophil depletion abrogated the observed synergy, identifying neutrophils as key mediators. These findings support combining antibiotics with innate immune modulators to improve infection outcomes, particularly in immunocompromised hosts.

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From Lab to Field: A Molecular Test for detecting *Phytophthora* spp. in Nursery Water Systems

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***Keywords*:** Diagnostics, Regulatory Pathogens, RPA, Ornamental and Restoration Nurseries

***Abstract*:**

Phytophthora pathogens, causal agents of root and crown rots in many ornamental species, are a recurrent challenge in nursery production, generating losses, affecting plant health, and releasing pathogens of regulatory concern into trade and natural ecosystems. Efforts to control pathogen spread are costly, making imperative the development of reliable and fast diagnostic tools. The recombinase polymerase assay (RPA) is a rapid and accurate method for detection of *Phytophthora* spp. that has been previously optimized for plant tissue. In this study, we optimized the RPA assay for *Phytophthora* detection directly from water. We used serial dilutions ranging from 10^5 to 10 spores/mL from nine different *Phytophthora* species frequently found in nursery systems, and filtered suspensions onto glass microfiber filters. We confirmed the specificity of *Phytophthora* RPA *TrnM* mitochondrial primers and probe on all tested species, and determined 100 spores/mL as the limit of detection of the assay. Current studies evaluating assay detection efficacy under real life scenarios include testing artificially inoculated water at nursery scale collection tanks, and from leachate water of potentially infected plants. Assay robustness at large scale settings will provide improved tools for early *Phytophthora* spp. detection in nursery production, preventing pathogen spread into trade and natural ecosystems.

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Active Epilepsy Is Associated with Higher Early Emergency Department Utilization and Long-Term Ipsilateral Recurrent Instability After Primary Shoulder Stabilization

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Keywords: Shoulder Instability; Epilepsy; Recurrent Instability; Emergency Department Utilization; Claims Database

***Abstract*:**

Patients with epilepsy are considered high risk for recurrent shoulder instability, but comparative, population-level outcomes remain limited. We evaluated whether active epilepsy is associated with increased early emergency department (ED) utilization and higher long-term ipsilateral recurrent instability after primary surgical stabilization. We performed a retrospective cohort study using a national administrative claims database. Patients undergoing primary surgical stabilization for shoulder instability were categorized as active epilepsy versus no epilepsy. Active epilepsy required a history of epilepsy within 10 years plus evidence of active disease within 12 months pre-index (seizure/convulsion encounter and/or antiseizure medication claim); controls had no epilepsy diagnosis codes. Primary outcome was ipsilateral recurrent instability at 2, 5, and 10 years. Secondary outcomes included 90-day all-cause ED utilization and 2-year recurrence stratified by arthroscopic versus open stabilization. To reduce confounding, 1:1 propensity score matching was performed on age, sex, Elixhauser comorbidity index, obesity, tobacco use, and diabetes. In the unadjusted cohort, 1,880 active epilepsy patients and 109,256 controls were identified; 1,572 matched pairs were analyzed. Active epilepsy was associated with higher recurrent instability at 2 years (4.33% vs 0.95%; RR 4.53, 95% CI 2.60–7.89; $p<0.01$), persisting at 5 years (5.98% vs 1.21%; RR 4.95, 95% CI 3.04–8.06; $p<0.01$) and 10 years (6.17% vs 1.27%; RR 4.85, 95% CI 3.01–7.81; $p<0.01$). Ninety-day all-cause ED utilization was also higher with epilepsy (16.48% vs 10.75%; RR 1.53, 95% CI 1.28–1.84; $p<0.01$). Elevated 2-year recurrence persisted after arthroscopic (4.06% vs 1.09%; RR 3.71; $p<0.01$) and open stabilization (11.42% vs 5.54%; RR 2.06; $p<0.05$). Active epilepsy was associated with higher early ED utilization and durable recurrence through 10 years, supporting enhanced preoperative counseling using absolute risk estimates and perioperative pathways emphasizing seizure optimization and structured early postoperative support.

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Oral Presentations III

Arctic Rusting Streams and Rivers Show Spatial and Temporal Variability in Dissolved Metal Concentrations from Acid Rock Drainage

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***Keywords*:** Water Quality, Metals, Acid Rock Drainage, Arctic, Streams

***Abstract*:**

Streams and rivers in Arctic Alaska are turning orange due to acid rock drainage that mobilizes metals from sulfide minerals below thawing permafrost. However, the spatial and temporal variability of chemical signatures from acid rock drainage, and the relative contributions of point versus diffuse sources remain poorly understood. Here, we performed repeat synoptic samplings of hillside seeps, tributaries, and mainstem sites in the Nakolikurok Creek watershed in the Brooks Range, Alaska, USA, during June, July, and twice in August 2024 to understand how acid rock drainage chemical signatures varied spatially and temporally. Seeps and impaired tributaries showed distinct chemistry from unimpaired sites. Hillside seep chemistry was highly temporally variable; for example, SO_4^{2-} concentrations in a single seep varied from 5960-13,700 mg/L. A subwatershed leverage (relative chemical influence) analysis indicated that tributaries contributed -13-6465% of dissolved iron and -8-151% total iron to the outlet of Nakolikurok Creek, suggesting that some tributaries dilute Fe while others disproportionately enrich downstream concentrations. Sulfate, a conservative tracer of acid rock drainage, was strongly related to continuous specific conductance (R^2=0.96), with specific conductivity and sulfate concentration peaking in late July. These findings demonstrate that acid rock drainage influences Arctic river chemistry through highly dynamic source contributions.

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Investigating the use of Xeno Nucleic Acids (XNAs) in guide-strand design for RNA-editing by ADAR

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Keywords**:** Xeno Nucleic Acid (XNA), RNA, Chimera, RNA Editing, ADAR Enzyme, Adenine (A), Inosine (I), Orphan Base

Abstract**:**

Adenosine deaminases acting on RNA (ADARs) are a family of enzymes that catalyze the deamination reaction of Adenine (A) to Inosine (I) in dsRNA. ADAR1 and ADAR2 perform the catalytic conversion of Adenine (A) to Inosine (I) in humans. The X-ray crystal structure of the human ADAR2 deaminase domain bound to double stranded RNA reveals the flipping of the target Adenosine (A) into the enzyme active site, which facilitates the ADAR editing. The structure also reveals how ADARs bind to the A-form double helical structure found in dsRNA. Chemical modification of the guide RNA improves the RNA editing rates and lowers the off-target RNA editing. In this regard we have designed a chemically modified guide RNA composed of XNA and RNA which exhibits ADAR1 specific A to I RNA editing in-vitro. Unlike regular unmodified guide the newly designed guide RNA shows minimal off target editing while maintaining high RNA editing efficiency for the target Adenosine (A). The guides designed were tested for different target sequences and exhibit similar patterns of editing efficiency while maintaining minimal off target editing. Kinetic assays performed show almost similar rates as the control guide RNA. Preliminary in-vivo RNA editing assays performed in HEK293T cells shows promising editing in HEK293T cells.

