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ABSTRACT BOOK

ABSTRACTS

1. ORACLE: Oncogenic Reversion via Attractor-guided Computational Landscape Engineering

Aaryan Senthilvanan

Cancer therapy has traditionally focused on eliminating malignant cells through cytotoxic, targeted, or immune-based approaches. ORACLE, Oncogenic Reversion via Attractor-guided Computational Landscape Engineering, proposes an alternative paradigm in which cancer is treated as a reversible cellular state rather than an irreversible disease. Because cancer cells and healthy cells share the same genome but occupy different gene regulatory attractor states, ORACLE seeks to identify interventions that restore normal cellular identity rather than destroy cells. ORACLE integrates single-cell transcriptomic and epigenomic data with gene regulatory network inference, dynamical systems modeling, and AI-driven molecular design. The platform reconstructs cancer-specific regulatory networks, models cellular behavior as attractor landscapes, and identifies minimal transcription factor perturbations capable of driving transitions from malignant to healthy states. These predicted interventions are translated into candidate therapeutics through the design of Transcriptional Chemical Inducers of Proximity, a class of bifunctional molecules engineered to modulate transcription factor activity through targeted recruitment of epigenetic regulators. Applied to glioblastoma multiforme, ORACLE identified a co-dominant mesenchymal and neural progenitor cell attractor architecture and predicted that simultaneous modulation of multiple master regulators was necessary for effective state reversion. The system generated candidate molecules targeting these regulators and achieved substantial reductions in computational cancer state scores during in silico validation. By combining systems biology, single-cell analysis, artificial intelligence, and computational drug discovery within a unified framework, ORACLE demonstrates a scalable approach for precision oncology and highlights the potential of AI to generate mechanistically grounded therapeutic strategies for complex diseases.

2. AODD-01: Autonomous Orbital Debris Dismantler Humanoid Robot for Orbital Debris Dismantling and Resource Recovery & Space Industrial Ecology

Iftitah Ahtikiszi, Mikhail Hajrin

Active Debris Removal (ADR) has traditionally focused on deorbiting large objects via capture and re-entry, discarding valuable material resources. This paper presents AODD-01 (Autonomous Orbital Debris Dismantler Humanoid), a 1.85 m, 305 kg humanoid robot designed to dismantle orbital debris into sorted material fractions for in-space manufacturing. We adopt a systems engineering approach to define the concept of operations, derive measurable requirements, conduct trade-studies, and assess lifecycle risks. The architecture comprises a 43-DoF humanoid morphology, dexterous manipulation toolkit, multi-modal perception, and Level-4 autonomy. A hybrid validation approach combines Python/PyBullet system-level simulation with analytical models for physical interactions. Results show that a single AODD-01 unit can process up to 8,000 kg of debris per year, recovering 87.3% of metallic dry mass as reusable feedstock. We discuss critical challenges including fragmentation control, legal ownership, and residual propellant handling through a formal risk register. We conclude that humanoid-form dismantler robots are technically feasible with near-term technologies and represent a paradigm shift from debris removal to resource recovery.

3. Metabolomics-Guided Precision Nutrition: A Sustainable Strategy for Reducing the Global Burden of Non-Communicable Diseases

Christiana Kolapo, Victor Kolapo

Non-communicable diseases (NCDs), including cardiovascular diseases, type 2 diabetes, obesity, and cancers, are major causes of global mortality and are strongly influenced by dietary and lifestyle factors. Even with established public health nutrition guidelines, there are still limitations to generalized dietary recommendations in providing solutions to individual differences in metabolic responses. In order to address this and improve disease prevention and health outcomes, metabolomics-guided precision nutrition is vital. This review explores the role of metabolomics-guided precision nutrition in addressing the global burden of NCDs. Metabolomics provides an in-depth analysis of small-molecule metabolites in biological systems, offering insights into diet-metabolism interactions and disease-related metabolic changes. Current evidence suggests that metabolomic biomarkers can improve understanding of individual dietary responses and support early

detection of metabolic dysfunction linked to obesity, type 2 diabetes, and cardiovascular diseases. Nevertheless, its application in public health and the clinical world has been limited due to insufficient population-specific data, especially in low- and middle-income countries, high costs, and a lack of standardized analytical frameworks. To address these challenges, this paper proposes a Metabolomics-Guided Precision Nutrition (MPN) framework comprising metabolic profiling, personalized dietary interventions, continuous monitoring, and policy integration. This framework aims to bridge advanced metabolic science with practical nutrition strategies. In conclusion, metabolomics-guided precision nutrition represents a transformative shift from generalized dietary guidelines to individualized interventions, with strong potential to reduce the global burden of non-communicable diseases.

4. Harnessing the Anti-oxidant Activity of Selected Natural-Product-based Molecules as a Strategy for Assessment of Inhibition of Hyaluronidase: Viable Options for Reducing Inflammation Phase in Chronic Burn Injury

Rusham Paul Chowdhury, Jyoti Senapati, Kazi Ahmed

Hyaluronidases are endoglucanases that break down hyaluronic acid (HA) into oligosaccharides and disaccharides by cleaving the β-1,4-glycosidic bond between N-Acetylglucosamine and glucuronic acid residue. The healing of a wound is a multi-stage process with several physiological processes related to the extracellular matrix (ECM). As part of the inflammatory response, several dermal enzymes are expressed that break down the components of the ECM. This then perpetuates the inflammatory cascade and delays downstream events, thereby increasing the risk of bacterial penetration and other comorbidities. In the present project, we wanted to use both computational and experimental techniques to evaluate some selected natural products and determine the possibility of reducing inflammation and inhibiting hyaluronidase as potential therapeutic agents for burn-induced inflammation. Selected molecules from the National Cancer Institute's Developmental Therapeutics Program (NCI-DTP) database were screened using integrated toxicity, pharmacological, and pharmacokinetic selection criteria, followed by molecular docking and molecular dynamics simulations. The computational analysis showed that the presented models were structurally stable and revealed the favourable protein–ligand interactions. Quercetin showed strong binding affinity and a favourable interaction pattern. Experimental validation revealed that quercetin exhibited significant hyaluronidase inhibition and strong antioxidant activity in the DPPH and FRAP assays, whereas marrubiin showed comparatively moderate activity in the same assays, consistent with the computational results. In conclusion, the computational and experimental results presented in this study suggest that quercetin is a promising natural hyaluronidase inhibitor that can be used to treat burn-related inflammation and maintain the integrity of the extracellular matrix.