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Structural uncertainty in reservoir operations models: a benchmark study across CONUS

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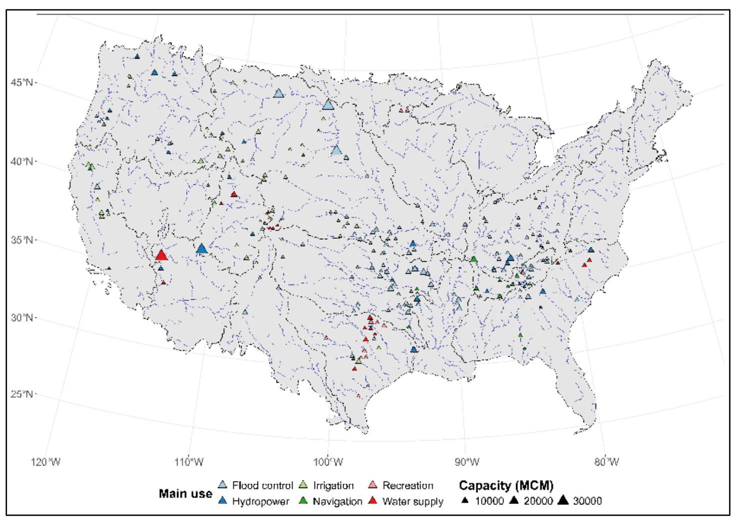
Keywords**:** Hydrological Models, Reservoir Policies, Uncertainty, Water Resources Management

Abstract**:**

Human activities substantially alter the hydrological cycle, yet their representation in hydrological models remains limited. Reservoir management is among the most influential interventions. In the contiguous United States (CONUS) alone, more than 52,000 dams provide storage capacity equivalent to 75% of the mean annual runoff, underscoring the need for improved modeling approaches. To quantify the uncertainty associated with alternative reservoir representations, we conduct a benchmark study across 250 reservoirs in CONUS, selected from the *ResOpsUS* dataset based on data availability for the 1990–2015 period. Multiple release policies, grouped into three main categories (generic, data-driven, and optimization-based), are implemented within a common reservoir simulation framework that accounts for key processes such as evaporation. This design enables a systematic assessment of the accuracy and limitations of these reservoir representations and their suitability under varying conditions (e.g., reservoir purpose, size, input data requirements, or operational data availability and quality). Model performance is evaluated by comparing simulated and observed release and storage time series for each policy. Results show that the choice of reservoir management representation significantly affects prediction accuracy, with potential cascading impacts on the calibration and simulation of hydrological processes.



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Programmable Non-replicating Mammalian Cells for Robust Biomanufacturing

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***Keywords*:** Biomanufacturing, intracellular hydrogelation, extracellular vesicles, viral vectors, therapeutic proteins

***Abstract*:**

Robust production of biologics and cell-derived nanoparticles is essential for modern medicine. Yet conventional biomanufacturing systems remain constrained by the dependence of biosynthesis on cell proliferation and survival. This coupling introduces tradeoffs between cellular fitness and production output, increasing variability, cost, and process complexity. Here, we engineer programmable non-replicating mammalian cells using our patented intracellular hydrogelation technology to create semi-living biosynthesis micromachines that sustain biomolecule production beyond the functional lifespan of natural cells. Intracellular polymer networks formed throughout the cytoplasm restrict replication while preserving metabolic activity, organelle integrity, and secretion capacity.

We demonstrate the utility of this platform across multiple bioproduct classes, including extracellular vesicles (EVs), lentiviral particles, and therapeutic antibodies. Engineered cells sustain EV secretion over extended culture periods compared to untreated controls and produce functional lentivirus with enhanced infectivity under stress conditions such as heat shock. Antibody secretion remains comparable to proliferative cells for up to seven days despite the absence of replication. By decoupling cellular survival from production, intracellular hydrogelation enables stable and parallelizable manufacturing workflows that are compatible with one-pot chemical modification, purification, and bioproduct stabilization strategies. Collectively, these findings establish engineered non-replicating cells as a versatile platform for next-generation biomanufacturing.

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Water management impacts on the accumulation of potentially toxic elements in rice grain: a meta-analysis

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***Keywords*:** Rice; Water Management; Heavy Metal; Metalloids, Potentially Toxic Element

***Abstract*:**

Rice can be a source of potentially toxic elements (PTE). Non-continuous flooding practices (NCFP) reduce methane emissions and water use, but they can alter the bioavailability of PTE by modifying soil redox potential, pH, and other geochemical processes. This meta-analysis evaluates the effect of NCFP on PTE accumulation in rice grain, explains the mechanisms of their observed increase/decrease, and highlights research gaps. Fifty-five studies comparing PTE grain concentration under continuous flooding and NCFP were selected, with 130, 67, 100, 36, 30, 19, 11, and 11 observations for As, inorganic arsenic (iAs), Cd, Pb, Cr, Hg, MeHg, and Ni, respectively. Due to limited data, pot and field studies were combined for PTE other than As and Cd. On average, NCFP decreased As, iAs, Pb, Hg, and MeHg grain concentrations by 39%, 24%, 21%, 63%, and 81%, but increased Cd and Ni concentrations by 115% and 187%, respectively. The effect on Cr was not clear due to discrepancies between pot and field experiments. Severe drying resulted in greater decreases in As and iAs but showed no significant difference from mild drying for Cd. Further field studies are needed to clarify NCFP effects, especially for Ni and Cr, where results were highly variable.

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What Makes Recharge Effective for Streamflow Support? Lessons from Basin Scale Hydrologic Modeling

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***Keywords*:** Managed Aquifer Recharge, Climate Resilient Streamflow, Sustainable Groundwater Management

***Abstract*:**

Understanding what makes managed aquifer recharge effective for streamflow support is essential for sustaining groundwater fed rivers and associated groundwater dependent ecosystems (GDEs) during seasonal low flow periods in alluvial basins. Although winter recharge is widely promoted as a strategy to enhance summer streamflow, clear guidance on when and where it is effective remains limited.

This study evaluates the seasonal hydrologic response to winter managed aquifer recharge using an integrated basin scale modeling framework representative of irrigated alluvial valleys under Mediterranean climate conditions. A fully coupled soil water, groundwater, and surface water model was applied over more than 30 water years to capture interannual hydrologic variability. A winter recharge scenario was implemented during a representative high flow year, with approximately 3,600 acre feet of diverted surface water applied between January and March.

Results show that winter recharge enhanced streamflow for several weeks beyond the recharge period by strengthening stream aquifer connectivity, with benefits extending into late spring. However, sustained summer streamflow enhancement was limited, as recharge primarily contributed to groundwater storage rather than prolonged baseflow support. Recharge effectiveness was strongly controlled by spatial proximity to stream corridors and by timing relative to seasonal flow recession. These findings highlight key hydrologic controls that should guide recharge design to maximize ecological and water management benefits.

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High-throughput machine-learning quantification of plant cellular barriers across species and microbial treatments

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***Keywords*:** Machine learning–based phenotyping, Plant cellular barriers, Plant–microbe interactions, Parasitic plant resistance (*Striga hermonthica*)

***Abstract*:**

Plant cellular barriers such as lignin, suberin, and aerenchyma are central to plant defense, yet their quantitative analysis remains labor-intensive and poorly reproducible across experiments. This limitation restricts rigorous comparisons across genotypes, treatments, and species. Here, I present a high-throughput machine-learning–based image analysis pipeline that enables automated, quantitative assessment of multiple cellular barriers from microscopy data.

Using sorghum as a model system, and extending the approach to rice and millet, the pipeline simultaneously extracts quantitative features describing endodermal lignification, suberization, and aerenchyma formation across tissues, genotypes, and microbial treatments. Application of this framework reveals barrier-specific responses to beneficial microbes that are difficult to resolve reproducibly using conventional manual quantification approaches. These quantitative phenotypes provide a foundation for testing how microbe-induced modulation of host barriers relates to resistance against parasitic plants such as *Striga*, as well as broader pathogen interactions.

Overall, this work establishes a reproducible and transferable platform for integrating cellular barrier phenotypes into plant defense studies. By enabling scalable, quantitative analysis of structural traits, the approach supports more rigorous experimental design and comparative analyses relevant to crop resilience and sustainable disease management.

***Funding Acknowledgements**: This work was supported by the Gates Foundation grant to Netherlands Institute of Ecology (NIOO) "PROMISE II: Promoting microbes for integrated Striga eradication" (INV-047255)*

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Valorization of Dairy Byproducts into Polyhydroxyalkanoates (PHA) Bioplastics via Halophilic Fermentation

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***Keywords*:** Whey Permeate, Circular Economy, Biopolymer Characterization, Sustainable Materials

***Abstract*:**

Cheese production generates large volumes of whey permeate, a lactose-rich byproduct that is often underutilized and represents both an environmental burden and a lost economic opportunity. While polyhydroxyalkanoates (PHAs) are promising biodegradable alternatives to petroleum-based plastics, their production cost remains heavily dependent on carbon feedstock price. Prior work demonstrated PHA production from delactosed permeate; however, systematic optimization and material characterization using whey permeate remained limited. In this study, whey permeate was converted into PHA using the halophilic archaeon Haloferax mediterranei under controlled batch fermentation conditions (Figure 1). The effects of sugar loading, nitrogen source, and aeration rate on cell growth and PHA accumulation were systematically evaluated. Following fermentation, biomass was harvested, and PHA was extracted and purified to over 90% purity. The purified PHA was characterized using compositional, structural, and thermal analyses. This work establishes a technically robust pathway for transforming lactose-rich dairy byproducts into high-purity biodegradable bioplastics. By converting a low-value waste stream into functional polymer materials, the study advances circular bioeconomy strategies and supports the development of climate-smart, value-added biomanufacturing within the dairy industry.

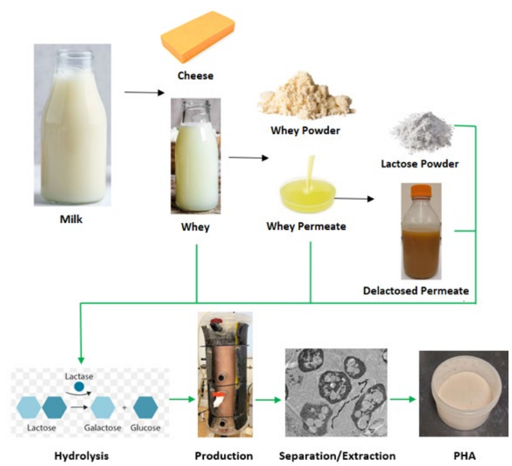

Figure 1. Bioconversion of whey permeate to polyhydroxyalkanoate (PHA).

Funding Acknowledgements: *This work was supported by California Dairy Research Foundation.*

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Flash Talks

A Sustainable Cellulose/Clay Aerogel Platform for On-Farm Nitrate Removal and Monitoring in agriculture Wastewater

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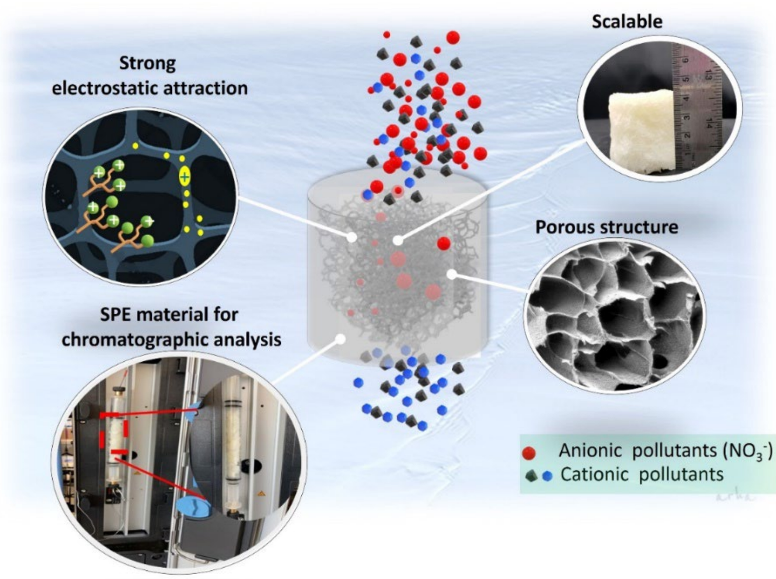
Keywords**:** Cationic Aerogel, Water Recycling, Preconcentration, Manure Wastewater, Nitrate

Abstract**:**

Excess nitrate loading from dairy manure wastewater poses a persistent threat to groundwater quality, ecosystem health, and regulatory compliance in intensive agricultural regions such as California's Central Valley. Here, we report the design of a sustainable, bio-based, and field-deployable cationic aerogel platform that integrates materials science innovation with agricultural water management needs. A hybrid cationic aerogel (CPC-MT@QMCC) was fabricated by entrapping cetylpyridinium-modified montmorillonite within a quaternized microcrystalline cellulose matrix, yielding a lightweight (10.6 $mg.cm^{-3}$), highly porous (≈70%), and mechanically robust three-dimensional network. The aerogel exhibited exceptional nitrate adsorption capacity, rapid kinetics (<30 min), and high dynamic binding efficiency (≈710 mg g^{-1}), outperforming commercial ion-exchange resins under comparable conditions. Importantly, the material demonstrated excellent regeneration, structural stability, and >95% nitrate recovery over multiple cycles, enabling both treatment and nutrient recovery. Application to real dairy manure wastewater achieved up to 96% nitrate removal and enabled preconcentration with a detection limit of 0.1 $mg.L^{-1}$, supporting regulatory monitoring requirements under nitrate control policies. The scalability, low production cost, and compatibility with on-farm treatment systems position this aerogel as a practical solution bridging advanced materials, agricultural outreach, and policy-driven water quality management for sustainable nutrient control in livestock operations.