5. The role of technology in increasing awareness of gender based violence among students in Kenya Methodist University

Ashley Kamau

Background: Gender-based violence (GBV) remains a serious public health and human rights concern in Kenyan universities, where stigma and silence undermine student safety despite strong legal protections. Widespread student technology use offers an underexplored avenue for GBV awareness and prevention. This study investigated the role of technology in increasing GBV awareness among Kenya Methodist University (KeMU) students by assessing existing awareness levels, evaluating the effectiveness of digital platforms and AI-driven tools in disseminating GBV information, and identifying barriers students face in accessing such information through technology. Methodology: A quantitative cross-sectional descriptive design was employed among KeMU undergraduate and postgraduate students with access to digital devices. Using the Yamane formula, a minimum sample of 573 was required; convenience sampling yielded 591 valid respondents from 601 collected responses. A structured questionnaire with Likert-scale, multiple-choice, and yes/no items was administered online. Data were cleaned, coded, and analyzed using descriptive statistics—frequencies, percentages, means, and medians—under approved ethical procedures. Results: Overall, 96.1% of students had heard of GBV, yet only 58.2% knew where to seek help. Digital platforms were rated effective by 80.9% of respondents (mean 4.02), and 98.9% used smartphones daily. Major barriers included fear of stigma (82.5%), confidentiality concerns (81.4%), and limited internet access (72.3%); only 55.8% were willing to use AI-based reporting tools. Conclusion: Technology substantially enhances GBV awareness among KeMU students,

although persistent structural, social, and trust-related barriers continue to constrain its full potential and reach.

6. From Correlation to Causation: Causal Feature Discovery Framework for Early Chronic Kidney Disease Detection

Jorge Creiann Jarme

Machine learning models for Chronic Kidney Disease (CKD) often prioritize predictive accuracy but rarely distinguish between correlation and causation. This study proposes a causal machine learning framework with explainable prediction that aims to identify clinically meaningful biomarkers for early CKD detection. Causal relationships learned from publicly available clinical data are compared with traditional feature selection methods before training multiple machine learning classifiers and selecting the best-performing one. By emphasizing causal feature discovery rather than predictive performance alone, this work aims to produce models that are both accurate and clinically interpretable, contributing toward more trustworthy AI for healthcare.

7. From Forests to Servers: Mapping the Environmental Footprint of AI Infrastructure Expansion

John Clarenz Medija

The rapid expansion of artificial intelligence (AI) infrastructure is increasing demand for data centers and associated digital facilities, yet the spatial environmental implications of this expansion remain insufficiently characterized. This study examines whether regional variation in AI infrastructure expansion intensity is associated with subsequent tree-cover change across selected metropolitan regions. A comparative geographic information system (GIS)-based framework was developed by integrating an AI Infrastructure Expansion Index (AIEI) with Hansen Global Forest Change data across nine study regions. Tree cover was defined using a ≥30% canopy-cover threshold for the 2000 baseline, while tree-cover loss from 2001 to 2025 was identified only where loss occurred within qualifying baseline areas. Absolute qualifying loss and loss as a percentage of the 2000 qualifying baseline were used to characterize environmental change, while Pearson and Spearman correlation analyses were employed as exploratory measures of linear and monotonic associations between infrastructure intensity and tree-cover outcomes. The results demonstrate substantial cross-regional variation in both AI infrastructure intensity and qualifying tree-cover change. Regions with higher AIEI values did not consistently exhibit greater proportional tree-cover loss, while regions with comparatively lower infrastructure intensity also displayed varying levels of baseline-normalized loss. The exploratory correlation results provide no sufficient evidence of a statistically significant relationship between AIEI and the examined tree-cover measures within the study sample. These findings suggest that regional AI infrastructure expansion intensity alone does not adequately explain observed variation in qualifying tree-cover change and that landscape characteristics and broader land-use processes may play important contextual roles. The study contributes a reproducible spatial framework for examining the land-cover dimension of AI infrastructure expansion and demonstrates the value of integrating infrastructure indicators with remotely sensed environmental baselines. The findings provide a basis for more spatially contextual approaches to sustainable data-center planning and future research on the environmental implications of AI infrastructure.

8. The Non-Hispanic Caribbean American Experience with Internalized Racism: A Phenomenological Investigation

Shalini Ramchune

Since the beginning of civilization, a societal racial hierarchy has been present, deeming dark-skinned people inferior to light-skinned people. This preliminary research prompts the need for a study to identify whether parents influence the development of their child's internalized racism. This study, therefore, examined internalized racism in adolescents of a scientifically neglected racial group: non-Hispanic Caribbean Americans. Using the transcendental phenomenological method and thematic analysis, the lived experiences of six participants aged 15–18 from the chosen racial group were analyzed. The results revealed three phenomenological themes: External Environment, Familial Influence, and Emotional Impact. Most participants expressed that their parents do not enforce a racial hierarchy but rather foster confidence and self-love

regarding their appearance. The implications of this study include sparking further research on American and gender influences and the adoption of these findings by adolescents, mental health professionals, and parents.

9. The Effect of Plant-Based Secondary Metabolites Derived from Chinese Medicine as an Efflux Pump Inhibitor to Minimize Antibiotic Resistance of Efflux Pumps in E. coli

Alicia Lin

Antimicrobial resistance is a growing global health crisis, with many bacterial strains developing resistance to multiple antibiotics. Consequently, novel antibacterial strategies are urgently needed. One promising approach involves inhibiting bacterial efflux pumps, membrane proteins that actively expel antibiotics and contribute to drug resistance. This study investigated whether plant-derived secondary metabolites used in Traditional Chinese Medicine could function as efflux pump inhibitors (EPIs) in *Escherichia coli*. Three candidate EPIs—Honeysuckle, St. John's Wort, and Huang Qi—were tested at five concentrations. Ampicillin served as the antibiotic control, while sodium malonate, a known EPI, was used as the positive control. The primary investigation employed a lawn-and-blotting assay to evaluate the individual and synergistic effects of the plant extracts by measuring zones of inhibition. Plates were imaged every 24 hours over a 72-hour period. Linear regression was used to assess trends across time and treatment groups. To further evaluate efflux pump activity, an ethidium bromide (EtBr) fluorescence assay was performed. Because functional efflux pumps export EtBr, reduced fluorescence indicates decreased efflux activity and greater inhibition. Data from the primary assay were analyzed using ANOVA and t-tests, while Tukey's Honest Significant Difference (HSD) test was applied to the EtBr assay. Overall, combinations of plant extracts demonstrated greater antibacterial activity than individual treatments, suggesting synergistic effects. Four treatment groups exhibited strong positive correlations, supporting the potential of Traditional Chinese Medicine-derived compounds as efflux pump inhibitors and highlighting their promise as adjunctive therapies to combat antibiotic resistance.

10. The Correlation Between Pesticides and Cancer

Mya Pop

Cancer is the leading cause of death in Salinas, California, an agricultural center constantly exposed to pesticides. This paper explores the historical development, modern use of pesticides and their connection to an increased cancer risk today. Research shows a correlation between pesticide exposure, specifically different chemical ingredients in pesticides, and many different types of cancers, like non-Hodgkin lymphoma, leukemia, and colon cancer, that all have dose-response relationships that show that a higher and prolonged exposure to pesticides increases the risk of cancer. Limitations in the research include a lack of regional/demographic specifications, as well as uncertainty about specific pesticides and their direct effects. Nonetheless, the evidence shows a correlation between pesticide exposure and cancer. The paper advocates for safer, sustainable alternatives such as Integrated Pest Management (IPM), biosolarization, and using microbial pesticides and parasitic insects. It emphasizes the need to prioritize community and individual health over economic profit.