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Practice Patterns of Joint-Preserving Alternatives to Reverse Shoulder Arthroplasty for Irreparable Rotator Cuff Tears

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***Keywords*: Irreparable Rotator Cuff Tear; Reverse Shoulder Arthroplasty; Superior Capsular Reconstruction; Tendon Transfer; Claims Analysis**

***Abstract*:**
Reverse shoulder arthroplasty (RSA) is increasingly used for irreparable rotator cuff tears, yet concerns regarding implant longevity and use in younger, active patients have sustained interest in joint-preserving alternatives, including superior capsular reconstruction (SCR), subacromial balloon spacer implantation (SBS), lower trapezius tendon transfer (LTT), and biologic tuberoplasty (BT). We evaluated contemporary adoption, persistence, and perceived effectiveness of these procedures using a surgeon survey and national claims analysis. A 24-item cross-sectional survey was distributed to Pacific-Western Shoulder and Elbow Society members (June–August 2025) capturing surgeon demographics, procedure utilization (ever/current), reasons for de-implementation, and perceived effectiveness across four joint-preserving options. In parallel, a national claims study identified adults undergoing first surgical management within 90 days of rotator cuff tear diagnosis with ≥365-day baseline activity and laterality anchoring for ipsilateral outcomes. Survey responses were summarized descriptively with graphical reporting. Eighty-nine surgeons responded; nearly all reported performing ≥1 joint-preserving procedure. SCR was most-commonly performed (79%), followed by LTT (46%), BT (36%), and SBS (28%). SCR had the highest reported reduction/abandonment (63%), followed by LTT (57%) and BT (52%); the most cited reasons were suboptimal outcomes (65%) and insufficient evidence (58%). Claims analyses identified 349,244 cases: arthroscopic rotator cuff repair 69.8%, arthroscopy alternatives 20.1%, shoulder arthroplasty 8.2%, and tendon transfer 0.10%; an SCR proxy code was 1.7%. From 2015 to 2023, arthroplasty increased from 4.1% to 14.9% of index strategies, while the SCR proxy declined from 2.5% to 1.2%. Arthroplasty use was strongly age-dependent (0.45% in 18–49 vs 22.9% in ≥70 years).

Surgeon reported de-implementation of joint-preserving procedures, particularly SCR, paralleled low and declining claims capture, alongside rising arthroplasty-driven salvage, suggesting consolidation toward RSA with selective niche use of joint-preservation pathways as evidence and confidence evolve.

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PAIRR: Designing a GenAI AWF System to Prioritize Linguistic Diversity

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***Abstract*:**

Automated writing feedback (AWF) systems have historically privileged "standard" language varieties, furthering linguistic marginalization. Grounded in linguistic justice (Baker-Bell, 2020) and translanguaging theory (Canagarajah, 2011), we designed a pedagogical approach called Peer and AI Review + Reflection (PAIRR), including a GenAI AWF tool called MyEssayFeedback, that celebrates language variation in college writing courses. Students can opt to utilize MyEssayFeedback to elicit linguistic justice-oriented comments on their paper drafts. Students are encouraged to critically interrogate MyEssayFeedback's output through follow-up prompting and reflection before revising their papers. Our study seeks to answer: What impact does this pedagogical approach have on (1) the linguistic diversity of students' writing and (2) students' attitudes about their writerly voice?

We tested the approach at seven U.S. colleges in 2025, reaching 1,633 students. We will measure the lexical and syntactic diversity of students' drafts and run linear mixed-effects models to discern how students' linguistic diversity changed through the intervention. Additionally, we will qualitatively analyze a stratified sample of students' reflections, GenAI interactions, and drafts to determine how the intervention influenced students' views of their writerly voice. Our presentation will illustrate how AWF systems can be designed to counter the homogenizing effects of GenAI, informing linguistically-just assessment.

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Characterization of the Penetration Response of Rotary CPT in Sands and its Engineering Application

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***Keywords*:** Rotary Cone Penetration Testing (RCPT), Model test, Penetration resistance, Sand properties, Cone roughness, Interface friction

***Abstract*:**

Penetrating into deeper soil and obtaining soil properties using probes with embedded sensors is a vital but challenging requirement for the design and construction of infrastructure systems. Rotary Cone Penetration Testing (RCPT) has been recently shown to build upon the established Cone Penetration Test. Specifically, rotation of the probe enhances the ease of penetration by reducing the soil penetration resistance and providing supplemental torque measurements that provide additional soil information. This study conducts comprehensive RCPT laboratory experiments using a robotic arm on sands of two distinct densities, with controlled variations in probe surface roughness and penetration velocity. The results demonstrate that the penetration force (F_z) and torque (T_z) are governed by the ratio of tangential to vertical velocity, referred to as the speed ratio (*SR),* rather than absolute velocities. Specifically, F_z decreases significantly and T_z increases initially and then reaches a constant value as *SR* is increased. The soil relative density affects the absolute F_z and T_z, yet it has no effect on the rate of F_z reduction with *SR*. Within an *SR* range of 4 to 16, RCPT results provide a reliable estimation of the probe-soil interface friction coefficient (μ'), based on comparison against μ' values measured in laboratory tests. These findings clarify the dominant factors affecting the penetration resistances in RCPT, demonstrate the potential for practical applications of the results, and establish a framework for RCPT data interpretation.

Funding Acknowledgements: *This work was supported by a scholarship from Tsinghua University.*

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Girls' pubertal development is associated with functional connectivity in peer evaluation task

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***Keywords*:** Pubertal Development, Pubertal Timing, Tempo, Adolescence, Functional Connectivity, Chatroom Task

***Abstract*:**

Growing evidence suggests that pubertal development shapes adolescent brain maturation; however, it remains unclear whether pubertal timing (earlier vs. later maturation) and tempo (rate of maturation) influence neural responses to peer evaluation. Using data from 120 girls in the Pittsburgh Girls Study, we examined how pubertal timing and tempo relate to neural activity and connectivity during a Chatroom fMRI task involving positive, negative, and neutral peer feedback. Regions of interest implicated in affective processing (anterior insula, subgenual and pregenual ACC, and amygdala) were examined for activity and functional connectivity when receiving positive (vs. neutral) and negative (vs. neutral) feedback from peers. No significant associations emerged for regional activation. However, faster pubertal tempo was associated with greater connectivity between the right anterior insula and medial prefrontal cortex, whereas earlier timing was linked to stronger amygdala–fusiform connectivity during peer rejection. Significant interactions between pubertal tempo and timing between right anterior insula and bilateral occipital regions/cerebellum, and between right pregenual ACC and right pre/postcentral gyrus were found. It revealed that faster maturation predicted greater connectivity among early-maturing girls, while slower maturation predicted greater connectivity among later-maturing girls. These findings highlight pubertal dynamics as key contributors to individual differences in socio-affective neural processing.

Funding Acknowledgements*: This work was supported by National Institutes of Health grants R01MH125873 (AEG), R01MH093650 (AEG, KEK, EEF), R01MH066167 (KEK), R03MH116519 (AEG), and R01MH056630.*

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Poster Session

Longitudinal flavoprotein fluorescence (FPF) in the optic nerve as a biomarker of oxidative stress in a nonhuman primate model of autosomal dominant optic atrophy (ADOA)

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***Abstract*:**

Purpose: To explore longitudinal trajectories of global optic nerve head (ONH) FPF in *OPA1* A8S heterozygous (*OPA1* Het) rhesus macaques. Methods: The Beacon imaging device (OcuMet Beacon®, OcuSciences Inc.) was used to image 32 *OPA1* Het and 54 *OPA1* WT macaques. At repeated visits, FPF was measured in the ONH, alongside electrophysiology (pattern ERG, PERG) and peripapillary retinal nerve fiber layer thickness (RNFLT) by optical coherence tomography (OCT). Results: ONH FPF/RNFLT increased from approximately 7 years in *OPA1* Het, diverging from *OPA1* WT; by approximately 14 years the separation was clear and it widened at older ages (Fig. 1A). At ≤7 years the ratio was similar (WT 0.068 ± 0.016 dB/µm; HET 0.071 ± 0.017 dB/µm), whereas it was higher in *OPA1* Hets thereafter (>7-≤14 years: WT 0.067 ± 0.014 vs HET 0.084 ± 0.023 dB/µm; >14 years: WT 0.074 ± 0.022 vs HET 0.096 ± 0.026 dB/µm; Fig. 1B). In *OPA1* Hets, global ONH FPF increased with thinner RNFL (R = −0.29, P = 0.0255) and with higher IOP (R = 0.41, P = 0.0038), with no association with PERG P50-N95 at 48 min (R = −0.03, P = 0.9157); likely due to the smaller sample size (Fig. 1C-E). Conclusions: ONH FPF worsens with age in *OPA1* mutant NHPs, which supports the use of FPF (and the ONH FPF/RNFLT ratio) as sensitive longitudinal endpoints for evaluating progression and therapeutic interventions.