11. Modeling Dark Matter Density Profiles in Spiral Galaxies Using Mass Decomposition and Symbolic Regression

Minal Matai

Studies of galactic rotation curves provide key evidence for dark matter, yet accurately modeling its distribution and influence on galactic dynamics remains a challenge. This study explores the dark matter density profiles of three spiral galaxies (NGC 3198, NGC 2403, and NGC 4559) using rotation curve data from the Spitzer Photometry and Accurate Rotation Curves (SPARC) Galaxy Database. Mass decomposition modeling was used to separate the contributions of visible and dark matter to each galaxy's rotation curve. The resulting parameters were used to calculate orbital velocities and density distributions. These were illustrated through one-dimensional radial profiles and two-dimensional contour maps, visualizing the transition radius at which dark matter becomes dominant over visible matter. Additionally, mathematical models of the observed rotation curves and the dark matter halo contributions were derived with symbolic regression to analyze functions without predefined assumptions. Results confirm that visible matter alone cannot make up for the observed rotation curves and that dark matter starts to dominate at larger radii. The calculated density profiles are comprised of downward trends which are consistent with the presence of extended dark matter halos. Symbolic regression revealed recurring terms, such as $\sqrt{r}$, across multiple spiral galaxies. The recurrence of this term

across multiple spiral galaxies suggests a common mathematical structure within current halo models and prompts further investigation. These findings support the central role of dark matter in galactic dynamics while underlining both the potential and limitations of using symbolic regression as a tool for astrophysical modeling.

12. Factors contributing to a career choice abroad among Rwandan students in Poland

Faucal Marie Providence Idufashe

Background: Increasing numbers of Rwandan students are pursuing higher education in Poland, drawn by the quality of academic programs. However, a significant proportion remain abroad or move to nearby countries after graduation. This study investigates the factors influencing career choices abroad among Rwandan students in Poland. Methods: A cross-sectional, observational, survey-based study was conducted targeting the Rwandan community in Poland. Data were collected via an online survey over two months (July–September 2022), with 219 respondents completing the survey. Statistical analyses were performed using SPSS. Results: The prevalence of migration intention among Rwandan students in Poland was 79.91%. Among socio-demographic factors, only religion showed a statistically significant association with the intention to remain abroad. Other factors-age, residence, education, and marital status were not significant. Key socio-economic factors influencing career choice included perceived connection to co-workers, organizational culture, and respect within the workplace. Income level did not significantly affect the decision. Conclusion: A high proportion of Rwandan students expressed intentions to pursue careers abroad, motivated by professional opportunities and a welcoming cultural environment. Further research using in-depth interviews is recommended to explore these factors more comprehensively.

13. Algorithmic Diplomacy: The Role of Artificial Intelligence in Shaping 21st Century Foreign Policy Decisions

Rabi Ul awal

This study explores the transformative role of artificial intelligence (AI) in reshaping foreign policy decision-making in the 21st century, conceptualized here as “algorithmic diplomacy.” As global politics becomes data-driven, AI technologies are being integrated into diplomatic practices to enhance strategic forecasting, risk assessment and real-time policy responses. This research investigates how AI systems ranging from machine learning algorithms to natural language processing tools are influencing the formulation and evaluation of foreign policy decisions across diverse geopolitical contexts. The paper adopts an interdisciplinary approach, drawing on international relations theory and computational governance to examine the implications of AI adoption in diplomacy. It analyzes how algorithmic tools process vast datasets, including social media discourse and security intelligence, to generate predictive insights that inform state behavior. While these technologies promise increased efficiency and speed in decision-making, the study also highlights risks such as algorithmic bias, opacity (black-box systems), over-reliance on automated recommendations. Furthermore, the research evaluates the strategic advantages gained by technologically advanced states, potentially widening the power asymmetry between nations and redefining global diplomatic hierarchies. It also explores the emergence of “digital diplomacy” and AI-assisted negotiation frameworks, where simulations and scenario modeling influence diplomatic strategies and conflict resolution processes. By combining theoretical analysis with contemporary case studies, this paper argues that AI is not tool but an active agent in shaping foreign policy paradigms. The study concludes by proposing a framework for responsible AI governance in international relations, emphasizing transparency and multilateral cooperation for algorithmic diplomacy which contributes to global stability.

14. Divergent Hydration Kinetics: Type-Aware Artificial Intelligence Framework for Compressive Strength Prediction and Sustainability Evaluation in Concrete Composites

Talal Malik

Artificial Intelligence (AI) has shown considerable promise in predicting the compressive strength of concrete. However, most existing data-driven approaches assume homogeneous material behavior and overlook the compositional differences between conventional and sustainable concrete. This study investigates the feasibility of developing a material-aware machine learning framework capable of predicting compressive strength while accounting for the intrinsic properties governing the behavior of different concrete types. Concrete datasets were preprocessed to identify parameters with statistically significant correlations to compressive strength.

Feature engineering was employed to introduce a novel **type** attribute distinguishing conventional and sustainable concrete, while sustainability-related variables were modeled separately for sustainability assessment. Analysis of the datasets revealed an anomalous relationship between age and compressive strength: conventional concrete exhibited the expected positive correlation, whereas sustainable concrete demonstrated a contrasting negative correlation. This divergence suggests differing hydration kinetics arising from the incorporation of Supplementary Cementitious Materials (SCMs) and their influence on Calcium Silicate Hydrate (C-S-H) gel formation. Linear Regression (LR) and Random Forest (RF) models were trained and evaluated using R^2, MAE, and MSE. The RF model substantially outperformed the linear baseline, achieving an R^2 of 0.993 compared with 0.831 for LR, confirming the predominantly non-linear nature of predictor-target interactions. The resulting models were integrated into graphical user interfaces for compressive strength prediction and sustainability assessment. Collectively, the findings demonstrate that incorporating material classification into AI-driven concrete modeling improves predictive performance while providing a practical framework for sustainable construction analysis and engineering decision-making.

15. Characterizing Genetic Factors in the Efficacy of Drug Combinations for Metastatic Breast Cancer

Verina Samir

Metastatic breast cancer impacts 20-30% of breast cancer patients and results in cancer spreading beyond its original tumor. It spreads from the breast to the lungs, liver, heart, etc. This tumor will spread to create more tumors within the blood, once it reaches this stage, it becomes much harder to treat because doctors have to target cancer in multiple areas of the body instead of just one. Metastasis means when cancer cells leave the original tumor and spread to other parts of the body through the blood or lymph system, which makes the cancer much more serious. Drug combinations such as Adavosertib with chemotherapy or PARP inhibitors (targeting WEE1) and Everolimus targeting mTOR have been used to treat metastatic breast cancer; however, there is a need for new therapies and new targets. To address this need, drug synergy data and known drug-gene interactions were sourced from SYNERGYxDB and DGIDB for multiple metastatic breast cancer cell lines. These datasets were analyzed using Python to pinpoint combinations with consistent efficacy. By relating these effective combinations to their corresponding gene targets, we identified that drugs targeting the genes WEE1 and MTOR were particularly effective in reducing cancer cell growth and improving treatment response. These genes are involved in the key process to how cancer cells survive and replicate, through DNA damage control and the cell cycle control. Our findings provide insights into potential therapeutic strategies for metastatic breast cancer and may inform the rational design of combination regimens for improved patient outcomes.