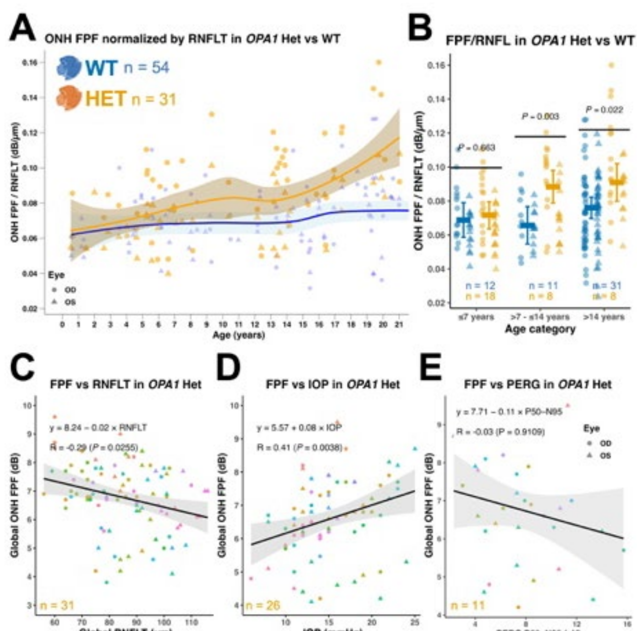

Figure 1. Global optic nerve head (ONH) flavoprotein fluorescence (FPF) in *OPA1* heterozygotes diverges from WT at 7 years and correlates inversely with retinal nerve fiber layer thickness (RNFLT) and positively with intraocular pressure (IOP). A, Global ONH FPF normalized by RNFLT across ages; LOESS mean ± CI. B, FPF/RNFLT ratio summarized by age categories; mean ± SD. C-E, Associations in *OPA1* heterozygotes: C, global ONH FPF vs global RNFLT (R = −0.29, P = 0.0255); D, global ONH FPF vs IOP (R = 0.41, P = 0.0038); E, global ONH FPF vs pattern ERG P50-N95 amplitude at 48 minutes (R = −0.03, P = 0.9109). C-E, each color denotes an individual animal.

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Almond-Ash Activated Concrete: Scaling Biomass Ash & Paver Production

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***Keywords*:** Almond Biomass Ash, Alkali-Activated Binder, Concrete Paver, Low CO_2 Cement

***Abstract*:**

Portland cement (PC) consumption of 4.2 billion metric tons yearly is responsible for about 8% of annual global greenhouse gas (GHG) emissions. Alkali-activated binders, which use no portland cement, offer a convenient alternative to conventional PC-based concrete to reduce GHG emissions. However, uptake of these binders in the industry has been slow, mostly due to their caustic nature and high cost of activators, typically reagent-grade chemicals, used to obtain the high pH necessary for binder dissolution and subsequent strength development. This research demonstrates that full replacement of reagents with potassium mineral-rich almond biomass ash in alkali-activated slag binders can achieve compressive strengths comparable to conventional PC-based mortar and concrete. Biomass ash obtained from a full-scale combustion trial with blended almond co-products (shells and hulls) from Northern California was characterized and used to produce pavers and conventional concrete. Ashes produced from almond biomass co-products in Australia and California were compared based on physical and chemical properties and performance in mortar at laboratory scale. While current work is predominantly focused on precast pavers, formulations containing additives for set time control were investigated to explore applications in conventional ready-mix concrete.

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Early-life immune landscape shapes cognition across the lifespan in rhesus macaques

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***Abstract*:**

We investigated whether infant immune organization predicts cognitive trajectories across the lifespan in rhesus macaques (*Macaca mulatta*). Cognition was measured using Preferential Looking (PL), which quantifies working memory via novelty preference, and a Visual Prediction (VP) task, which assesses spatial memory by testing gaze to a withheld final stimulus location after repeated spatial presentations. In a large cohort ($n = 4090$) at CNPRC, immune markers collected at 3-4 months were matched with concurrent cognition. Higher $CD4^+$ counts predicted increased novelty preference ($p < 0.01$), whereas elevated $CD8^+$ counts predicted poorer performance ($p < 0.01$). We re-tested a subset of the same animals (n=40-50) in later life (15–21 years). In the PL task, higher infant $CD8^+$ T cells and neutrophils predicted poorer late-life memory ($p < 0.05$), whereas infant lymphocytes were positively associated ($p < 0.04$), and glucocorticoids were negatively associated ($p < 0.05$) with VP performance. These findings indicate that early immune and endocrine profiles become biologically embedded, shaping cognitive function across life.

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Toward Comprehensive Catalogs of Volcanic Seismicity: Insights from Template-Matching, Machine Learning and Network Coherence at Mount Saint Helens Volcano

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***Abstract*:**

Resolving the structure and dynamics of magmatic systems in the lower crust remains particularly challenging due to limited observational constraints. Here, we compare advanced seismic detection methods using continuous data from the Mount St. Helens network during the 2008–2024 non-eruptive period. Starting from the Pacific Northwest Seismic Network VT catalog (4,088 events), a template-matching (TM) approach by Hirao et al. (2025) produced a high-resolution catalog containing 31,215 VT events and ~10,000 regional tectonic earthquakes. We evaluate this catalog against a machine-learning (ML) workflow using the VolPick model (Zhang et al., 2024), which yields over 100,000 robust detections after filtering, including VT, regional tectonic, and deep long-period (DLP) earthquakes. TM performs best during intense VT swarms by improving event tracking, whereas ML substantially enhances long-term catalog completeness by detecting earthquakes absent from the template database, particularly during quiescent periods. The ML approach identifies and locates 43 DLP events, nearly doubling the number in the original catalog. We are also testing CovSeisNet (CSN), a coherence-based method for automated DLP detection. CSN successfully recovers known DLP events, and ongoing work integrates TM, ML, and CSN to better characterize LP/DLP source processes and their implications for subsurface fluid and magma transport.

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Immunological and Safety Profile of CCL3 Therapy in Diabetic Wound: A Pre-Clinical Study

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***Keywords*: Diabetic Wound, CCL3, Immunological Safety, Toxicity, Wound Healing**

***Abstract*:**

Diabetic foot ulcers are a complication of diabetes, accounting for 60–75.5% of lower-extremity amputations and adding $9–12 billion annually to U.S. healthcare costs. Impaired neutrophil recruitment during injury compromises early infection control, rendering diabetic wounds vulnerable to infection and delayed healing. CCL3 (MIP-1α) is a chemokine that recruits immune cells and enhances innate immune defense. We previously demonstrated that topical CCL3 restores neutrophil function, reduces bacterial burden by ~99%, and accelerates wound healing in diabetic mice. However, its systemic safety profile under diabetic conditions remains unclear.