16. A Continuous-Time Finite-Island Model with Sex-Differentiated Migration and Distinct Island Populations for the Gene Flow Analysis of X-linked Recessive Diseases

Christ Ian Navarro, Matthew Jerome Arciaga, Khaila Nicole Marquez, Anne Scena Nicolas, Rhianne Aira Paz, Guiller Jobert Suarez

Disorders arising from genetic mutations remain a significant public health challenge, as many lack definitive cures and diagnostic testing is often prohibitively expensive for the general population. X-linked recessive (XLR) diseases pose a unique epidemiological threat: their recessive nature allows them to remain phenotypically silent, facilitating unwitting transmission by asymptomatic carriers. Mathematical modeling offers a powerful tool to understand the mechanisms by which these genetic diseases proliferate. Developments in mathematical and population genetics can provide critical insights into the spread of XLR diseases in partially isolated populations, such as geographically distinct municipalities. In this study, through the use of vectors and matrices, we enhanced a recent model to account for migration, the reduced reproductive ability of affected individuals, and sporadic mutations that can cause healthy couples to have affected offspring. Using asymptotic analysis, we then assessed how these variables affect the growth and decay of the infected population. We further applied this mathematical framework to the ongoing XDP epidemic in the Philippines, tracking the disease's transmission networks across neighboring municipalities to better understand its regional dynamics and generate predictive insights into the outbreak.

17. Functional Brain Connectivity During Naturalistic Movie Watching and Cognitive Flexibility in Early Childhood

Renata Ziganova

Executive functions develop rapidly in early childhood and are supported by distributed brain networks, but the neural basis of cognitive flexibility during naturalistic activity is not well understood. I examined whole-brain functional connectivity during movie watching in 64 typically developing preschoolers (mean age 4.83 ± 0.81 years) from OpenNeuro (ds000228), using the Harvard–Oxford atlas and splitting participants by DCCS performance. Between-group differences were tested with independent-samples t-tests (FDR correction); PCA, graph-theoretical metrics, and Random Forest regression were also applied. Group-average connectivity was broadly similar across DCCS groups; several connections were nominally significant before correction but none survived FDR, and global graph measures showed no group differences. The Random Forest poorly predicted DCCS scores, with age the strongest predictor. These results suggest whole-brain connectivity during movie viewing does not explain individual differences in cognitive flexibility here, and age-related maturation may be more influential; larger, network-specific studies are warranted.

18. Can national vaccination coverage forecast measles activity? A longitudinal ecological study of 33 Latin American and Caribbean countries, 2011–2025

Matias Sandoval Mancilla

Background. National measles-containing vaccine coverage is used to assess vulnerability, yet transmission depends on subnational immunity gaps, importation, and circulation. We tested whether national coverage can identify Latin American and Caribbean countries reporting measles in the following year. Methods. A longitudinal ecological study linked WHO/UNICEF first-dose measles-containing vaccine (MCV1) coverage estimates with WHO-reported measles cases for 33 countries, 2010–2025. Vaccination debt was defined as the three-year shortfall below 95% MCV1 coverage. The outcome was any measles case in the next year. We estimated year-adjusted logistic associations with country-clustered uncertainty. Early-warning performance was evaluated using leave-one-country-out validation, area under the receiver operating characteristic curve (AUC), Brier score, and bootstrap. Models using calendar year, vaccination debt, prior-year measles activity, or both were compared. Rolling-origin validation tested 2018–2025. Results. Among 483 country-years, 75 were followed by measles. Vaccination debt was not associated with next-year activity (odds ratio per 10 percentage-point-years, 1.01; 95% CI, 0.83–1.23). In the validation set (472 country-years; 73 events), the debt model showed weak discrimination (AUC, 0.60; 95% CI, 0.55–0.67) and did not improve the Brier score over calendar year (0.132 vs. 0.129). Prior-year activity performed better (AUC, 0.70; 95% CI, 0.64–0.75; Brier, 0.115). Temporal validation produced the same ranking. Conclusions. We did not detect an association between three-year MCV1 debt and next-year measles activity, and out-of-sample discrimination was weak. Vaccination's importance remains; early-warning assessment should integrate transmission, subnational immunity, importation pressure, and surveillance quality.

19. Children Left Behind? Pediatric Eligibility and Geographic Access in Antibody-Mediated Neuroinflammatory Trials: A Registry-Based Cross-Sectional Study

Matias Sandoval Mancilla, Karime Melgarejo Acuña

Background. Children with autoimmune encephalitis (AE), myelin oligodendrocyte glycoprotein antibody-associated disease (MOGAD), and neuromyelitis optica spectrum disorder (NMOSD) often receive evidence extrapolated from adults. We quantified pediatric eligibility and geographic access in therapeutic trials. Methods. This registry-based cross-sectional study analyzed ClinicalTrials.gov records downloaded July 29, 2026. We screened interventional trial-disease records with starts during 2016–2026 and included protocols evaluating immune-directed treatment, disease modification, or acute-attack rescue. Two age thresholds were assessed: younger than 18 years and younger than 12 years. Unique trial identifiers were used for global and geographic estimates; disease-specific analyses retained trial-disease pairs. Wilson 95% confidence intervals (CIs) quantified uncertainty. Results. Among 316 query-result records, 141 trial-disease pairs underwent curation; 98 pairs representing 91 unique trials were included. Eighteen trials permitted participants younger than 18 years (19.8%; 95% CI, 12.9–29.1), and six permitted children younger than 12 years (6.6%; 95% CI, 3.1–13.6). Pediatric eligibility occurred in 10/24 AE, 2/7 MOGAD, and 6/67 NMOSD trial-disease pairs; no MOGAD trial permitted children younger than 12 years. Of 76 trials reporting site countries, six included Latin

America or the Caribbean (7.9%), and two included Mexico (2.6%). Sensitivity estimates for eligibility younger than 18 years ranged from 17.0% to 20.9%. Conclusions. Four of five registered therapeutic protocols excluded all minors, with the largest gap in NMOSD. Registered eligibility does not establish enrollment or treatment access; however, these findings identify design and geographic gaps requiring pediatric protocols and broader regional participation.

20. AN AD5941-BASED MICRONEEDLE WEARABLE ELECTROCHEMICAL PLATFORM FOR CONTINUOUS MULTI-BIOMARKER MONITORING AND IMPEDANCE-GUIDED SENSITIVITY CALIBRATION IN SIMULATED INTERSTITIAL FLUID

Fabio Farias Saavedra, Leonardo Espinoza Machuca

The poor long-term reliability of electrochemical interfaces limits the clinical usefulness of continuous multi-biomarker monitoring, a significant global health issue considering that 1.3 billion diabetes mellitus patients are expected globally in 2050. Enzymatic biosensors lose sensitivity over time due to factors like biofouling and coating degradation, compromising the reliability of the data they generate. Recent multiplexed microneedle arrays have targeted glucose, lactate, and alcohol, while impedance-driven recalibration has so far been demonstrated only for single-analyte glucose sensing on benchtop instrumentation. However, MiskiGlux integrates both capabilities on the same wearable front-end: rather than treating drift as an external, reference-based correction, it models the microneedle–fluid interface through a Randles-type equivalent circuit. MiskiGlux is an AD5941-based wearable microneedle electrochemical platform for continuous multi-biomarker sensing in interstitial fluid. The platform integrates a minimally invasive microneedle set used as electrodes for chronoamperometric enzymatic sensing and periodic electrochemical impedance spectroscopy (EIS) diagnosis within a compact, low-power analog integrated circuit. Periodic EIS measurements will extract values associated with solution charge-transfer resistance, electrode-electrolyte interface double-layer capacitance, and low-frequency transport behavior, which together elucidates biofouling and mass-transport limitations at each electrode. These descriptors will train a Random Forest regression model to estimate time-dependent changes in sensor sensitivity and derive impedance-guided calibration factors per analyte channel. The platform will be validated in simulated interstitial fluid under controlled biomarker concentrations and induced fouling/degradation conditions, comparing uncorrected and impedance-corrected responses over repeated sensing cycles. This framework positions electrochemical impedance as an embedded calibration signal for adaptive, reliability-aware, multi-analyte metabolic monitoring.

21. Characterizing Acetylene's Behavior in Interstellar Ice Analogs

Rhianne Mae Tabayoyong, Julia Santos

Stars form when clouds of gas and dust collapse under gravity, creating a protostar surrounded by a disk from which planets can form. Acetylene (C_2H_2) may be a key building block for complex organics in planet-forming disks, but gas-phase chemistry cannot explain the amounts observed, pointing to icy dust grains as the source. C_2H_2 has no dipole moment and cannot be detected at submillimeter wavelengths, but it can be identified through infrared absorption using telescopes such as JWST. Limited lab data on C_2H_2's infrared signature in interstellar ices make its presence hard to confirm or rule out. Using a cryogenic ultra-high vacuum chamber, we grew ice analogues of pure C_2H_2 and C_2H_2 mixed with H_2O, CO, and CO_2, then monitored their infrared spectra and desorption via mass spectrometry as the ices warmed from 15 K to 200 K. C_2H_2's spectral signature and desorption behavior depend strongly on the surrounding ice matrix. H_2O produces the largest effect on peak shape and desorption temperature through hydrogen bonding, CO has an intermediate effect, and CO_2 has the least effect, yielding the sharpest peaks among diluted mixtures. In water ice, the fraction of C_2H_2 trapped past its sublimation temperature depends on the H_2O:C_2H_2 ratio rather than total ice thickness, leveling off once enough H_2O is present. These reference spectra will help interpret C_2H_2 detections in JWST ice data and estimate its release temperature near young stars, informing whether icy C_2H_2 accounts for the mismatch between observed gas-phase organic chemistry and current formation models.

22. UV Photodestruction of Ethylamine in Astrophysical Ice Environments

Addison Snyder, Michelle Brann

Ethylamine, a small organic molecule detected in astrophysical environments, has a structure that suggests potential biological relevance, as an amine group is present. The photostability of such an organic molecule

when exposed to cosmic rays or UV photons on an icy dust grain during planet formation determines whether it will be present within protoplanetary disks and planetesimals after system development. We conduct experiments to analyze the ultraviolet (UV) photodestruction of ethylamine ices formed in a low pressure, low temperature ultra-high vacuum chamber. Specifically, we examine pure ethylamine at various layers and temperatures, as well as within matrices mixed with common interstellar molecules (CO, CO2, H2O). Each experiment, ethylamine is dosed as a gas to form ice layers and then irradiated with a 160nm UV lamp, accompanied by infrared spectra scans. We find that ethylamine is easily destroyed by UV photons. Most significantly, the decay curves for many experiments display two separate destruction rates, suggesting that there is a second process occurring after the initial breakdown of ethylamine. Increasing the amount of pure ice layers at 15K and the experimental temperature of 50-layer ices causes the difference between the initial and second decay rate to decrease, as the initial breakdown is taking place so quickly, only the second, slower, process is observable. Depositing ethylamine in a mixture, however, increases the amount of decay observed after UV exposure. We can use the results of these experiments to determine whether ethylamine could be present in protoplanetary disks and nascent planets.

23. Training the Adaptable Brain: A Self-Directed Exploration of Neuroplasticity

Patient Irinatwe

My interest in neuroplasticity began through everyday observations. During high school, I noticed that my chemistry teacher could write with both hands, while one of my classmates could play songs on the guitar simply by hearing them. These experiences made me wonder how the brain develops different abilities through learning and practice. This curiosity inspired me to investigate whether consistent self-directed training could produce observable changes associated with neuroplasticity. This research explored three main areas: bilateral motor training, targeted cognitive activities, and auditory processing. Over several months, I carried out structured daily practice involving non-dominant hand writing, Braille reading and writing, Sudoku, mathematical problem-solving, drawing, and flute practice. I documented my progress through personal observations and simple performance measures, while comparing my experiences with established neuroscience literature. Throughout the project, I observed gradual improvements in motor coordination, handwriting control, Braille proficiency, logical reasoning, problem-solving speed, drawing confidence, and musical ability. The research also highlighted the importance of consistency, focused attention, appropriate rest, and persistence, as challenges such as muscle fatigue, pain, and discouragement were encountered during training. Although this investigation involved only a small number of participants and relied on behavioral observations rather than direct neurological measurements, the findings were consistent with current scientific understanding of neuroplasticity. This project strengthened my understanding that meaningful learning occurs through sustained practice and curiosity, while demonstrating how independent research can encourage further scientific investigation into the remarkable adaptability of the human brain.

24. Gas-phase Transport Limitations and Activated-Carbon Filtration in Enclosed FDM printing chambers

Johnson Che

Desktop fused deposition modeling (FDM) 3D printers are increasingly used in homes, schools, and laboratories, but high-temperature materials such as ABS can release volatile organic compounds (VOCs) that accumulate inside enclosed spaces. Activated-carbon filters are commonly used to reduce these emissions, yet many filtration designs focus primarily on carbon quantity while giving less attention to how contaminated air moves through the chamber and reaches the carbon bed. This project investigates whether gas-phase transport is an important limiting factor in VOC mitigation during enclosed extrusion. The objective of this study was to determine whether active chamber recirculation reduces VOC sensor response at matched activated-carbon mass. ABS filament was extruded in a sealed acrylic chamber under conditions with varying carbon masses and circulation activity. VOC levels were measured using two SGP41 sensors placed at different chamber locations, with additional gas resistance and temperature recordings as secondary measurements. The findings show that active recirculation produced substantial VOC reductions even when carbon mass was held constant. At both 30 g and 60 g carbon, active recirculation lowered endpoint response, cumulative response, and differences between sensor locations. In particular, 30 g carbon with active recirculation performed similarly to or better than 60 g carbon under passive circulation, suggesting that airflow and chamber mixing can be as important as

sorbent quantity under these conditions. Overall, this study supports the interpretation that enclosed-printer VOC filtration is not only capacity-limited, but also transport-limited, and that airflow structure should be considered in future emission-control designs.