We conducted a 14-day toxicity study in diabetic (db/db) and normoglycemic (db/+) mice. Animals were randomized into four groups: db/+ + PBS, db/db + PBS, db/db + CCL3 (1 µg), and db/db + CCL3 (10 µg). Full-thickness dorsal wounds were created and treated with a single topical dose. Animals were monitored, and hematological, biochemical, and histopathological analyses were performed on day 14.

CCL3 treatment caused no mortality or adverse clinical effects. Hematological and biochemical parameters remained within normal ranges, and no additional organ injury was observed. Diabetic control mice exhibited hepatic and renal pathology, which was not exacerbated by CCL3. These findings demonstrate that topical CCL3 is well tolerated and supports further translational evaluation.

Funding Acknowledgements: *This work was supported by a NIH (R01DK135557-02) funding agency.*

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Mitochondrial respiratory complexes of Ustilago maydis

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***Keywords*:** Respiratory Complexes, Mitochondria, Fungi

***Abstract*:**

Respiring organisms commonly utilize a structurally and functionally conserved set of five mitochondrial respiratory protein complexes (CI to CV) that transfer electrons and pump protons to produce ATP. There are variations in higher-order assemblies (supercomplex), accessory subunits, and regulation. For example, fungal respiratory complexes are homologous to those of mammals, but unlike those of mammals, fungal respiratory complexes function in parallel with diverse branching respiratory pathways. It is unclear whether there are structural differences between obligate and non-obligate aerobic fungi. Available structures of fungal respiratory complexes are from a single clade (Ascomycota) out of nine total clades, and high-resolution structural information for supercomplexes is currently unavailable. Here, we present structures of the mitochondrial respiratory complexes in *Ustilago maydis,* an aerobic fungus in the Basidiomycota clade, all assembled into a supercomplex. We isolated functionally active respiratory complexes from *U. maydis* mitochondria and visualized them at near-atomic resolution using single-particle cryogenic electron microscopy (cryoEM). Our results help contextualize how variations in supercomplexes influence critical structural elements within complexes and may influence function. Our findings will provide additional insight into how higher-order assemblies are utilized to increase the functional plasticity of conserved mitochondrial respiratory complexes.

Funding acknowledgments:

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Beyond Equilibrium: Amorphous Precursor-Mediated Ti Uptake and Its Implications for TitaniQ Thermobarometry

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Keywords**:** Geothermometry, Nano-Geoscience, Titanium-in-Quartz

Abstract**:**

Titanium-in-quartz (TitaniQ) thermometry and barometry are widely applied to volcanic and plutonic systems, yet experimental calibrations differ in pressure sensitivity and in their treatment of TiO_2 activity ($aTiO_2$; Wark & Watson, 2006; Thomas et al., 2010; Huang & Audétat, 2012). Reported discrepancies are commonly attributed to pressure effects or $aTiO_2$ assumptions, but may also reflect differences in experimental design, including starting materials (silica glass vs. quartz seed) and Ti sources (rutile vs. anatase). We conducted piston-cylinder time-series experiments following established high-pressure quartz-growth approaches (Acosta et al., 2020), systematically varying run duration on silica glass and TiO_2. Focused ion beam (FIB) cross-sections and lift-outs were analyzed by transmission electron microscopy (TEM) to resolve nanoscale phase relations at quartz growth interfaces. Anatase-bearing experiments contain a distinct amorphous SiO_2–TiO_2 layer absent in Ti-free control experiments. This layer thickens from ~150 µm after 1 day to ~250 µm after 4 days and is interpreted as a migrating crystallization front capable of advecting Ti during quartz growth. Metastable, precursor-mediated Ti uptake provides a mechanistic explanation for inter-laboratory calibration variability and carries implications for TitaniQ thermometry calibration, Ti diffusion chronometry (Cherniak, 2007; Jollands et al., 2020), and interpretations of magmatic storage conditions.

Funding Acknowledgements*: UC Davis Startup Funds*

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AI and Kinetic Modeling of Thermal Death in Yellow Mealworm (*Tenebrio molitor*) Larvae

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***Abstract*:**

Insect farming for food and feed has grown rapidly; however, current processing conditions neither guarantee nor clearly describe humane practices during slaughter. Our study developed statistics-based kinetic and data-driven artificial intelligence (AI) models to describe thermal death of yellow mealworm (YML) subjected to hot air (HA) and hot water (HW) treatments. For HA treatments, AI boosting models (CatBoost, XGBoost, and LightGBM) were evaluated to assess how larval characteristics (mass, length, width, moisture content, and area-to-volume ratio) influence death time. For HW treatments, statistical (Normal and Weibull distributions) and kinetic (Sigmoidal) models were applied to predict larval survival probability under isothermal conditions (primary models), which were subsequently correlated with processing temperatures (secondary models) to estimate death kinetics under variable thermal conditions. Among the AI models, LightGBM showed the best performance (RMSE = 3.592, MAE = 2.581, R^2 = 0.924), with air temperature identified as the most influential feature. Sigmoidal models adequately described both Normal and Weibull survival distributions, although Normal distribution–based models showed more stable behavior in secondary modelling. Overall, this integrated framework provides a quantitative basis for selecting thermal processing conditions that ensure effective slaughter of YML while promoting welfare-oriented practices.

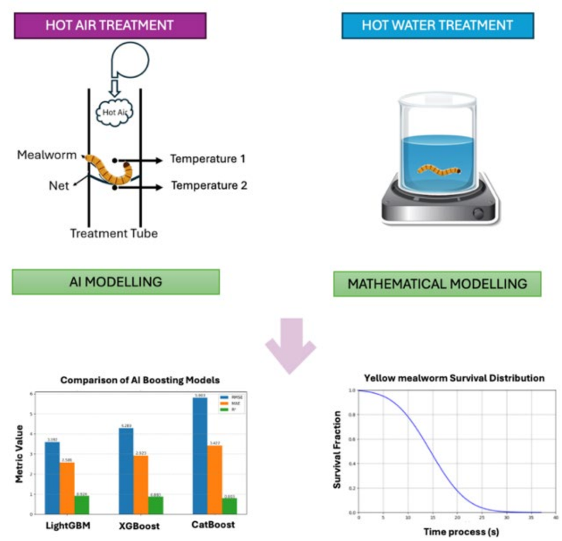

Figure. Overview of experimental and modelling workflow

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Interspecific competition in poison frog tadpoles

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***Keywords*:** Juvenile Aggression, Species Interaction, Automated Tracking Software

***Abstract*:**

Aggressive competition among juveniles is documented in many species and is especially fierce in poison frog tadpoles that compete for limited resources in temporary rearing pools. The size of these pools affects resource abundance and social environment, with bigger pools having more resources but also more competition and smaller pools having fewer resources but also less competition, potentially influencing the aggressive behavior of juveniles. To understand the evolution of juvenile competition we used two taxa of poison frogs - Dendrobates tinctorius found in bigger pools and Ranitomeya imitator found in smaller pools - to test if individuals behave differently in the presence of con- vs. hetero-specifics. We set up encounter experiments pairing tadpoles with individuals of their own or another species. We used automated tracking of video recordings to analyze the movement of each individual in the encounter. We found a species-specific difference in response to heterospecific individuals: while D. tinctorius shows increased movement in the presence of heterospecifics compared to conspecifics, R. imitator shows the reverse. This result suggests that tadpoles can distinguish between con- and hetero-specifics and may deploy different behavioral strategies depending on the species identity of their opponents (fight/flight vs freeze).