25. Saliency-Guided Augmented Data Framework has Potential to Improve Equitable Thyroid Cancer Diagnosis for Black and Hispanic Patients, Uninsured Individuals, Lower-Income Populations, and People Living in Rural Areas

Avi Stone

Across the United States, Black and Hispanic patients, uninsured individuals, lower-income populations, and people living in rural areas are disproportionately affected by delays in thyroid cancer diagnosis. With early detection, five-year survival rates exceed 99% but fall to 50-71% once metastasized. Thyroid nodules occur in up to 68% of adults with malignancy rates of 10%. Diagnosis relies on time-intensive ultrasound interpretation by radiologists using the American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS), creating challenges for early diagnosis in medically underserved populations. Research shows that AI can expedite diagnosis, but convolutional neural network (CNN)-based thyroid cancer detection is restricted by limited high-quality datasets to train CNNs. Today, traditional augmentation and GAN-generated synthetic data are used to improve training in research settings. This study presents a novel Saliency-Guided Augmented Data Framework (SGAD-F) using model-derived saliency maps to guide augmented image generation for CNN training which preserves diagnostically meaningful regions throughout the augmentation process. CNNs trained while using SGAD-F outperformed ACR TI-RADS across all recorded performance metrics and exceeded other CNNs trained using existing data generation methods in the most clinically important metrics, including accuracy, sensitivity, NPV, and LR-. These SGAD-F-guided CNNs introduce the possibility of efficient thyroid cancer diagnosis in underserved populations. Further, SGAD-F could aid in the diagnosis of rarer conditions by expanding limited datasets with high-quality data for CNN training. CNNs trained with SGAD-F-guided data may allow for earlier thyroid cancer diagnosis in populations who currently face disproportionate barriers to timely diagnosis.

26. Do the Clinical Signs of Canine Acute Pancreatitis Vary by Region? A Meta-Analytic Test

Aiden Bai

The clinical signs of canine acute pancreatitis (CAP) are reported at widely varying rates across the veterinary literature. Whether this reflects true regional differences in presentation or inconsistency in how signs are defined has not been directly tested. I ran a two-stage random-effects meta-analysis of five published CAP case series (Pápa, Han, Fabrès, Chawanlawuthi, Berman) from Asian and European settings, estimating the prevalence of five clinical signs and case fatality using the Freeman–Tukey double-arcsine transformation and REML estimation in R (metafor). Pooled prevalence was highest for vomiting (78.1%, 95% CI 63.4–89.9) and anorexia (62.0%, 42.3–79.9), with case fatality 29.9% (15.7–46.3); between-study heterogeneity was extreme (I^2 up to 98%). Three signs were then tested for a regional (Europe versus Asia) moderator effect with Bonferroni correction. Only lethargy showed an association surviving correction ($p=0.0002$, $R^2=88.8\%$), but its European arm rests on a single cohort, so region reflects study-specific differences in ascertainment that cannot be disentangled from the comparison; diarrhea did not survive ($p=0.034$). For abdominal pain—the only sign with a balanced two-versus-two study split—region explained essentially none of the heterogeneity ($p=0.574$, $R^2\approx0\%$), though with three to four studies per model these estimates are underpowered and cannot exclude a regional effect. These results provide no reliable evidence that geography drives the reported variation in CAP signs. Regardless of the cause, the extent of unexplained heterogeneity argues for standardized clinical-sign definitions in future CAP research.

27. Attachment Insecurity and Well-Being in Dementia Spousal Caregivers: The Moderating Role of Marital Satisfaction

Vincent Lai, Daniel Argueta, Kelly Brice, Bryan Denny, Charles Green, Luis Medina, Jensine Paoletti-Hatcher, Paul Schulz, Jennifer Stinson, E. Lydia Wu-Chung, Cobi Heijnen, Christopher Fagundes

Caregivers for spouses with Alzheimer's disease and related dementias (AD/ADRD) who exhibit insecure attachment orientations (i.e., anxiety and/or avoidance) may be at risk for poor physical and mental health. Marital satisfaction, or caregivers' evaluations of their spousal relationships, may buffer this risk. A

cross-sectional sample of 264 AD/ADRD spousal caregivers completed self-report measures of adult attachment, marital satisfaction, and depressive symptoms, and provided blood samples. Cytokine production by in vitro lipopolysaccharide (LPS)-stimulated peripheral blood leukocytes, including interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), IL-1β, and IL-10, were measured and combined to form a composite index of systemic inflammation. We conducted multiple regression models to assess the associations between adult attachment orientation, marital satisfaction, and outcomes of depressive symptoms and LPS-stimulated inflammatory cytokine production. Greater attachment avoidance was associated with more depressive symptoms and higher LPS-stimulated cytokine production, and these associations were weaker at higher levels of marital satisfaction. Greater attachment anxiety was associated with more depressive symptoms, and unexpectedly, this association was stronger at higher levels of marital satisfaction. Marital satisfaction did not moderate the association between attachment anxiety and LPS-stimulated cytokine production. Our work contributes to the body of research examining psychosocial factors that shape well-being among caregivers. These findings may inform future interventions that focus on the marital relationship to improve caregiver well-being. These interventions may benefit avoidantly attached caregivers, but anxiously attached caregivers may benefit most from approaches tailored to their specific attachment orientation.

28. Acute Physiological and Psychological Responses to a Culturally Adapted Bharatanatyam-Based Exercise Intervention in Older Indian Adults: A Pilot Comparative Study

Aditi Trivedi, Shriya Nagammanavar, and Niharikha Vimal

Falls contribute to loss of independence among older adults. Conventional fall-prevention programs often struggle to maintain long-term engagement, particularly in culturally diverse populations. Bharatanatyam, a classical Indian dance form, incorporates weight shifts, meditation, and coordination that support balance while increasing cultural relevance. This pilot study evaluated whether a Bharatanatyam-inspired movement program integrating mobility exercises could serve as an engaging and effective alternative to traditional exercise among older Indian adults. Eight older adults from the Leander, Texas, area participated in three structured 30-minute sessions of a Bharatanatyam-inspired program and a traditional program. Participants completed PANAS mood, perceived well-being, enjoyment, likelihood to return, and Borg RPE exertion scales. Heart rate was measured using smartwatches, and a Talk Test was administered immediately after each session. The Bharatanatyam-inspired exercise fostered stronger emotional well-being (4.78/5 vs. 4.17/5) and a high likelihood to return (4.78/5 vs. 4.83/5), suggesting deeper engagement through rhythm and cultural familiarity. Exertion levels varied between programs, with the cultural movement sessions showing a smaller heart-rate change (77.5 → 76.9 BPM) and lower perceived exertion (≈4.8), while the generic exercise demonstrated a greater heart-rate reduction (75 → 72.7 BPM) and higher perceived exertion (≈8.75). Despite its gentler intensity, the cultural movement program still promoted sustained cardiovascular activation. Both programs improved mood and engagement. The cultural movement emphasized emotional and social benefits, while the generic exercise emphasized physical challenge. Larger studies are needed to confirm long-term effects on fall risk.