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Low-cost spark-induced breakdown spectroscopy for real-time characterization and source identification of toxic metals

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Keywords**:** Toxic Metal Aerosols, Real-Time Monitoring, Low-Cost Sensors

Abstract**:**

Real-time characterization of airborne toxic metals is crucial for air quality monitoring, particularly for environmental justice communities disproportionately impacted by Hazardous Air Pollutants. While conventional methods like X-Ray Fluorescence (XRF) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) offer high accuracy, their significant cost and operational complexity limit widespread deployment. To address this, we developed the Toxic-metal Aerosol Real-Time Analyzer (TARTA), a low-cost instrument based on Spark-Induced Breakdown Spectroscopy. This system has demonstrated Limits of Detection comparable to commercial XRF systems at approximately 1/80th of the price.

In this work, we present key hardware and software advancements to further improve the performance and portability of the system. Structurally, an air pulling system was integrated into the nozzle assembly to minimize particle loss and enhance particle collection efficiency. Furthermore, spectrometer exposure time was optimized to minimize background noise, enhancing the signal-to-noise ratio (SNR). On the software side, a source identification algorithm was implemented to enable real-time determination of pollution origins alongside elemental concentration. Additionally, the system transitioned to an onboard Raspberry Pi to simplify field operation. These improvements significantly enhance the robustness and portability of TARTA, providing an accessible tool for communities to rapidly identify and respond to hazardous emission events.

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Mathematical modeling of modern stromatolites

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Keywords**:** Modern Stromatolites, Biofilm, OpenFOAM, Microbial Plant Ecology

Abstract**:**

A laminated structure formed by photosynthetic microbial biofilms is called stromatolites. Ancient stromatolites, formed by oxygenic photosynthetic microbes, played a significant role in the oxygenation of Earth's atmosphere during the Great Oxidation Event. Modern stromatolites are still forming at the bottom of Antarctic lakes. The morphology of stromatolites depends on the environmental conditions of the medium. The present work is motivated by the microbial pinnacles of Lake Vanda, Antarctica. An attempt at mathematical modeling of stromatolite growth (pinnacle formation) under sunlight and nutrient limitations in flowing water has been carried out using OpenFOAM (a C++ based open source platform with finite volume methods). The formulation builds upon the biofilm growth model proposed by Guibert et al. (SoftwareX 29, 102011, 2025). The model includes biomass growth, biomass diffusion, nutrient transport, light attenuation, and the dynamics of living and dead biomass. Living and dead biomass are responsible for active and inactive growth regions within the biofilm, respectively. Currently, the model is under development and validation. The preliminary results resemble the growth and morphology of \textit{in situ} biofilms. In the present work, the effect of nutrient concentration on the growth rate and morphology of the pinnacles is investigated.

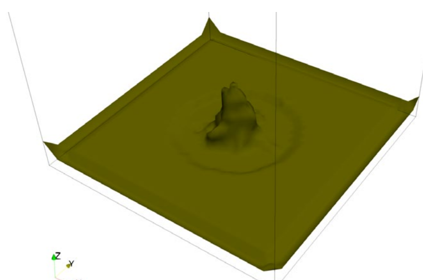

Fig. A sample result of pinnacle formation

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Understanding Drivers of Water Availability at the Local Level in California

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***Keywords*:** Water Availability and Shortage, Machine Learning, Water Management Factors, Hydroclimatic Factors

***Abstract*:**

Water availability at the local level in California depends not only on hydroclimatic factors but also on access to water infrastructure, water rights seniority, and other management and regulatory factors. Each irrigation district has varying water portfolios – such as deliveries from local, state, or federal water projects with different regulatory regimes – adding complexity to understanding water availability. Consequently, spatially proximate districts can experience vastly different water shortage impacts under similar climatic conditions. The roles of hydroclimatic and water management factors on local water availability in California are not well understood, limiting our ability to anticipate and manage vulnerability across California's agricultural regions. This study examines how hydroclimatic and water management factors influence water availability using a data-driven approach, highlighting the impact of management factors in shaping local water supply outcomes. We determine water availability at the irrigation district level as a function of different sources and collect data on factors such as precipitation and water rights seniority. We then use machine learning to link these factors to observed water availability patterns. This work aims to develop a tool to explain local water availability using external variables, informing decision-makers to mitigate water scarcity impacts and enhance resilience in California's agricultural sector.

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Question of Reduction: Percutaneous Reduction Improves Modified Radiographic Union Scores for Intercalary Femoral Fractures at 12 weeks

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***Keywords*: Femoral Shaft Fracture; Butterfly Fragment; Percutaneous Reduction; mRUST; Intramedullary Nailing

***Abstract*:**

Diaphyseal intercalary ("butterfly") fragments are common in comminuted femoral shaft fractures, yet the benefits of fragment reduction remains uncertain. We hypothesized that percutaneous intraoperative reduction would improve early radiographic healing. We retrospectively reviewed adults treated with intramedullary nailing for AO/OTA 32B femoral shaft fractures at a Level I trauma center.

Early healing was quantified using the Modified Radiographic Union Score at 12 weeks (mRUST-12). Demographics (age, sex, BMI) and operative variables (percutaneous reduction and adjunct fixation) were recorded, and postoperative anteroposterior radiographs were used to assess fragment displacement. Associations with mRUST-12 were tested using multivariable linear regression; displacement constructs were modeled separately because of collinearity. mRUST-12 was available for 47 patients (mean age 37.3±19.0 years; BMI 27.4±5.1). In a complete-case adjusted model (n=32), percutaneous reduction was independently associated with higher mRUST-12 (B=+1.62, 95% CI 0.28–2.96; $p=0.020$), while increasing age predicted lower scores (B=−0.039 per year; $p=0.026$). In adjusted displacement models (n=47), greater postoperative proximal and fragment displacement were associated with lower mRUST-12 ($p=0.009$ and $p=0.022$, respectively).

Complications were uncommon and did not differ by percutaneous use. Percutaneous reduction may enhance early union without increasing complications, but incomplete 12-week follow-up may introduce selection bias and warrants validation in larger cohorts.

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Dietary tribromoethanol supplementation reduces enteric methane emissions in beef cattle

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***Keywords*:** Cattle, Climate Change, Greenhouse Gas Emissions, Methane, Tribromoethanol

***Abstract*:**

The livestock industry is a significant contributor to global greenhouse gas emissions, with enteric methane (CH_4) from ruminants representing a major source. Feed additives that suppress methanogenesis offer a promising mitigation strategy if animal performance is maintained. This study evaluated the effects of 2,2,2-tribromoethanol (TBE) on enteric CH_4 emissions, dry matter intake (DMI), and average daily gain (ADG) in beef steers. Twenty-four Angus steers (477 ± 27 kg initial bodyweight) were assigned to one of three dietary treatments: control (0 mg TBE/kg DMI), low (15 mg TBE/kg DMI), or high (30 mg TBE/kg DMI), using a replicated 3 × 3 Latin square design with three 28-d periods. TBE was incorporated into a total mixed ration formulated to meet nutrient requirements. Enteric gas emissions were measured using a GreenFeed system during the final week of each period, while DMI and BW were recorded throughout. Supplementation with TBE significantly reduced ($P < 0.05$) CH_4 production by 15.6% and 32.2% for the low and high treatments, respectively. Methane yield and intensity were also reduced by up to 28.0% and 33.4%. No differences were observed in DMI or ADG among treatments ($P > 0.05$). These results indicate that TBE effectively reduces enteric CH_4 emissions without negatively affecting feed intake or growth performance in beef steers.