29. Understanding Behavioral Transitions in Hydra through Graph Theory

Linda Liu, Christophe Dupré, Florian Engert

Hydra, a genus of small freshwater cnidarians, possesses a simple anatomy and is among the earliest organisms to develop a nervous system. The functions of this nervous system are limited, with most related to movement. One such movement is its capacity to transition between sessile and nomadic states in a motion referred to as “somersaulting,” in which the organism anchors its tentacles to a substrate, lifts its foot, and repositions it. Somersaulting reflects the organism’s ability to respond to external stimuli in a decentralized nervous system. In an effort to form a deeper understanding of the ability of decentralized nervous systems to respond to their environment, graph theory and a continuous-time semi-Markov process were used to model the postural transitions. We identified key behavioral states, tracked transitions between these states across video data, and differentiated successful and failed movement attempts. Our preliminary model captures state transitions with high probability and offers insights into the mechanisms underlying Hydra locomotion. Notably, successful locomotion requires extended length, and failed somersaults may occur at any length but tend to cluster in time

around successful ones. Additionally, environmental factors were introduced and hydra were found to be partial to visual light stimuli when hungry.

30. Microfluidic Tumor-on-a-Chip Technology in Lung Cancer Therapeutics

Chloe Lee, Hew Yue Mock, Yu Ern Leow

Lung cancer currently stands as the leading cause of cancer-related mortality worldwide. With diverse molecular subtypes, lung cancer presents challenges in therapeutic development as each tumor exhibits distinct biomechanical and biochemical characteristics. Unfortunately, most conventional preclinical models—two-dimensional (2D) monolayer cell cultures and three-dimensional (3D) models, such as multicellular spheroids and patient-derived organoids (PDOs)—fail to fully replicate the highly complex physiological characteristics of lung tumors. To bridge this gap, bioengineered microfluidic Tumor-on-a-Chip (TOC) and Organ-on-a-Chip (OOC) systems have advanced cancer research by encapsulating 3D cell constructs within micro-machined devices. Microfluidic chips integrate perfusion as well as nutrient and oxygen gradients to closely mimic native pulmonary architecture and the complex tumor microenvironment (TME). By recreating these pivotal physiological features of lung tumors, scientists are able to study hypoxic and acidic regions of the solid tumors that can reduce the efficacy of targeted therapy and chemotherapy. Hence, utilizing microfluidic platforms for lung cancer modeling provides a more clinically relevant environment to investigate drug penetration and therapeutic response. Our research project investigates how microfluidic technology is integrated into modern oncology in preclinical drug screening for lung cancer. It evaluates how these platforms facilitate the investigation of drug efficacy and resistance, and improve the prediction of therapeutic responses compared with conventional in vitro models. Ultimately, this project evaluates how these innovations have accelerated preclinical evaluations and drug development processes, and explores their potential to advance future clinical trials and precision oncology.

31. Computational Complexity of Optimization Problems via Random Spin Hamiltonians

Kasirga Hamidi, Alex Kamenev

Optimization problems lie at the heart of computer science, physics, finance, and many other critically important fields. However, many such problems are computationally infeasible, being NP-hard. We study the energy landscape of 3D Ising spin glass models with random couplings to understand how landscape structure affects the performance of classical algorithms in finding true ground states. Using exact enumeration for small system sizes (N) and Monte Carlo sampling for larger ones, we analyze ground state energies, rare-event statistics, and energy level distributions as the number of spins increases. We find that the sampled average ground state energy deviates from the true ground state energy with increasing system size and scales with a $\exp(b/\sqrt{N})$, a and b being constants. Furthermore, data show that the 3D Ising spin glass rapidly becomes harder to sample as the system size increases, and deep minima are both rare and scarcely degenerate, corresponding to exponentially hard-to-find events, as indicated by the relationship between local minima and degeneracy around them. Additionally, energy level spacings show Poisson statistics, indicating uncorrelated random spectra. Overall, these results demonstrate that the structure of the energy landscape is what makes the optimization problems hard for classical algorithms.

32. Ethics-by-Design in Health Data Engineering for AI-Driven Healthcare Systems

Francisca Mbanwusi

Artificial intelligence is redefining the role of health data within contemporary healthcare systems. Rather than serving solely as a repository of clinical information, health data now functions as foundational infrastructure that enables clinical decision support, predictive analytics, population health surveillance, and digital health innovation. Consequently, the quality, governance, and engineering of health data have become critical determinants of the safety, reliability, and trustworthiness of AI-enabled healthcare. Despite growing attention to responsible AI, scholarly and policy discourse remains disproportionately focused on algorithmic performance and model governance, often overlooking the ethical challenges embedded within the engineering of health data itself. This paper argues that ethical AI is fundamentally dependent on ethical data engineering. It advances a conceptual framework that embeds ethical principles across the health data lifecycle, encompassing data acquisition, stewardship, interoperability, quality assurance, privacy protection, bias mitigation, transparency, and governance. The paper contends that these considerations should be treated as core

engineering requirements rather than downstream ethical safeguards. By positioning ethics as an integral component of health data engineering, this perspective shifts the focus of responsible AI from algorithm-centred accountability to infrastructure-centred responsibility. The proposed framework provides a foundation for designing AI-driven healthcare systems that are technically robust, ethically defensible, and capable of supporting equitable and trustworthy digital health ecosystems.

33. Diagnostic Accuracy of Serum MicroRNA-155 as a Non-Invasive Biomarker for Early-Stage Non-Small Cell Lung Cancer: A Meta-Analysis

Nitya Gaddamanugu

Non-small cell lung cancer (NSCLC) accounts for approximately 85% of all lung cancer cases worldwide and remains the leading cause of cancer-related mortality due to late-stage diagnosis (Hou et al., 2016). When detected at Stage I, the 5-year survival rate reaches nearly 80%, whereas advanced-stage detection drops survival outcomes below 15–20% (Hou et al., 2016). Low-dose computed tomography (LDCT) is the current screening standard; however, it suffers from high false-positive rates and limited accessibility (Li et al., 2024). Circulating microRNAs, specifically serum MicroRNA-155 (miR-155-5p), have emerged as promising non-invasive epigenetic biomarkers owing to their high biostability in blood serum and early dysregulation during oncogenesis (Hou et al., 2016; Li et al., 2024). To systematically evaluate the diagnostic accuracy of serum miR-155 as a non-invasive liquid biopsy biomarker for discriminating early-stage NSCLC (Stages I–II) from healthy controls and benign lung lesions, synthesizing pooled sensitivity, specificity, and area under the summary receiver operating characteristic curve (SROC-AUC). Serum miR-155 represents a highly accurate, minimally invasive biomarker capable of detecting early-stage NSCLC. Integrating serum miR-155 testing into routine clinical screening protocols could significantly improve early detection rates, facilitate prompt surgical intervention, and reduce lung cancer mortality. Future research should focus on standardized RT-qPCR normalization controls and large-scale, prospective multi-center clinical trials to validate multi-miRNA diagnostic panels for clinical application.