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Genomic diversity and host-specificity in Corynebacterium pseudotuberculosis using comparative population genomics

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Keywords**:** Host/Microbe Association, Machine Learning, Pangenome, Point Mutation, SNP

Abstract**:**

Corynebacterium pseudotuberculosis infects multiple livestock hosts, yet the genomic basis of host adaptation remains unclear. We analyzed 788 genomes from diverse hosts and geographic origins using pangenome reconstruction, core-genome phylogeny, SNP analyses, and machine learning. The species exhibits a largely conserved genome with a closed pangenome (core genome comprising 45.8% of loci) and limited gene gain or loss across lineages. Population structure reveals pronounced clonality within the two biovars, ovis and equi, with host-associated clustering consistent with biovar classification. The nitrate reduction and molybdenum cofactor biosynthesis operons consistently distinguish equi isolates. Virulence genes are broadly conserved, including universal presence of the phospholipase D gene (*pld*). Antimicrobial resistance determinants remain rare and sporadically distributed. Host-associated SNPs primarily occurred in genes linked to transport systems, transcriptional regulation, and key metabolic pathways. Functional enrichment highlights amino acid biosynthesis and transport processes, suggesting that host adaptation arises chiefly from allelic variation within a stable genomic backbone rather than from the acquisition of novel virulence factors. This evolutionary pattern likely contributes to long-term persistence in livestock populations and enhanced environmental resilience. These findings provide a comprehensive population genomic framework for understanding host specificity and evolutionary dynamics in this important livestock pathogen.

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Re-designing reservoir operations for a decarbonizing grid under climate change

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***Keywords*:** Energy Transitions, Climate Change, Decarbonization, Multi-objective Optimization

***Abstract*:**

Hydropower systems are increasingly exposed to two converging pressures: climate-driven changes in hydrology and the rapid integration of variable renewable energy (VRE) into electricity markets. Historically, reservoir operations were developed under assumptions of climatic stationarity and a primarily fossil-based grid, assumptions that no longer hold in today's evolving conditions. To maintain satisfactory performance of both the water and energy system, operating policies must adapt to ensure robustness across diverse climate and energy futures.

This work evaluates how alternative multi-objective reservoir operating policies perform under 2050 climate and energy system scenarios in the Columbia River Basin. Policies are assessed across key metrics-- hydropower generation, flood risk, system revenue, and fossil fuel displacement-- revealing which strategies generalize well under deeply uncertain conditions. Sensitivity analysis and scenario discovery methods are used to identify the climatic and energy drivers most critical to policy vulnerability and effectiveness.

The results show that robust policies improve tradeoffs by seasonally adjusting the use of inflow forecasts, reservoir storage, and energy market signals to better align hydropower operations with both hydrologic regimes and renewable energy variability. These insights support the development of resilient, transferable water-energy strategies for managing complex multi-objective systems in a decarbonizing grid.

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Trusting Machine Learning with Physics: A Fidelity Verification Framework for Complex Systems

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Keywords**:** Explainable Artificial Intelligence, Complex Systems, Ocean Circulation, Machine Learning

Abstract**:**

Neural networks are increasingly used to model complex physical systems, yet a fundamental question remains: has the model learned a faithful representation of the system, or is it merely pattern matching? This distinction is especially critical in high stakes forecasting, where unverified or nonphysical reasoning can lead to catastrophic failures, from medical diagnosis to extreme weather prediction.

We present a generalizable fidelity verification framework that probes *how* neural networks make predictions by linking their internal decision strategies to dynamical regimes and mechanistic indicators. The framework is demonstrated using an idealized two-box model of the Atlantic Meridional Overturning Circulation, a system characterized by hysteresis and sparsely sampled tipping points. We target regime prediction under both present-day conditions and climate-change-induced scenarios that lie far outside the training distribution.

Across a hierarchy of neural network architectures, including individual and ensemble models, we combine epistemic and aleatoric uncertainty with explainable artificial intelligence tools to distinguish physically meaningful learning from spurious correlations. This work provides a quantitative pathway for verifying model fidelity, supporting cautious optimism about data-driven modeling while emphasizing the necessity of interpretability and validation in complex systems.

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Utilizing biophysically accurate computational models of NaV1.2 to simulate mutations and therapeutics in neonatal and adult neurons and neuronal networks.

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***Keywords*:** SCN2A, Nav1.2, Sodium Channels, Computational Modeling, Neuronal Networks

***Abstract*:**

Dysfunction of *SCN2A*, the gene encoding $Na_V1.2$, is implicated in a spectrum of severe neurological disorders including infantile epileptic encephalopathies, autism spectrum disorder, and intellectual disability. The high number of unique *SCN2A* mutations renders the traditional approach of developing biological models for each variant unfeasible. Therefore, we leveraged *in silico* modeling to simulate a *SCN2A* mutations and drugs that would be prohibitive in a conventional laboratory setting. We utilized Hodgkin-Huxley equations to model channel kinetics for multiple *SCN2A* mutations, then integrated them into reconstructions of layer 5 pyramidal neurons with complex morphological features. To understand $Na_V1.2$ dysfunction at the system level, our neuron model was incorporated into a cortical column model with over 10,000 interconnected neurons and more than 30 million synapses to investigate network dynamics. Some $Na_V1.2$ mutations exhibit different properties in their neonatal versus adult isoforms. To address this, we constructed an immature neuron model to simulate a neuron undergoing early development. It features a smaller morphology with fewer dendritic branches and different distribution of ion channels compared to the adult neuron. Using our computational models, we aim to accurately predict disease states that can be altered using therapeutics personalized to each child's genetic diagnosis.

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Optimizing sample preparation for solving multiple respiratory supercomplex structures from Mung Bean (*Vigna radiata*)

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***Abstract*:**

The mitochondrial respiratory chain is critical for energy generation in diverse species. The electron transport chain in mitochondria contains four membrane bounded complexes, complex I, II, III and IV. These complexes form higher order structures of defined stoichiometry, for example supercomplex $I+III_2$, supercomplex III_2+IV, supercomplex $I+III_2+IV$ (a.k.a the respirasome) or the megacomplex I_2+III_2. Structures of the respirasome and megacomplex have been observed in mammals, algae, euglenozoa and ciliates. Though the respiratory chain organizations can vary across species, the relative positions of CI and $CIII_2$ within the supercomplexes are highly conserved. Although, biochemical data and low-resolution negative stain indicate that plants have respirasomes and megacomplexes, and larger supercomplexes are observed in algae, no high resolution structures are currently available for any plant supercomplex larger than $I+III_2$. By optimizing the sample preparation process, including extraction material, sucrose gradient and grid freezing condition, we are able to purify a mixture of intact respirasomes and megacomplexes. Data collection through single particle cryoEM gives reconstructions at near atomic resolution and reveals a previously unknow binding position for CIV within respiratory supercomplexes.

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