34. Preventing Mosquito Puncture and Saliva Transmission: Evaluation of Novel Topical Barriers using Oncopeltus fasciatus Model

Yana Dewan

The purpose of this experiment is to test the effectiveness of topical defenses against the puncture and saliva transfer of mosquitoes, by using *Oncopeltus fasciatus* as a model. Mosquitoes are vectors for human diseases that cause millions of deaths annually by transmitting pathogenic saliva. The main defense against them is chemical repellents, which are inefficient, environmentally harmful, and expensive for most where mosquito populations are greatest. If a gel containing virgin coconut oil (VCO), hydrolyzed keratin (HK), and bentonite clay (B) is used, then the number of skin punctures and saliva transmission will be the lowest. Formulas VCO+B, VCO+HK, and VCO+B+HK were applied to artificial skin containing bromothymol blue, a pH indicator. Then it was exposed to an O. fasciatus for 10 minutes. No topical gel was the control. The number of punctum and whether saliva transfer occurred was recorded. The results affirmed that the VCO+B+HK barrier allowed for 0 milkweed bug punctures and no saliva transmission, the least out of all barriers. The control produced the highest number of punctures and saliva transfer, followed by the VCO+HK gel, then the VCO+B. The t-tests and chi-squares conducted showcases that the data was largely statistically significant. The results supported the research hypothesis. This was likely due to the combination of the semi-occlusiveness and fatty acid composition of virgin coconut oil, the low-permeability and thickness of calcium bentonite clay, and hydrolyzed keratin's ability to fill microscopic gaps, forming a cohesive and structurally sound barrier.

35. The Effect of Varying Urea 46-0-0 Concentrations on the Growth of Chlorella vulgaris

Yana Dewan

The purpose of this experiment was to determine the influence of varying Urea 46-0-0 concentrations on the growth of *Chlorella vulgaris*. Urea is globally utilized as a nitrogen fertilizer in pesticides and insecticides, making it easily susceptible to agricultural runoff. Because it thrives on nitrogen, *Chlorella vulgaris* is both dangerous as an algal bloom and crucial industrially. The algae were placed in a medium of mineral water and 2 concentrations of Urea: 25% and 59%. No Urea was utilized as the control. The *Chlorella vulgaris* was situated in indirect sunlight for 10 days; their growth was then measured with a SpectroVis in absorbance units. It was

hypothesized that the algae treated with 25% Urea concentration would produce the greatest growth. The results affirmed that *Chlorella vulgaris* treated with a 25% concentration grew, on average, 0.042 AU greater than the 59% concentration and 0.053 AU greater than the control. The algal growth under 59% was less than the 25% but still greater than the control. The t-tests conducted showcased the data was statistically significant. The results supported the research hypothesis. This is likely because the nitrogen content in the 25% concentration inflated lipid production and accelerated photosynthesis within the *Chlorella vulgaris*, producing exponential growth. However, the 59% concentration likely had too much nitrogen and ammonia in its compound, causing it to become toxic to the algae instead and ultimately eliminate it. Further studies should investigate the optimum amount of Urea 46-0-0 for algae growth and how other chemical fertilizers influence it.

36. Implantable Targeted Neuro-Delivery System: A Novel and Non-Invasive Treatment for Multiple Sclerosis

KaLong Chan, Francine Guevara, Emmanuel Brown

Multiple Sclerosis (MS) is a chronic autoimmune inflammatory disease of the central nervous system. Despite roughly 3 million people worldwide being affected by this neurological disorder, there is currently no permanent treatment in mainstream healthcare. Multiple Sclerosis is characterized by immune-mediated responses that result in demyelination, as well as long-term neurodegeneration, which further translates into MS progression. Conventional treatments, including disease-modifying therapies (DMTs) and corticosteroid injections, have been effective in reducing inflammation and relapses. However, they were not engineered to reverse pre-existing neurological damage prior to diagnosis, which leaves disease progression largely unaddressed. The major constraint of these treatments stems from the inability to cross the blood-brain barrier to target specific cellular mechanisms underlying disease progression. Recent research has shifted from relapse-focused treatments to targeted biological interventions and molecular mechanisms that contribute to chronic inflammation. In response to these shortcomings, our group proposes an Implantable Targeted Neuro-Delivery System, a bioengineered delivery platform that bypasses the blood-brain barrier and releases therapeutic agents into the cerebrospinal fluid (CSF) in a regulated manner. The device enables controlled dispersion of therapeutic agents through dual-implanted catheters, with one connected to the lumbar region and another at the mid-upper thoracic region. This modality, coupled with natural CSF pulsatile flow, allows the two infusion sites to spread and overlap, creating more uniform drug coverage. The device delivers BTK inhibitors and regenerative agents to target chronic inflammation and promote remyelination. This therapeutic modality targets cellular mechanisms underlying MS and establishes the foundation for future reversible treatments.

37. The Role of Gut Microbiota Dysbiosis in the Development of Mood Disorders and Neurodevelopmental Conditions

Shivani Chalichama

The gut microbiome has emerged as an important regulator of both physiological and neurological health as a result of its bidirectional communication with the central nervous system via the gut–brain axis. Increasing evidence suggests that disruptions in the composition of the gut microbiota, known as microbiota dysbiosis, contribute to the development of mood disorders and neurodevelopmental conditions. This review examines current research on the relationship between microbiota dysbiosis and disorders including major depressive disorder and autism spectrum disorder. It explores how early-life environmental influences, such as birth method, infant feeding practices, antibiotic exposure, and stress, shape the gut microbiome and increase vulnerability to dysbiosis. The biological mechanisms linking gut dysbiosis to altered brain function, including immune activation, microbial metabolite production, inflammatory signaling, and vagus nerve communication, are discussed to explain how microbial imbalance affects neurological and behavioral outcomes. Evidence from both animal models and human studies demonstrates associations between reduced microbial diversity, increased inflammation, and disease-specific behavioral and physiological changes. Finally, emerging therapeutic approaches, including probiotics, dietary interventions, and microbiome-targeted therapies, are evaluated for their potential to restore microbial balance and improve mental health outcomes. Additionally, current findings highlight the gut microbiome as an important contributor to neurological and psychological health and support continued research into microbiome-based strategies for the prevention and treatment of mood disorders and neurodevelopmental conditions.

38. Investigating the Effects of Engineered Plasmid Systems on VHL-Mediated Molecular Glue Interactions

Marvel Hanna, Alex Bendel, Nicolas Thomä

Approximately 85% of disease-causing proteins are considered "undruggable" by conventional small molecules, limiting treatment options for many cancers and other diseases. Molecular glues address this challenge by promoting interactions between proteins that do not naturally bind, enabling targeted protein degradation. This study investigated whether engineered plasmid systems and the GluePCA platform could be used to identify novel molecular glue-mediated protein interactions involving both the Von Hippel–Lindau (VHL) E3 ligase and Cyclophilin A (CYPA). We hypothesized that computationally predicted target proteins could be experimentally validated as molecular glue-dependent binding partners. Engineered plasmid constructs were generated for predicted target proteins and evaluated using GluePCA. Positive controls produced reproducible compound-dependent interaction signals, validating the experimental platform. Initial VHL studies established a reliable workflow for constructing and testing candidate targets. The same strategy was then applied to the CYPA platform using computationally predicted binding partners. Although several CYPA candidates were successfully cloned and screened, the predicted interactions could not be independently validated. These findings establish a reproducible workflow for engineering and evaluating candidate molecular glue targets while emphasizing the importance of rigorous experimental validation in molecular glue discovery. The validated screening platform provides a foundation for future studies aimed at expanding the molecular glue target space and improving computational approaches for identifying therapeutically relevant protein interactions.